COMMUNITY MEDICINE

with Recent Advances

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Third Edition

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Dedicated to

The Revered Memory
of Public Health Stalwarts,
My Parents
and
Teachers

Preface to the Third Edition

It is indeed a great pleasure with professional satisfaction to bring forth this third edition of *Community Medicine with Recent Advances* with an exclusive cover page reminding some of the great stalwarts, who have contributed to public health in terms of lives that can be saved. This edition, coming after a gap of four years of second edition, is a major transition as the book is growing along with the field.

As per the title, the edition encompasses many recent advances. To mention a few, electronic waste management, telemedicine, National Programme for Control of Diabetes, Cardiovascular Diseases and Epidemiology of Stroke, National Programme for Control of Occupational Diseases, Tobacco and Health, National Tobacco Control Programme, National Urban Health Mission, Adolescent Reproductive and Sexual Health, Global Eradication of Measles, Public Health Standards for Primary and Community Health Centers, International Health Regulations and many others.

The edition retains the basic organization of the second edition with the contents being modified and reshuffled. There is an upgradation of some of the chapters like nutritional requirements, categorization of TB patients under RNTCP, new WHO growth standards, Phase III of National AIDS Control Organization, Anti-retroviral Therapy, postexposure prophylaxis against HIV, integrated counseling and treatment center, etc.

Some of the topics are rewritten such as adolescent health, influenza, National Mental Health Programme, health problems of the aged, TB and HIV, treatment of MDR-TB/XDR-TB and others. Many diagrams and color photographs have been incorporated.

New information which have been added are immunization schedule, Indian diabetic score, glucose memory test, nuchal translucency scan, adverse events following immunization, etc. All this was possible as a result of the feedback that I was fortunate enough to receive from my colleagues from various parts of the country in the intervening period of my time.

I recognize, any work of this scope will contain mistakes and omissions. I intend to continue my practice of incorporating such corrections into subsequent editions.

My sincere thanks to Dr Indira Murali of Christian Medical College, Kochi, Kerala, India, who had enough patience to provide a big list of suggestions for the improvement.

I also thank sincerely Mr Venugopal, Branch Manager, M/s Jaypee Brothers Medical Publishers, Bengaluru, Karnataka, India, for the great care bestowed in publishing the book.

My special thanks to Shri Jitendar P Vij (Group Chairman), Mr Ankit Vij (Managing Director), Mr Tarun Duneja (Director-Publishing) and Mr KK Raman (Production Manager) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, who were successful in getting the book displayed as a reference book in international libraries of UK and US.

I also thank Dr BA Varadaraja Rao, Professor and Head, SS Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India, for his excellent cooperation in writing the book.

Finally, I thank Mr Sanjeev GP Kumar, Gundal Compu-Center, Davangere, Karnataka, India, for his valuable help in preparing the manuscript.

AH Suryakantha

Preface to the First Edition

The publication of this book is the end result of teaching community medicine to undergraduate and postgraduate students for more than three decades. Though the book is written primarily for undergraduates, it would also be useful for postgraduate students of community medicine. Considering an ever-increasing demand for a comprehensive book on community medicine, an attempt has been made to make the book, student-friendly, teacher-friendly, examiner-friendly and doctor-friendly.

The book is student-friendly because it is written in an understandable way, covering the entire syllabus prescribed by Medical Council of India (MCI), including the recent advances. The matter is presented in such a way as to avoid confusion and to make the reading of the book a pleasurable experience. Topics like biostatistics would encourage the students to take up the research activities. The lucid language of the book would facilitate quick revision.

The book is teacher-friendly because they may appreciate the presentation of the subject matter exhaustively and clearly, having tentacles attached to various other branches of medicine such as obstetrics, pediatrics, dermatology, psychiatry and general medicine, in order to conform to the changing profile of community medicine.

The book is examiner-friendly because it covers the vast areas of the subject to enable asking questions vertically, horizontally and tangentially.

The book is doctor-friendly because it would help the general practitioners and the rural medical officers in providing not only curative services, but also preventive and promotive services to the community at large, motivating them to a healthier, and happier life.

In spite of sincere attempt to make the book a comprehensive one, there may be some gaps, imperfections and mistakes. Readers are requested to give the feedback in the form of remarks and suggestions, which will be accepted sportively for the improvement of next edition.

I sincerely thank Mrs Jyothi and staff members of Zen Computers for their excellent typing work and helpful services.

I would like to express my appreciation of the patient forbearance borne by my wife Smt Usha during the entire period of preparation.

Lastly, I am grateful to Mr Venugopal, Branch Manager, Bengaluru, Karnataka, India and the entire team of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for making my dream a reality.

AH Suryakantha

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SECTION 1

Basic Concepts of Community Medicine

- Introduction to Community Medicine
- Concept of Health
- Concept of Disease
- Concept of Prevention

CHAPTER 1

Introduction to Community Medicine

Community medicine is that branch of medicine, which deals with the study of provision of preventive, promotive, curative, rehabilitative and evaluative services to the community at large, through an organized comprehensive health care delivery system.

The goal is to identify the health problems and needs of the defined population (community diagnosis) and to provide the comprehensive health care (preventive, promotive, curative and rehabilitative services) in an organized manner followed by the evaluation of the services.

The term community medicine is only a new terminology. It is the successor of the terms hygiene, preventive medicine, social medicine and public heath.

HYGIENE

This word is derived from Greek word 'Hygiea', the Goddess of Health. Her disciples were called hygienists, who practiced hygiene for health. Hygiea is represented as a beautiful woman, holding in her hand a bowl from which a serpent is drinking. In Geek mythology, the serpent testifies the art of healing, which symbol is retained even today. During ancient days, due to lack of knowledge about disease causation and spread, hygiene and cleanliness was the only option for the promotion of health and prevention of disease. Hygiene is defined as 'the Science of health and embraces all factors contributing to healthful living'. Hygiene continued to be in prominence until further knowledge about disease causation was acquired.

Later, when 'Germ theory of disease causation' came to light, in 1840, the term, 'Public Health' came into general use, directed towards the maintenance and improvement of the health of the people. In 1920, Professor Winslow defined public health as 'the science and art of preventing the disease, prolonging life and promoting health and efficiency through organized community efforts, such as control of communicable disease, sanitation, health education, etc. so as to enable every citizen to realize his birth-right of health and longevity'. Thus, the importance of preventing the disease was highlighted. The interventions were applied to healthy persons so as to prolong life. Thus, the scope was broadened.

The discoveries in microbiology in the turn of 18th century became a turning point in the etiological concept of disease. Possibility of disease prevention first came to focus when James Lind, while traveling in a ship in 1748 conclusively showed that scurvy can be prevented by the use of fresh citrus fruits. Cellen reported that he himself drank milk inundate with mercury to prevent syphilis. But the major thrust came with the discovery of small-pox vaccine by Edward Jenner. Thus, the concept of preventive medicine was developed as a branch of medicine distinct from public health, based on etiology, applied to 'healthy' people for the control of infectious disease in the community.

PREVENTIVE MEDICINE

Leavell and Clark defined preventive medicine as 'the science and art of preventing the disease, prolonging life and promoting physical and mental health and efficiency'.

Thus, the scope of preventive medicine was broadened from the general measures of health promotion (i.e. Hygiene) to specific measures of disease prevention by immunization,

including both. Thus, the term preventive medicine is regarded as synonymous with public health.

SOCIAL MEDICINE

This term was first used by Jules Gurein, a French physician in 1848. However, it was during 1911, Alfred Grotjahn of Berlin who stressed that social factors play a dominant role in health and disease.

Social medicine is defined as, 'The study of man as a social being in his total environment' (Physical, biological and social environment). Thus, social medicine became an extension of preventive medicine.

Social medicine achieved academic respectability in England, when John Ryle was appointed as the first Professor of social medicine at Oxford University in 1943, and Professor Crew at Edinburgh. This subject consists of the following components:

Social anatomy, social physiology, social pathology and social therapy.

Social Anatomy

Just like human anatomy, deals with the structures of the body, so also social anatomy deals with the structure of the society, which consists of total population, their age and sex-wise distribution, socioeconomic classification, types of housing, occupation, industries, temples, schools, etc. The study of social anatomy gives a background information in understanding health and disease phenomena in the community.

Social Physiology

Just like human physiology deals with the functions of the body, so also social physiology deals with the functions of the society. The various aspects of human physiology and the corresponding aspects of social physiology are shown in **Table 1.1**.

Table 1.1 The various aspects of human physiology and social physiology

Human physiology	Social physiology
Respiration	Air, ventilation, housing
Digestion	Nutrition and health
Excretion	Disposal of refuse, sewage excreta, dead-bodies, etc.
Reproduction	Family welfare services
Growth	Demography and population dynamics
Coordination	Customs, habits, traditions, beliefs, cultural practices, etc.

Social Pathology

Just like human pathology, deals with the study of abnormal structure of the body organs, the social pathology also deals with the study of defects in the society such as strikes, lock-outs, theft, murder, robbery, sexual assault, juvenile delinquency, etc. and just like the extent of pathology is studied by postmortem studies so also the extent of social pathology in the community is studied by social post-mortem, which consists of morbidity and mortality (disease and death) surveys. Such surveys also help us to understand the social factors responsible for the prevalence of the disease in the community (explained under 'Sociology').

Social Therapy

Just like medical therapy (treatment) consists of administration of drugs, so also social therapy consists of adoption of social and political actions in the community. Social action consists of giving health education to the community, launching immunization program improvement of sanitation, etc. so that the people become health conscious, vaccine conscious, latrine conscious, water conscious, etc. Political action consists of implementation of certain legal measures for the health, safety and welfare of the people. Examples for heath legislations are Medical Termination of Pregnancy-Act (MTP-Act); Prevention of food Adulteration Act (PFA-Act); Employees' State Insurance Act (ESI-Act); Indian Factories Act (IFA), etc.

COMMUNITY DIAGNOSIS

This consists of identification and quantification of health problems, in terms of morbidity and mortality rates (disease and death rates) and their influencing factors in a community. This helps to prioritise the health problems and implement control measures. On the other hand, when a diagnosis is made in an individual by the doctor based on signs and symptoms, it is called 'clinical diagnosis'. The differences between clinical diagnosis and community diagnosis are shown in **Table 1.2**.

Community and Hospital Medicine

There are two areas of work for the physician, viz. community medicine and hospital medicine. The differences are given in **Table 1.3**.

Table 1.2 Differences between clinical diagnosis and community diagnosis

Clinical diagnosis	Community diagnosis
Made by the doctor (Physician)	Made by the epidemiologist
Concerned with individual case	Concerned with a defined population
Concerned with only sick people	Concerned with both sick and healthy people
Doctor examines the patient	Epidemiologist conducts surveys
It is arrived at based on signs and symptoms	It is arrived at based on natural history of disease
It involves laboratory investigations	It involves epidemiological investigations
Doctor decides the treatment	Epidemiologist decides the plan of action
Treatment is the main aim	Prevention and promotion is the main aim.
It involves follow-up of case	It involves the evaluation of program
Doctor is interested in technological advances	Epidemiologist is interested in statistical values

Table 1.3 Differences between community medicine and hospital medicine

Features	Community medicine	Hospital medicine
Service area	Provides health care to the people of defined geographic area	Draws patients from ill-defined catchment area
Operational strategy	Both active and passive operational strategies are applied, i.e. both providers and consumers are on the move	Only passive operational strategy is applied, i.e. responsibility lies on the patient to come to hospital for treatment
Organizational framework	Consists of community health centers, primary health centers and subcenters	Consists of a loose conglomeration of primary, secondary and tertiary care hospitals.
Nature of care	It is comprehensive (i.e. preventive, promotive, curative and rehabilitative)	Only curative care, leading to freedom from illness
Intersectoral coordination	Exits between the health department and the health related departments	Virtually no intersectoral coordination exists
Program participation	Promotes active participation in the operation of National health programs	Has limited scope in the participation of National health programs
Cost-benefit analysis	Gives high cost-benefit ratios by involving minimum expenditure and yielding maximum results	Gives poor cost-benefit ratios by involving maximum expenditure and yielding minimum benefits

With the emergence of noncommunicable disease such as hypertension, diabetes, cancer, accidents, etc. and due to their multifactorial etiology, the concept of 'multifactorial disease causation' came into vogue. So, measures like early diagnosis, identification of risk-factors, limiting the development of disability and rehabilitation of handicapped persons were included in the subject. Thus, the scope was broadened from hygiene to preventive and social medicine and now to community medicine. Thus, the concept of community medicine came into vogue.

Whatever may be the terminology, the ultimate goal is to prevent the disease, promote the health and to prolong the life of the people. This is based upon the principle that 'Prevention is better than cure'. Not only prevention is better than cure, but also it is simpler than cure, safer than cure, cheaper than cure and easier than cure. This is a universal truth.

CHAPTER 2

Concept of Health

INTRODUCTION

Health is defined (by WHO) as 'A state of complete physical, mental and social well-being of an individual and not merely an absence of disease or infirmity' (infirmity = weakness, feebleness, opposite of firmness).

Health is not an end in itself but the means to another end namely to lead socially and economically a productive life.

As per the definition, health is three dimensional—the physical, the mental and the social. Nonmedical dimensions which can be included are spiritual, emotional, vocational and political dimensions.

PHYSICAL DIMENSION

A person is said to be physically healthy, when all the organs and systems in the body are functioning perfectly at their optimum capacity.

The signs of physical health are good complexion, a clean skin, bright eyes, lustrous hair, well built, with firm flesh, a sweet breath, a good appetite, sound sleep, regular activity of bowel and bladder and coordinated bodily movements. All the systems function normally, all the special senses are intact, the resting temperature, pulse rate, respiratory rate and blood-pressure are all in the normal range for the individual's age and sex.

The physical health of an individual can be assessed by the history of having taken treatment or hospitalization for any illness, thorough clinical examination, anthropometric measurements, biochemical and laboratory investigations.

MENTAL DIMENSION

A person is said to be mentally healthy, when he/she is having a perfect state of balance with the surrounding world, having harmonious relation with others, the intelligence, memory, learning capacity, judgment are normal, not having any internal conflicts, accepts criticism sportively, has got good self-control emotionally, solves the problems intelligently, has full self-confidence, is well adjusted with others and is satisfied with what he possesses. He is cheerful and calm. The mental health of an individual can be assessed by his behavior, and attitude.

SOCIAL DIMENSION

An individual is said to be socially healthy, when he is accepted, respected and loved by all in the family, by his friends, relatives, neighborers, colleagues and others.

SPIRITUAL DIMENSION

This is a holistic dimension. A person is said to be spiritually healthy, when he possesses 'Sound mind in a sound body', with the knowledge of philosophy, leading a simple life with a very high level of thinking. Thus, spiritual is 'something' which transcends physiology and psychology.

EMOTIONAL DIMENSION

This is rather difficult to differentiate from mental health. However, a person is said to be emotionally healthy, when he

does not loose temper or does not develop tension and has self-control.

VOCATIONAL DIMENSION

An individual is said to be healthy vocationally, when he is capable of earning sufficiently to lead the life successfully.

POSITIVE HEALTH

A person who is healthy physically, mentally and socially (and spiritually) is said to be in a state of 'Positive health', i.e. highest standard of health.

Thus, enjoying a state of health:

- Is a fundamental human right
- Is the essence of productive life
- Is the integral part of development
- Is central to the concept of quality of life
- Is world-wide social goal.

WELL-BEING

The well-being of an individual has two components, objective and subjective.

Objective Component

This relates to 'Standard of living', which includes educational level, income, occupational status, standard of housing, nutrition, sanitation, dress and other comforts of modern living. This primarily depends of GNP (Gross National Product) includes the gross income generated within the country as well as the net income received from abroad.

Subjective Component

This relates to 'Quality of life', which is determined by a combination of factors such as health, happiness, education, social and intellectual attainments, freedom of action, justice and expression.

The quality of life can be evaluated by a composite index called 'physical quality of life index' (PQLI) which consolidates three indicators viz infant mortality rate, life expectancy at age one and Literacy. This indicator PQLI is used for national and international comparison of human well-being.

For each component, the performance of the individual countries is placed on the scale of 0 to 100, where '0' represents the 'worst' performance and 100 represents 'best' performance and 50 represents 'average'. The composite index is calculated by taking the average of all the three indicators, giving equal weight to each of them. The resulting PQLI is thus scaled from 0 to 100, as follows:

a. IMR weightage is on the scale of 0 to 100. Zero is for an IMR of 220/1000 live-births and 100 for 7/1000 live-births. This is referred to weighted IMR as 'A'.
b. The weightage of life-expectancy at age 1 is on the scale of 0 to 100. It is Zero for 38 years and 100 for 77 years. This referred to as 'B'.
c. Actual literacy rate is considered. It is referred to as 'C.'

$$\text{Average} = \frac{A+B+C}{3}$$

PQLI does not depend upon per capita GNP, unlike standard of living, showing thereby that '*money is not everything*.' For example, Middle East oil rich countries with high per capita income have low PQLI whereas Sri Lanka and Kerala with low per capita income have high PQLI. Thus, PQLI does not measure economic growth of a country but it measures the results of social, economic and political policies. The ultimate objective is to attain a PQLI of 100.

HUMAN DEVELOPMENT INDEX

Human development index (HDI) is also a composite index consisting of life expectancy at birth, educational attainment and income (GDP). These three are the basic dimensions of human development:

GDP

Gross domestic product, i.e. the gross income generated within the country, excluding the net income received from abroad.

HDI

Values range between 0 to 1. This allows for international comparison.

To construct the index, fixed minimum and maximum values have been established for each of these components (say x_1).

- Life expectancy at birth : 25 years and 85 years
- Adult literacy rate : 0 percent and 100 percent
- Combined gross enrolment ratio (school) : 0 percent and 100 percent
- Real GDP per capita (PPP$) : $ 100 and $ 40,000
- Real GDP per capita for India : ₹ 1670/-

The individual indicator can be computed by the following general formula:

$$\text{Index} = \frac{(\text{Actual } x_1 \text{ value}) - (\text{Minimum } x_1 \text{ value})}{(\text{Maximum } x_1 \text{ value}) - (\text{Minimum } x_1 \text{ value})}$$

The life expectancy at birth for India (2011) is 63 and 64.2 years for men and women respectively. Then

$$\text{Life expectancy index} = \frac{62.8-25}{85-25} = \frac{37.8}{60} = 0.63$$

Adult literacy rate of India is 53.5 percent.

$$\text{Adult literacy index} = \frac{53.5-0}{100-0} = \frac{53.5}{100} = 0.535$$

The combined gross enrolment ratio for India is 55 percent.

$$\text{Combined gross enrolment index} = \frac{55-0}{100-0} = \frac{55}{100} = 0.55$$

As the real GDP per capita for India is ₹ 1670/-, then adjusted real GDP per capita (PPP$) index will be:

$$\text{Real GDP per capita index} = \frac{\log(1670)-\log(100)}{\log(40,000)-\log(100)} = 0.47$$

Human development index is the simple average of above three indices.

$$\frac{0.63+0.54+0.47}{3} = \frac{1.64}{3} = 0.546$$

Depending upon the HDI, the countries have been graded as follows:

HDI	Grade (of human development category)
> 0.8	High
0.79 to 0.50	Medium
< 0.5	Low

Accordingly India comes in medium human development category, ranking at no 132 out of 174 countries.

The other related indices are:

- Gender related development index (GDI)
- Gender empowerment measure (GEM)
- Human poverty index (HPI).

SPECTRUM OF HEALTH

Health of an individual is a dynamic process. It is never static. It is always influenced by the factors making the individual to survive. At any given point of time, the health of an individual changes in a range of spectrum varying from the highest point of positive health to the lowest point of death **(Fig. 2.1)**.

The transition of health from one level to other level is so gradual that it is very difficult to say when one level ends and the other level begins. It is only in acute cases, under exceptional condition, there is sudden decline from the state of positive health to the state of death. An attempt to attain the state of positive health indicates the improvement in the quality of life.

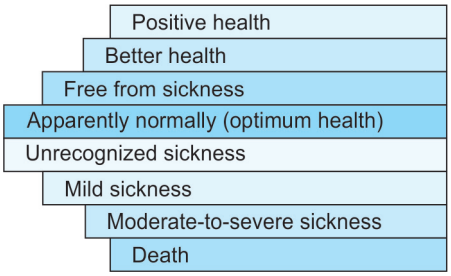


Fig. 2.1 Spectrum of health

DETERMINANTS OF HEALTH

The factors which determine the health of an individual are many. Some are inside the body (genetic/intrinsic factors) and some are outside the body (environmental factors). The interaction of these factors may either promote or deteriorate the health. Thus, health is multifactorial. The important determinants are:

Genetic (Biological) Factors

The health of the human being is to some extent is determined by the genetic constitution that takes place at the time of conception. Once the constitution of the genes takes place, it is permanent and it cannot be altered. If the constitution of the genes is defective, it results in certain diseases, which are transmitted by heredity such as sickle cell anemia, phenylketonuria, certain types of diabetes, mental retardation, etc. Thus, carrying the genes from the parents is called genotype and its external manifestation is called phenotype. There is no treatment for genetic diseases. However, it can be prevented to some extent by 'Genetic counseling' to the (potential) couples before marriage.

Environmental Factors

Internal environment is constituted by various organs and systems of the body. Their harmonious functioning is called 'Homeostasis'.

The external (macro) environment is made up of physical (such as air, water, soil, etc.) biological (such as plants and animals) and social environment (such as culture beliefs, traditions, customs, etc). Any disturbance either in the internal or external environment, disturbs the health of an individual. According to ecology, health is a state of dynamic equilibrium between the human being and the environment (Ecology is a science of relation between man and his environment).

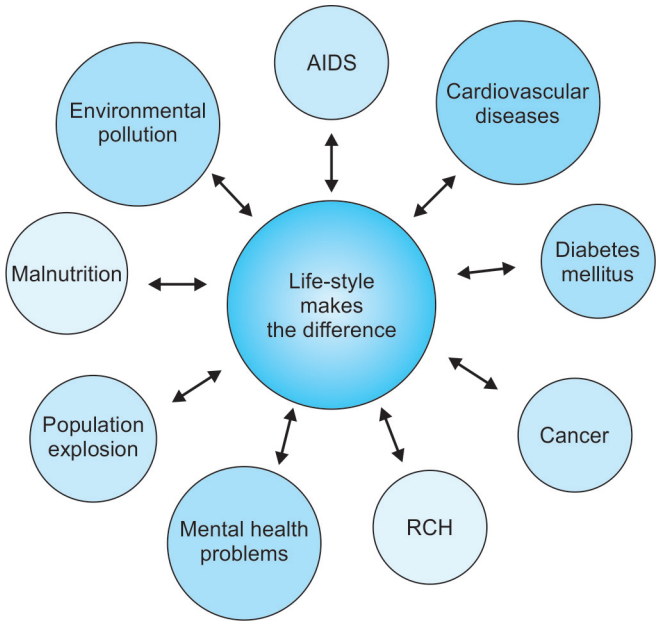


Fig. 2.2 Life style makes the difference

Life Style (Way of Living)

This denotes 'health-behavior' of persons. This includes cultural patterns, social values, behavior of habits. (e.g. smoking, alcoholism, multiple sexual partners, etc). Many diseases have shown a strong association with certain life-styles, e.g. AIDS, coronary heart disease, obesity, lung cancer. Therefore, persons having these risk-factors/habits are considered as 'at risk groups.' These life styles are developed through processes of socialization and social interaction with parents, friends, peer groups, etc. **(Fig. 2.2)**.

However, not all life style factors are harmful. There are many life styles that promote health. For example, adequate nutrition, yoga exercises, meditation, enough sleep, etc.

Socioeconomic Conditions

The important socioeconomic factors influencing the health are education, occupation and income of the individual.

Education

It has been observed that illiteracy is associated with increased morbidity and mortality. Specially female literacy level is very important. To some extent literacy compensates the effects of poverty on health.

Occupation

It has also been observed that morbidity and mortality is more among the unemployed than the employed persons. Unemployment problem itself causes psychological and social damage.

On the other hand, there are many occupations, which affect the health of the workers in the industries. They are discussed under occupational diseases.

Income

This is the most important 'Key' factor, which determines the standard of living, quality of life and thus the health status of the individual and community at large. Diseases of the poor socioeconomic status are malnutrition, tuberculosis, leprosy, gastroenteritis, worm infestation, etc. and the diseases of the affluent society are obesity, hypertension, coronary artery disease, diabetes, etc.

Thus, illiteracy, unemployment and poverty are associated with increased morbidity and mortality.

Health Services

The availability of health care services such as immunization services, family welfare services, nutritional services, educational services, etc. not only prevent the diseases but also promote the health and prolongs the life of the people, which in turn is essential for social and economic development of the country.

Aging of the Population

Even though health services prolong the life of the people, aging of the population itself is a matter of concern because chronic diseases and disabilities accompany the aging process.

Other Factors

The services from the health related departments like food and agriculture, social welfare, education, rural development, urban development, etc. are the other contributory factors for improving the standards of living. Their services are provision of protected water supply, good roads, lighting, etc. This is called intersectoral coordination.

INDICATORS OF HEALTH

These are the guidelines which indicate the health status of a country.

Uses

- To measure the health status of a country
- To compare the health status of one country with that of another country
- To assess the health care needs

- To plan and implement health care services
- To evaluate the health care services.

Since health is not defined in measurable terms and since health is multidimensional and is never static, health is measured multidimensionally, indirectly. These indicators are classified as follows:

- Mortality indicators
- Morbidity indicators
- Disability rates
- Nutritional status indicators
- Health care delivery indicators
- Utilization rates
- Indicators of social and mental health
- Socioeconomic indicators
- Health policy indicators
- Environmental indicators
- Indicators of quality of life
- Other indicators.

Health index is usually considered as an amalgamation of health indicator.

Mortality Indicators

The different mortality indicators used to assess the health status are:

Crude death rate (CDR): It is defined as number of deaths per 1000 population, per year, in a given area. It indicates the rate at which people are dying. Higher the crude death rate, poorer is the health status of a country. A decrease in CDR indicates overall improvement in the health of the population. Afterall reducing the death rate is the goal of health care. National figure is 7.48/1000 population (2011).

Even though CDR indicates the overall health status of a country, it is considered to be of less significance for international comparison, because of differing age-sex composition.

Infant mortality rate (IMR): It is defined as the number of deaths of infants per 1000 live births, during a given year in a given population/country.

It is a very comprehensive indicator, a sensitive indicator and the most important indicator of health because it reflects not only the quality of maternal and child health services but also the availability and utilization of the services. It also indicates the socioeconomic conditions under which the infants live.

Thus, IMR is an, universally accepted indicator of health status. The current IMR in India is 47.57/1000 live-births (2010). It is about 12 times high compared to developed countries like UK, USA, Sweden, Japan, etc.

Maternal mortality rate (MMR): This also indicates the quality of services provided to mothers of reproductive age group, i.e. antenatal, natal and postnatal services.

The current MMR in India is 2.12 (2010) per 1000 live-births. This is about 50 times high compared to developed countries mentioned above.

Child mortality rate: It is the number of deaths of children between 1 to 4 years, during a given year per 1000 mid-year population of that age group. This excludes infant mortality. In India, it is 24/1000 population of that age.

This is also considered as an indicator of health, because it is related to nutritional services, immunization services, family welfare services, etc.

Under 5 proportional mortality rate: It is the proportion or percentage of total deaths occurring among the children below 5 years of age. This includes both infant mortality and child mortality rates. High rate indicates poor health status.

Proportional mortality rate: The proportional mortality rate of communicable diseases means the percentage of total deaths due to communicable diseases is an useful indicator because it indicates the magnitude of preventable mortality.

Morbidity Indicators

These reveal the burden of diseases in a community. Thus, these are used to supplement the mortality rates.

The following morbidity rates are used for assessing the health status:

- Incidence rate
- Prevalence rate
- Notification rate
- Out patients attendance rate
- Hospital admission and discharge rate
- Duration of stay in the hospital.

Incidence rate: It is the number new cases of a particular disease occurring per 1000 population in a year.

Prevalence rate: It is the total number of both old and new cases existing in the population during a given period or time. It is expressed in percentage, i.e. percentage of the population suffering from a particular disease.

Disability Rates

It is the percentage of the population, unable to perform the routine expected, daily activities due to injury or illness. For example, eating, walking, dressing, going to toilet etc. This is used to supplement the mortality and morbidity indicators. Disability rate quantifies the seriousness of the disease.

The disability rates are divided into two groups:

1. Event type indicators:
   - Number of days of restricted activity
   - Bed disability days
   - Work loss days (or school loss days) (Sickness absenteism).
2. Person type indicators:
   - Limitation of mobility (confined to bed or to house)
   - Limitation of daily activity.

Sullivan's index: This is computed by subtracting the duration of bed disability (during life) from the expectation of life at

birth. This is one of the recent indicators. For example, if the expectation of life is 62.6 years for an Indian and the disability days is 7.6 years, the Sullivan's index is 62.6-7.6 = 55 years.

Health adjusted life expectancy (HALE): It is the number of years a newborn is expected to live in full health, based on current morbidity and mortality. This term HALE was previously known as DALE (Disability adjusted life expectancy).

Disability adjusted life year (DALY): It is the number of years lost in the healthy life of an individual due to disability. One DALY is 'one lost year of healthy life'. It is a measure of the burden of disease in a defined population and the effectiveness of the interventions. Even though it is a valid indicator of health, its use is limited because of the non-availability of the necessary data.

Nutritional Status Indicators

These are:
- Incidence of low birthweight
- Weight and height standards of children up to 5 years.

Health Care Delivery Indicators

These indicate the availability of health man-power resources of the country and thus the provision of health care **(Table 2.1)**.

Table 2.1 Health care delivery indicators

Population	Suggested in India
Doctor: Population	1:2,500
Nurse: Population	1:5,000
Health worker: Population	1:3,000
Pharmacist: Population	1:10,000
Lab technician: Population	1:10,000
Subcenters: Population	1:3,000
Health center: Population	1:30,000

Utilization Rates

It is the proportion (percentage) of the people actually utilizing the health care services, in a given population during a given year.

For example:
- Proportion of infants 'Fully immunized'
- Proportion of expectant mothers, who have received 'Adequate antenatal care'
- Proportion of deliveries conducted by 'Trained birth-attendants'
- 'Bed-occupancy' rate in the hospitals
- Coverage with insecticidal spraying.

These indicators not only indicate the availing of health care services but also indicates whether the need was felt or not, whether there was rapport between the provider and the consumer and also the accessibility and the acceptability of the services.

Indicators of Social and Mental Health

These include the rates of crimes, assault, murder theft, suicides, homicides, accidents, juvenile delinquency, prostitution, gambling, drug-abuse, lock-out of industries etc. To these may be added divorces, family violence, battered baby syndrome, battered wife syndrome, etc. These indicators provide a guide to implement social action for improving the social and mental health of the people.

Socioeconomic Indicators

- Growth rate of the population
- Per capita income; Gross national product (GNP)
- Percentage of people below poverty line
- Level of unemployment
- Dependency ratio
- Literacy rate
- Family size
- Per capita calorie availability
- Percentage of over-crowded houses.

Even though these do not directly measure the health status of a country, these are helpful in assessing the socio-economic status of the country, which has got an impact on the health of the country.

Health Policy Indicators

These are the proportion of the budget (NGP) spent on health services and health related services such as water supply, sanitation, nutrition, housing, community development, etc.

Environmental Indicators

These reflect the quality of physical and biological environment. These include the indicators relating to pollution of air, water, noise, radiation, solid waste, etc. Important ones are:
- Percentage of houses receiving safe water supply
- Percentage of houses having adequate sanitary facilities, etc.

Indicator of Quality of Life

This is 'Physical quality of life index' (PQLI)—explained under 'well-being' of health.

Other Indicators

Other indicators are 'Health for all' indicators (explained under Part V). Thus, it is seen from above, that there is no single comprehensive indicator to assess or to measure the health status of a country. Each indicator reflects one aspect of health. An ideal indicator comprising a number of components is yet to be developed.

CHAPTER 3

Concept of Disease

INTRODUCTION

(Dis = opposite, Ease = comfort; health)

Webster defines disease as 'A condition, in which body health is impaired and performance of vital functions in the body is interrupted.' In other words, disease is a physiological or psychological dysfunction of the body.

Illness is a subjective feeling of not being well.

Sickness is a state of social dysfunction (i.e. inability to perform his 'Social role').

WHO has defined health but not disease, because of the following limitations:

- Disease has got a spectrum varying from subclinical state to severe illness.
- Onset may be sudden (as in food poisoning) or insidious (as in leprosy).
- The diseased person may be apparently healthy but may be spreading to others (as in carrier state).
- The same pathogen may cause more than one disease (e.g. streptococci).
- The same disease may be caused by more than one organism (e.g. diarrhea).
- The course of the disease may be short or prolonged.
- It is difficult to demarcate between normal and abnormal state as in hypertension, diabetes, mental illness, etc.
- The final outcome of the disease is variable, i.e. recovery, disability or death.

THEORIES OF DISEASE CAUSATION

Old Theories

Till the end of the 18th century, various theories were in vogue, e.g. Supernatural theory of disease (e.g. curse of God; an evil eye). The Ayurveda considers that the disease is due to imbalance of the '*tridoshas*.' These are *vata* (air), *pitta* (bile) and *kapha* (mucus). The Chinese medicine believes that the disease is caused due to imbalance of male principle (Yang) and female principle (Yin).

Germ Theory of Disease

The discoveries in microbiology at the turn of the 18th century became a turning point in the etiological concept of disease. Louis Pasteur (1860) demonstrated the presence of bacteria in the air. Robert Koch (1877) showed that anthrax was caused by bacteria. These discoveries of Pasteur and Koch confirmed the germ theory of disease. Many microbes were discovered in quick succession—*Gonococcus* in 1847, *Typhoid bacillus*, *Pneumococcus* in 1880, tubercle bacillus in 1882, *Vibrio cholerae*, in 1883, *Diphtheria bacillus* in 1884 and so on.

Koch's postulates must be fulfilled before any micro-organism is considered as 'necessary cause' for any disease. The postulates are:

- The organism must be constantly associated with the lesions of the disease.
- It should be possible to isolate the organism from the lesions.
- Inoculation of the isolated organism into the experimental animal should reproduce the lesions of the disease.
- It should be possible to reisolate the organisms in pure culture from the lesions produced in experimental animals.

Thus, the emphasis has shifted from empirical causes (like bad air as cause in malaria) of old theories to microbes of Germ theory. But now it is recognized that a disease is rarely caused by a single agent alone but depends upon a number of contributory factors.

Limitations of Germ Theory

The germ theory is unable to explain:

- Why only some people suffer from the disease after exposure to microorganisms and not all, as with exposure to tubercle bacilli.
- Why some people do not suffer from the disease even though they harbor the pathogens in the body (as in healthy carriers of typhoid).

EPIDEMIOLOGICAL TRIAD

These limitations led to the concept of 'Epidemiological or ecological triad.'

According to this model **(Fig. 3.1)** disease occurs when the equilibrium between agent, host and environment is disturbed. Thus, this model explains that some persons do not suffer from the disease even though they harbor the pathogens because an equilibrium is established between the causave agent and the host.

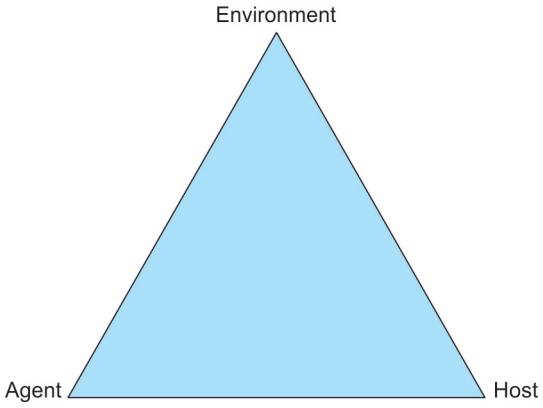


Fig. 3.1 Epidemiological triad

Theory of Multifactorial Causation (Web of Causation)

Now, it is recognized that a disease is not only caused by an organism but also predisposed by many factors contributing to its occurrence, specially 'modern diseases' of civilization like lung cancer, diabetes, coronary heart disease, mental illness, etc. These predisposing factors are social, economic, cultural, genetic, psychological factors, etc. (including poverty, illiteracy, ignorance, poor living condition, over-crowding, etc).

This theory of multifactorial causation was putforth by Pettenkofer of Munich (1819-1901). This theory de-emphasizes the 'Germ theory' (or single cause idea).

It is now known that most of these factors are so much linked to life-style and human behavior that they are considered as 'Risk-factors', in the web of causation of the disease.

A risk factor is an attribute which has a potential value as a predictor for the unfavourable outcome in an individual, such as disease, disability or death.

The multiple factors in the web of causation of coronary heart disease are excess of smoking, fat intake, lack of physical exercise, obesity, etc. The concept of multifactorial causation was put forward by Pettenkofer.

A risk factor could be modifiable or nonmodifiable. For example, obesity is a modifiable risk factor in coronary artery disease. Gall stones are more common among women. Here, sex is a nonmodifiable risk factor.

This multifactorial theory offers multiple approaches for the prevention and control of the disease.

NATURAL HISTORY OF DISEASE

It means the evolution of a disease process in an individual, from its early stage to final stage of recovery or death, in the absence of any intervention such as prevention or treatment. This differs from disease to disease and from person to person.

Understanding the natural history of a disease is essential because knowledge of prevention can be applied at different phases of the disease process.

The natural history of an infectious disease occurs in two phases—prepathogenesis and pathogenesis **(see Fig. 4.1)**.

Prepathogenesis Phase

This phase refers to the period before the onset of disease. During this phase, interaction is taking place among the three components of epidemiological triad namely agent, host and environment, each representing the angle of a triangle respectively.

As long as there is equilibrium among these three interacting factors, so long the person will be healthy. Once the equilibrium is disturbed, disease process starts. In other-words, potentially we are all in the prepathogenesis phases (midst) of many diseases, both communicable and non-communicable.

Just like when the seeds are ploughed into the soil, crops are grown under favorable conditions, so also when the causative agent invades the host, disease occurs under favorable environment.

Depending upon the interaction, there may be development of either one case or an epidemic.

Agent Factors

A disease 'Agent' is defined as a substance, living or non-living or a force, tangible or intangible, the excessive presence or relative lack of which initiates the disease process.

The disease agents are broadly classified into the following groups—physical, chemical, biological, mechanical and nutritional agents.

Physical agents: Heat, cold, radiation, noise, atmospheric pressure, humidity, etc.

Chemical agents:

- *Endogenous:* Urea, uric-acid, bilirubin, ketones, calcium oxalate, etc.
- *Exogenous:* Dust, gas, fumes, metals, allergens, etc.

Biological agents: Viruses, rickettsiae, bacteriae, fungi, protozoa, helminths, arthopods, etc.

For disease to be produced, a biological agent should have the following features:

- Infectivity, i.e. ability to invade and multiply in the host
- Pathogenicity, i.e. ability to produce illness
- Virulence, i.e. ability to produce severity and fatality.

Mechanical agents: Friction, force, injury, sprain, accidents, etc.

Nutritional agents: Nutrients like proteins, fats, carbohydrate, vitamins, minerals and water-the excess or deficiency of which results in disease.

Host Factors

These are the factors in the individual which determine the outcome of the interaction among three factors. These are as follows:

Age: Certain diseases are peculiar in certain age group. For example: Measles and diphtheria among children, hypertension and diabetes among middle-aged.

Sex: Certain diseases like lung cancer and coronary heart diseases are common among men and Rheumatoid arthritis, hyperthyroidism, diabetes, obesity are common among women. Diseases of the prostate occur only among men and toxaemias of pregnancy only among women.

Ethnicity: Ankylostomiasis is less frequent and sickle-cell anemia is more frequent among Negroes. Thalassemia is common among people of Mediterranean region.

Occupation: This not only determines the income but also the health hazards arising out of the occupation, e.g. Pneumoconiosis.

Literacy level: Higher the literacy level, lower is the incidence of the disease.

Income: This is the 'key' factor determining the standard of living and influencing the development of the disease. Lower socioeconomic status predisposes for infectious diseases and higher status for noncommunicable diseases.

Martial status: Cancer cervix is common among married women than among unmarried women. Similarly, STDs and HIV are common among unmarried than married persons.

Nutritional status: Poor nutritional status makes a person more vulnerable to infectious diseases.

Life-style factors: Like smoking, alcoholism, drug-abuse, lack of exercise, multiple sexual partnership, etc favor the development of diseases.

Environmental Factors

These are classified into physical, biological and socio-cultural environment.

- Physical environment: Air, water, soil, food, etc.
- Biological environment: Plants, animals, insects, rodents, microbes, etc.
- Psychosocial environment.

Psychosocial factors like exposure to stressful situation such as death or divorce of the parents, desertion, loss of employment, birth of a handicapped child, etc. produce feelings of anxiety, tension, anger, depression, frustration etc. predisposing for diseases like hypertension, headache, duodenal ulcer, bronchial asthma, mental illness, etc.

Often worries and depression predispose for committing crimes, violence, suicide, murder, etc. and some such persons go to the rescue of alcohol, drug-abuse, etc. thus man is viewed as an 'Agent' of his own diseases.

Cultural practices such as customs, beliefs, traditions, taboos, cooking and feeding/eating practices, etc. also have influence on the health of the people in the community.

Risk Factors

This term is related to 'Agent-factors', because risk factors are significantly associated with the development of a disease, specially noncommunicable diseases, like coronary artery

disease, cancer, peptic ulcer, mental illness, obesity, diabetes, etc.

A risk factor is defined as an attribute, may or may not be modifiable, which has a potential value as a predictor for the unfavourable outcome such as disease, disability or death but often absolute proof is lacking, e.g. smoking as a risk factor for lung cancer. Smoking does not imply that lung cancer will occur and in its absence, the disease will not occur. This risk factor can be modified by intervention or eliminated, thereby reducing the possibility of occurrence of disease. This is called 'Primordial prevention.'

Often the risk factors act synergistically in the same individual, e.g. smoking and high serum cholesterol act synergistically and result in coronary heart disease.

Modifiable risk factors are smoking, lack of exercise, obesity, serum cholesterol, etc. the nonmodifiable (immutable) risk factors are age, sex, genetic constitution, race, family history, etc.

The risk factors may characterize the environment also, such as air pollution, water contamination, substandard housing, etc. indicating the need for improving the quality of health services.

The relation between the risk factor and the occurrence of the disease and also the degree of risk can be established with epidemiological studies such as case-control and cohort studies.

The detection of risk-factor will help in applying the knowledge of prevention.

The different diseases and their risk factors are as follows:

Disease	Risk factors
1. Coronary heart disease	Smoking, cholesterol, obesity. Lack of disease exercise, Type A personality.
2. Lung cancer	Smoking, ionizing radiation, asbestos dust, air pollution.
3. Stroke	High blood-pressure, elevated cholesterol level, smoking.
4. Vehicular	Alcohol, nonuse of seat belts, excessive accidents speed, roadway design.
5. Diabetes	Obesity, lack of exercise, excessive food consumption.
6. Cirrhosis	Alcohol, decreased protein intake. of liver

Risk Groups (Susceptible Population)

These are the groups of individuals, who are exposed to or associated with risk factors and therefore they are at high risk of morbidity and mortality, either because of the constitution or of the environment physically, biologically or socio-culturally. These are the people who require identification and health care services most. This is known as 'Risk-approach.' For example, children are at risk groups for malnutrition, women of childbearing age are at risk group for nutritional anemia. In essence, the risk-approach is a managerial device, e.g. MCH services is a 'managerial tool.'

The following are the at risk groups depending upon the situation:

- *Physical situation:* Poor living condition, over crowding, lack of sanitation.
- *Biological situation:*
  - Age-wise (LBW-newborns, infants, toddlers, elderly).
  - Sex-wise (Females in reproductive age)
  - Physiological state (Pregnancy, malnutrition)
  - Genetic factors (Strong family history)
- *Sociocultural situation:* Socioeconomic class, life-style, habits, beliefs, customs, traditions, etc.

Pathogenesis Phase

The period of pathogenesis phase starts, when the causative disease agent enters the human being successfully. Having entered the body, irrespective of the route, goes to the site of election, lodges there, gets adopted, multiplies, reaches an optimum number, disturbs the structure and function of that organ, produces changes in the blood and tissue fluid and results in the development of signs and symptoms.

The period between the successful entrance of the organism and the onset of the first symptom is called 'Incubation period.'

After the onset of clinical features, the final outcome of the disease may be total recovery, chronicity, disability or death of the individual.

The infection may be clinical or subclinical and when subclinical, the person will not have recognizable signs and symptoms (Asymptomatic case) but may spread the disease agent to others, acting as 'carrier,' as in typhoid, diphtheria.

When the person develops clinical signs and symptoms, he is called a 'Clinical case.' Invariably a case spreads the disease to others.

ICEBERG PHENOMENON OF DISEASE

According to this concept, the disease in the community is compared to an iceberg **(Fig. 3.2)**.

When a piece of ice is allowed to float on water, a small portion is visible and a major portion is submerged in the water. The visible tip of ice is compared to clinical cases, which the physician sees in the community. The major submerged portion of ice corresponds to hidden mass of unrecognized diseases such as latent cases, inapparent, carriers, asymptomatic and undiagnosed cases in the community,

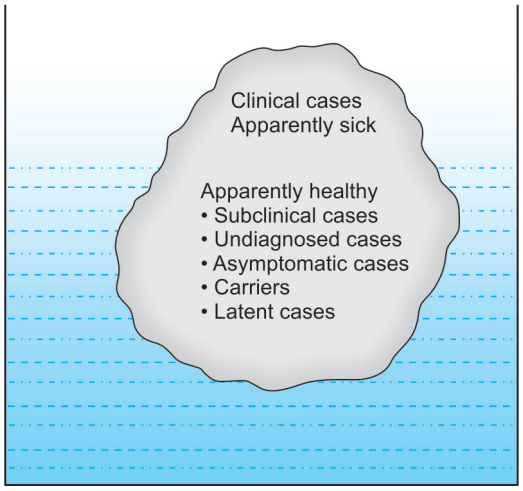


Fig. 3.2 Iceberg of diseases

which are all responsible for the constant prevalence of the disease in the community.

In some diseases like hypertension, diabetes, anemia, malnutrition, mental illness, etc. the unknown morbidity (corresponding to large submerged portion of ice) is more than the known morbidity in the community and constitutes an important, undiagnosed reservoirs of disease in the community. Their detection and control is a challenge to the modern technique of community medicine.

CHAPTER 4

Concept of Prevention

INTRODUCTION

The objective of community-medicine is to oppose the disease process in order to preserve the health, promote the health, prolong the life and to minimize the sufferings by preventing the occurrence of the disease. The disease can be prevented by opposing its natural history at different levels **(Fig. 4.1)**.

There are three levels of prevention—primary, secondary and tertiary.

PRIMARY PREVENTION

This is the measure undertaken in the period of pre-pathogenesis (i.e. before the development of the disease) which removes the possibility of occurrence of the disease.

Especially, it is all the more important in those diseases, for which no treatment is available, e.g. AIDS, cancer, rabies, carries tooth, etc.

Primary prevention can be adopted by two modes of intervention—namely Health promotion and Specific protection.

Health Promotion

This consists of 'general measures,' which will strengthen the individual/host and prevents the occurrence of the disease by interrupting the interaction among the three factors of epidemiological triad**.**

The various measures of health promotion are:

- Health education (on personal hygiene, oral hygiene, nutrition education, life-style, etc.).
- Sex education.
- Adequate nutrition.
- Improvement in the environmental sanitation (such as control of insects, provision of protected water supply, sanitary disposal of sewage, etc.).
- Promotion of breastfeeding and proper weaning.
- Family planning and spacing of births.
- Genetic counseling (premarital and marriage counseling).
- Efficient antenatal care and postnatal care.
- Recreation facilities (sports, games, cultural activities, etc.).
- Improvement in the literacy level.
- Yoga exercises and meditation.

Specific Protection

This consists of 'specific measures,' which prevent specific diseases. The various measures are:

- Immunization against vaccine preventable diseases
- Silver nitrate or penicillin eye drops against ophthalmia neonatorum
- Condom against AIDS
- Use of specific nutrients (Vitamin A against nutritional blindness, IFA against nutritional anemia, iodized salt against iodine deficiency disorders)
- Helmet against head-injury
- Masks against pneumoconiosis
- Ear plugs against noise induced deafness
- Lead apron against radiation hazards
- Visor against welding keratitis
- Barrier cream against occupational skin cancer
- Avoidance of allergens and carcinogens

- Sterilization procedures of surgical instruments
- Pasteurization of milk
- Traffic signals against road accidents
- Quality control of foods, drugs and cosmetics, etc.

These measures need to be applied in specific situation for specific groups. They are more concrete and effective.

PRIMORDIAL PREVENTION

It is also a primary level of prevention of the disease but it is with reference to noncommunicable diseases, such as Obesity, hypertension, diabetes, cancer, coronary artery disease, etc. This consists of elimination or modification of 'risk factors' of the disease. In such chronic, non-communicable diseases, the etiological (causative) agent is not known (or not established) and the etiology is discussed in terms of 'risk factors.' They may act as contributory factors.

There are two approaches for the primordial prevention:

- Population (mass) strategy
- High-risk strategy.

Population Strategy

This is directed at the whole population, irrespective of individual risk level. For example, it is shown that a small reduction in the average blood pressure or serum cholesterol in the population, goes a long-way in reducing the prevalence of coronary artery disease in the community. This approach is directed towards changes in the life-style of the population by health education from the childhood itself. The results of these measures cannot be perceived immediately but are seen after several years or decades.

High-risk Strategy (Individual Strategy)

This is directed to those individuals, who are at high risk of getting the disease. These high-risk group can be detected by screening procedures (Explained under epidemiology of noncommunicable diseases).

SECONDARY PREVENTION

This is the measure undertaken in the early stage, after the onset of the disease or even much before the development of permanent pathology in the individual.

The intervention is by 'Early diagnosis and treatment.' This can be done by various screening procedures.

Early Diagnosis and Prompt Treatment

This helps in the following ways:

- Helps in recovery from the disease (restoration)
- Reduces the duration of illness in the individual
- Minimizes the suffering
- Prevents the development of complications
- Prevents further spread of the diseases in the community
- Prevents or postpones the death of the individual.

Thus, early diagnosis and prompt treatment is like 'Stamping the spark rather than calling the fire-brigade to put out the fire.'

Strictly speaking early diagnosis and prompt treatment cannot be termed prevention, since the diseases has already occurred but it is a primary preventive measure for the community.

The different screening procedures for the early diagnosis of the disease are as follows:

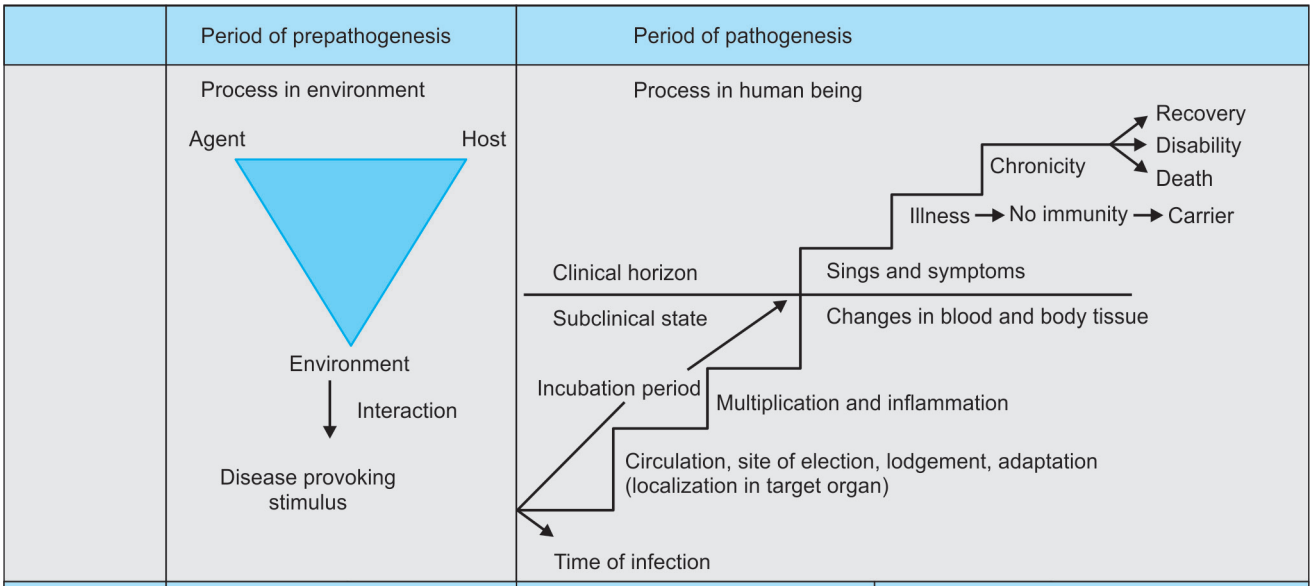
Screening procedures	Diseases diagnosed early
• Periodical recording of weight of a child	Malnutrition
• Contact tracing	STDs
• Cluster testing	STDs
• Blood and urine exam	Diabetes mellitus
• Periodical examinations of industrial workers	Pneumoconiosis
• Screening of blood donors	HIV/AIDS, hepatitis B, syphilis, malaria
• Recording of blood pressure	Hypertension
• Pap smear of cervix	Cancer cervix
• Reading Snellen's chart	Refractive errors
• Self-examination of breasts by woman	Ca-Breast

Different modalities of treatment are chemotherapy, radiotherapy, immunotherapy, hormonal therapy, psychotherapy, physiotherapy, oral rehydration therapy and surgery.

Conditions where the treatment is for a long period as in tuberculosis or leprosy, the physician should ensure 'Case holding', i.e. to see that the patient takes the treatment correctly and completely.

TERTIARY PREVENTION

This is the measure undertaken, when the disease process is sufficiently advanced, (i.e. in the late pathogenesis phase).



Levels of prevention	Primary prevention		Secondary prevention	Tertiary prevention	
Modes of intervention	Health promotion	Specific promotion	Early diagnosis and treatment	Disability limitation	Rehabilitation
Nature of measures	Promotive	Preventive	Curative	Restorative	Rehabilitative
Examples	Health education Sex education Adequate nutrition Improvement of sanitation Promotion of breastfeeding Family planning Genetic counseling Recreation facilities Yoga exercises	Immunization Condom against AIDS Vitamin A against nutritional blindness Helmet against head injury Lead apron against radiation hazards Avoidance of allergens and carcinogens Pasteurization of milk	Screening procedures for early diagnosis • Recording weight to diagnose malnutrition • Investigations in a pregnant mother • Contact tracing and cluster testing for STDs. • Blood and urine exam for diabetes • Periodical examination of industrial workers • Pap smear for Ca Cx Modalities of treatment • Chemotherapy • Surgery • Immunotherapy • Radiotherapy • Psychotherapy • Oral rehydration therapy	Intensive or aggressive treatment Ex. Treatment of corneal xerosis to prevent blindness	**Types:** Physical Vocational Social Psychological **Examples:** School for the blind (Braile for the blind), Artificial limb, Crutches, Wheel chair, Hearing Aid, Graded exercises, Intraocular lens for cataract patients Reconstructive surgery in leprosy

Fig. 4.1 Natural history of a communicable disease and application of preventive measures

Tertiary prevention can be adopted by two modes of intervention—disability limitation and rehabilitation.

Disability Limitation

This means limiting the development of further disability in the individual by giving intensive or aggressive treatment, when the patient comes in the advanced stage of the disease.

The objective is to prevent the transition from impairment to handicap.

The sequence of events in a disease process are:

Disease → Impairment → Disability → Handicap

Impairment: This means defect in the structures and function of an organ or a part of the body. The impairment may led

to the development of secondary impairment as in leprosy, where damage to nerves (primary impairment) may lead to plantar ulcers (secondary impairment).

Disability: This means inability to carry out certain routine, expected activities, considered normal for the age, sex etc, due to impairment.

Handicap: This means experiencing disadvantage in the life and not able to play the role, expected out of her/him, resulting from the impairment or disability for example.

	Disease	Impairment	Disability	Handicap
1.	Accident	Loss of foot	Inability to walk	Loss of job
2.	Vitamin 'A' deficiency	Corneal xerosis	Blurring of vision	Blindness and loss of job
3.	Leprosy	Involvement of nerves	Inability to work because of claw hand	Unemployment

Rehabilitation

This is the measure undertaken in the individual, when the disease is very much advanced and the patient experiences the disadvantage in the life and becomes disabled, handicapped and dependent.

Rehabilitation is defined as 'Combined and co-ordinated use of physical, social, vocational and psychological measures for training and retraining the individual to the highest possible level of functional ability', so that the individual becomes useful to himself, to the family and to the community at large.

In rehabilitation, it is essential to identify the remaining capacities in such an individual and adopt measures to make him fit, independent, productive, useful and active member in the family and community.

Strictly speaking, the process of rehabilitation should begin from the time the disease is identified.

The different aspects of rehabilitation are:

• Physical rehabilitation	Restoration of function
• Vocational rehabilitation	Restoration of earning capacity
• Social rehabilitation	Restoration of relationship in the society
• Psychological rehabilitation	Restoration of personal dignity and confidence

Examples of rehabilitation are:

- Establishing the schools for the blind
- Providing aids for crippled, such as artificial limb, crutches, wheel chair, hearing aid, etc.
- Reconstructive surgery in leprosy
- Graded exercises in paralysis
- Intraocular implantation of lens among cataract patients.

BIBLIOGRAPHY

1. GOI. MOHFW. Family Welfare Statistics in India. 2011.
2. Kass LR. Concepts of Health and Disease. Interdisciplinary perspectives. Massachusetts. Addison-Wesley Publishing House, 1986.
3. Last JM. A Dictionary of Epidemiology. Oxford University Press, London 1983.
4. Leavel HR, Clark EG. Preventive Medicine for the Doctor in His Community. McGraw Hill, New York, 1965.
5. Park K. Park's textbook of Preventive and Social Medicine. 18th edn, 2005.
6. UNDP. Human Development Report. Oxford University Press 1999.
7. WHO Health for All Sl No. 6, 1981.
8. WHO Technical Report Series No. 419, 1969.
9. WHO Technical Report Series No. 535, 1973.
10. WHO Technical Report Series No. 587, 1976.
11. WHO Technical Report Series No. 668, 1981.
12. WHO Technical Report Series No. 678, 1978.
13. WHO Technical Report Series No. 731, 1986.

SECTION 2

Environment and Health

- Environment and Water
- Air and Ventilation
- Noise
- Light
- Radiation
- Housing
- Meteorology
- Disposal of Wastes
- Management of Hospital Waste
- Electronic Waste Management
- Medical Entomology

CHAPTER 5

Environment and Water

INTRODUCTION

Environment is the external factor/factors present around man and has got an influence on the health of the human being. According to ecologists, health is a state of dynamic equilibrium between man and his environment and when this equilibrium is disturbed, ill-health (disease) occurs.

Such an environment has been divided into four components:

1. Physical environment
2. Biological environment
3. Social environment
4. Cultural environment.

PHYSICAL ENVIRONMENT

This consists of non-living things and certain physical forces/energy present around man. These are water, air, soil, housing, radiation, light, noise, vibration, refuse, wastes, etc.

BIOLOGICAL ENVIRONMENT

This consists of living things around man. These are plants, animals, rodents, insects and microbes like bacteriae, viruses, rickettsiae, parasites, fungi, etc.

SOCIAL ENVIRONMENT

This consists of occupation, literacy, income, religion, standard of living, lifestyle, availability of health services, etc.

CULTURAL ENVIRONMENT

This consists of knowledge, attitude, beliefs practices, traditions, culture, customs, habits, etc.

Such an environment of man is being polluted due to industrialization, urbanization and such other human activities. Man only is responsible for the pollution of his environment.

Sanitation is 'the science of safeguarding the health.' The term environmental sanitation is defined by WHO as, 'the control of all those factors in man's physical environment, which exert a deleterious effect on physical development, health and survival.' Safeguarding health means prevention of diseases.

Most of the communicable diseases in India are due to poor environmental sanitation, i.e. contamination of water, pollution of air, soil, unhygienic disposal of sewage, refuse and waste, infestation of insects, rodents, etc. Poor environmental sanitation supplemented by social factors like poverty, illiteracy, ignorance, poor standard of living, over-crowding, etc. are mainly responsible for the increased morbidity and mortality in our country. Therefore, improvement of environmental sanitation is crucial for the prevention and control of many communicable diseases in our country.

WATER

Man can survive for five weeks without food but not more than five days without water. Water is essential and predominant constituent of cell protoplasm. In that way 70 percent of our body weight is due to water only.

Water has got an influence on the health/life of an individual both directly and indirectly. It is related directly because water is essential for digestion, regulation of body temperature, removal of the wastes from the body through tears, perspiration, urine and feces and for lubricating the joints. It also acts as a buffer by neutralizing the acids produced in the body. Moreover, it is a necessary vehicle for all metabolic processes in the body.

Deficiency of water in the body causes dehydration, acidosis, shock, urinary tract infections, indigestion and constipation.

The daily requirement of water for drinking purposes is about 2.5 liters per head. Consumption of water 2 to 3 times the actual requirement is also not harmful. Therefore it is always advisable to drink as much water as we can!

Water has an influence on the health of the human beings indirectly also. It acts as a vehicle for transmission of many communicable diseases like typhoid, diarrheal diseases, viral hepatitis A, poliomyelitis, etc. Water also constitutes the breeding place for the mosquitoes, which transmit many diseases to human beings, like malaria, filariasis, Japanese encephalitis, dengue fever, etc.

Man also needs water for domestic purposes such as cooking, washing clothes, cleaning utensils, gardening and above all for drinking. He also needs it for commercial, industrial and recreational purposes.

Since water has got an influence on the health of the individual, the water used by him should be of good quality.

Water for drinking purposes must be safe and wholesome. A safe and wholesome water is a one which is:

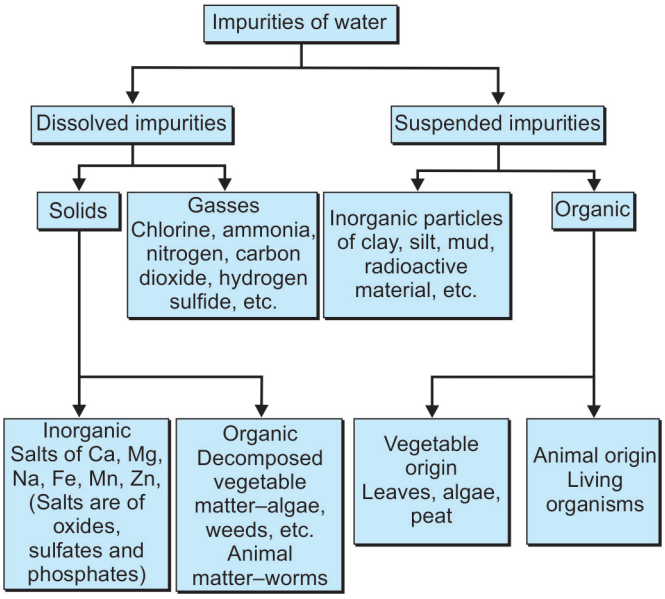
- Free from pathogens
- Free from harmful chemical substances
- Pleasant to taste (i.e. free from odor and color)
- Usable for domestic purposes.

Water is said to be 'contaminated' when it contains pathogens or harmful chemical substances and it is said to be 'polluted,' when it contains substances or impurities affecting the physical quality of water such as color, odor, taste and turbidity.

A clean, potable water is free from contamination and safe for consumption.

Impurities of water: Explained in the **Flow chart 5.1**.

Flow chart 5.1 Impurities of water and their types



WATER CYCLE

This is also called as 'hydrologic cycle.' Water is evaporated from the surface waters like ocean, rivers, lakes, ponds, reservoirs and also from plants and trees as transpiration to form clouds. By cooling effect clouds precipitate and falls to earth as rain, snow, dew, mist or hail. On reaching the earth's surface, a part of it evaporates and remaining runs away and forms different types of surface waters. From the surface water, a part of it percolates into the earth and becomes subsoil or ground water, which reappears as springs (The flowing surface water is called 'run-off').

Thus, in the nature, there exists a continuous water cycle involving stages of evaporation, precipitation, run-off, percolation, transpiration without any beginning or end. In this cycle, water become materially changed and becomes contaminated/polluted.

Compared to rain water and surface waters, ground-water (subsoil water) is safe for drinking purposes, because earth/ground acts as a filtering medium.

Merits of Ground Water

- It is free from pathogens and harmful chemical substances
- It does not require purification
- It often is available even during summer season.

Demerits of Ground Water

- The mineral content (salts of calcium and magnesium) is high, making the water hard
- It requires certain arrangements like pump to lift the water.

The usual source of ground water are wells and springs.

WELL

It is an artificial pit or hole, sunk into the earth to reach the subsoil water. Different types of wells are:

- Shallow well
- Deep well
- Artesian well.

According to method of construction, wells are also classified into dug-wells and tube-wells.

Shallow Well

Dug well is a well, which taps the water from above the first impervious layer **(Fig. 5.1)**. The term 'shallow' has nothing to do with the depth of the well.

Shallow well water is liable for contamination from the surface. The sources of pollution are surface-washings, drains, privy, cess-pools, septic-tanks, etc. If the soil is of porous nature, the impurities will also percolate into well and water becomes polluted.

The area which drains the pollutants or pathogens to a particular well is called 'Cone of filtration' (Zone of influence) represented by an inverted cone, the apex being represented by the bottom of the well and the base to the surface of the earth. If there is any source of pollution within this area, contamination is likely to occur. Usually this area of drainage is four-times the depth of the well. Most of the wells in our country are shallow wells. Pollution can be detected by introducing a solution of fluorescine and caustic soda (or paraffin oil or culture of *Bacillus prodigiosus* or solution of rhodamin. B) in this area and by examining the water at different of time for the testing material.

Deep Well (Driven Well)

It is a one, which taps the water from below the first impervious layer of the earth (i.e. between the first and the second impervious layers of earth). Generally it yields more water and safer water compared to shallow well. Since water is obtained from below the impervious layer, it is better protected from chances of pollution. As the water percolates deeper and deeper, absorbs more of salt and becomes harder and harder.

Differences between Shallow Well and Deep Well

	Shallow well	Deep well
1.	Taps the water from above the first impervious layer of earth	Taps the water from below the first impervious layer of earth
2.	It is hard-water	It is very hard water
3.	It is liable for contamination	Not liable for contamination
4.	It is not safe water	It is safe water
5.	Usually dries up during summer	Usually does not dry even during summer
6.	Easy and cheap to construct	Difficult and costly to construct

Artesian Well

It is a kind of deep well, in which the water table is at a higher level than the surface of the earth, because of the slope of the impervious layer **(Fig. 5.2)**. So the water is held under pressure between the two impervious strata. When the bore taps the water, water comes out in the form of fountain.

They are so called 'Artesian wells', after the old province of Artoise in France, where these wells are common. They are not common in India.

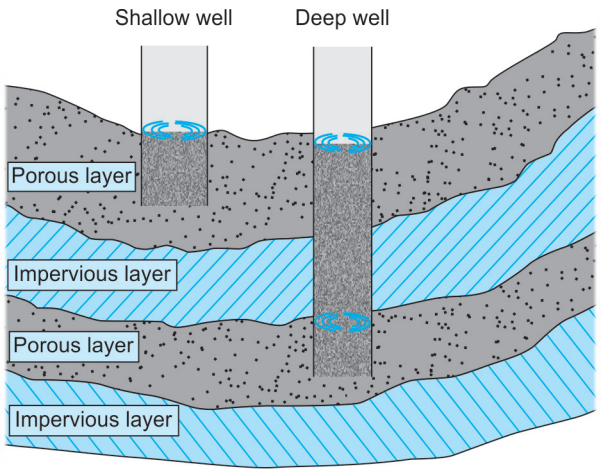


Fig. 5.1 Shallow and deep wells

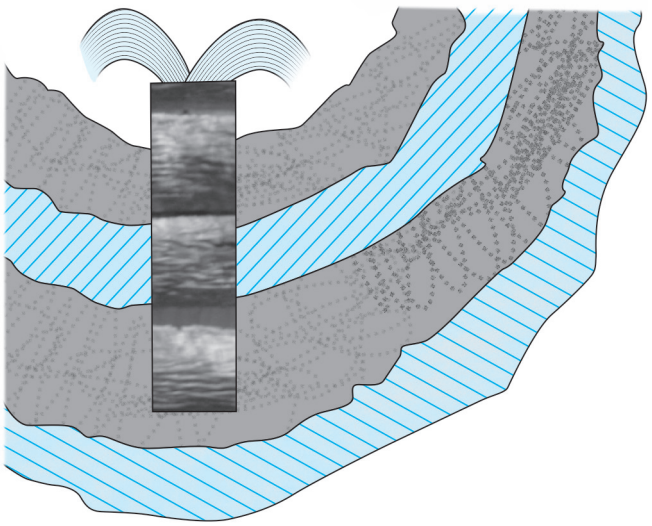


Fig. 5.2 Artesian well

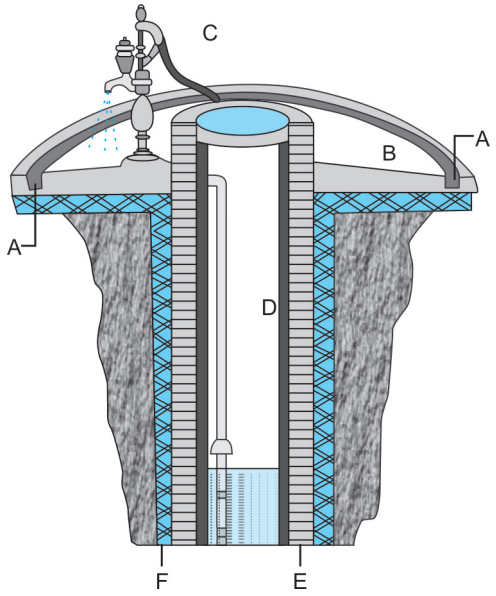


Fig. 5.3 Sanitary well. A. Channelled drain; B. Platform; C. Pump; D. Cement lining; E. Brick work; F. Puddled clay
Source: Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.

Sanitary Well

A sanitary well or an ideal well is a one which is properly located, well constructed, protected against contamination and yields safe water **(Fig. 5.3)**.

The criteria of a sanitary well are:

Location

It should be located about 60 meters (but not more than 100 meters) away from the human habitation, preferably in an elevated area.

Construction

Lining: It should be lined by stones, set in cement, to a considerable depth of about 6 meters, so that water should come from the bottom of the well and not from the sides, because water coming from the bottom will be purer.

Parapet wall: The lining is extended to about 1 meter above the ground level as a parapet wall, to prevent surface washing from entering the well.

Platform: A concrete platform of about 1 meter, around the well, sloping toward the periphery, connected to a pucca drain, is constructed so that the spilled water is drained to a distance beyond the cone of filtration.

Protection

Cover: The well must be covered so that the dust and animal droppings are prevented from falling into the well.

Hand pump: The well is fitted with a pump or machine to lift the water.

Cleanliness: This is maintained near the well by strictly prohibiting washing the clothes, animals, utensils, taking bath, etc. Dumping of wastes and refuse should be prohibited. There must be common rope and a bucket to draw the water and not individual ropes and buckets.

HEALTH HAZARDS OF WATER CONTAMINATION

These are classified into two broad groups: Biological and chemical hazards.

Biological Hazards

These are the classical (or specific) water borne diseases, caused by the presence of an infective agent or an acquatic host in the water.

a. *Those caused by the presence of infective agents:*
   - Viral diseases—Viral hepatitis A, E, poliomyelitis, rotavirus diarrhea
   - Bacterial diseases—Typhoid, paratyphoid fever, bacillary dysentery, *E. coli* diarrhea, cholera
   - Protozoal diseases—Amoebiasis, giardiasis
   - Helminthic diseases—Ascariasis, enterobiasis, trichuriasis, hydatid disease
   - Leptospiral disease—Weil's disease.

b. *Those caused by the presence of aquatic hosts:*
   - Snail—Schistosomiasis (Bilharziasis)
   - Cyclops—Dracontiasis (Guineaworm disease), fish tape worm disease (hymenolepis diminuta).

Chemical Hazards

These are nonspecific water borne diseases. These occur due to presence of certain harmful substances or due to the presence of higher or lower concentrations in the water, as follows:

- Deficiency of fluoride, lesser than 1 mg per liter, results in dental caries and excess of fluoride results in dental fluorosis among children and skeletal fluorosis among adults and elderly.
- Deficiency of iodine results in goiter.
- Excess of nitrates (more than 45 mg per liter) results in cyanosis among infants, i.e. infantile methemo-globinemia
- The dissolved organic impurities like sulphates and chlorides causes diarrhea and gastric disturbances like dyspepsia.
- The salts of lead, iron and zinc are responsible for constipation and colicky abdomen.
- Excess of lead results in lead-poisoning (plumbism)
- Inorganic suspended impurities such as mica, in hilly regions, causes diarrhea.

- Hardness of water is unsuitable for boilers in industries. However, it appears to have a beneficial effect against cardiovascular diseases.

Other water associated diseases or hazards resulting from contact with water are infections of eyes, ears, nose, throat, vulvo-vaginitis and ringworm infections of foot.

The diseases which are transmitted because of inadequate use of water are shigellosis, trachoma, conjunctivitis and scabies. They are also called as 'water washed diseases'.

Other group of diseases, related to water, are mosquito-borne diseases, because water is the breeding place for the mosquitoes.

PURIFICATION OF WATER

The purpose is to produce hygienically safe and aesthetically pleasing water. This can be studied under two headings.

- Purification of water on large scale
- Purification of water on small scale.

PURIFICATION OF WATER ON LARGE SCALE

This is required for towns and cities. This is done in three steps—storage, filtration and chlorination.

Storage

The raw water drawn from the sources like rivers, canals, lakes, tanks, ponds, is stored in big concrete tanks, called 'Storage tanks' (Sedimentation tanks), where heavier particles and suspended impurities will settle down by the gravitational force and water is purified to some extent by natural physical means. Water is stored for about one or two days. During this period, water becomes purified in chemical means also, in that the aerobic bacteriae oxidize the organic matter with the help of dissolved oxygen. Water is purified to some extent biologically also by the natural death of pathogens. Thus, water is purified physically, chemically and biologically to some extent.

Filtration

This is the second step of purification of water. This is done mainly to remove the pathogens and to certain extent the colloidal particles or suspended impurities which have escaped in the first step, i.e. storage. The effective filtering media is sand. There are two types of filters—slow sand filters and rapid sand filters.

Slow sand filters: They are also called as 'Biological filters'. This method was first used in England (in 1804) and Scotland (in 1835) in early part of 19th century based on the observation that muddy water percolating through the earth, came out on a hill side in clear stream. Later its usage was spread throughout the world. This method was adopted when coagulation process of water was unknown and the spread of water borne diseases due to micro-organisms were not yet discovered.

Slow sand filters require vast area and therefore they are constructed outside the city limits, below the ground to a depth of about 4 meters.

Each slow sand filter is a rectangular masonry tank, measuring about 0.1 to 1.0 acre area. Two or more of such tanks are constructed, so that one or other should always remain functioning to maintain the supply of water. The elements of a slow sand filter are **(Fig. 5.4)**:

- Supernatant raw water column
- A bed of graded sand and graded gravel
- An under drainage system
- A system of filter control valves.

The upper water column is about 1.5 meter height. The height is maintained. The filtering medium proper is the bed of fine-sand, of about 1.2 meter height, the effective diameter of the sand grains being 0.15 to 0.35 mm. This is supported by the bed of coarse-sand, which in turn is supported by bed of graded gravel (i.e. fine gravel supported by course gravel) of about 0.4 meter height. At the bottom, it is supported by perforated pipes, which drains the filtered water.

As the water percolates through the sand, it is purified by physical, chemical and biological processes.

Physical processes are sedimentation and straining. Sedimentation is due to the constant head of pressure over the sand bed. Mechanical straining of turbid materials takes place in the interstices of the sand particles.

To start with, the filter acts as a mechanical strainer. But within 2 to 3 days, the surface of the sand-bed gets covered with a slimy, greenish, jelly like layer, known as 'Vital layer', 'Zoogleal layer', 'Scmutzdecke' or 'Biological layer', which is composed of algae, planktons, fungi and diatoms (low vegetable organisms). It is this layer which purifies the water by chemical and biological processes. The formation of this

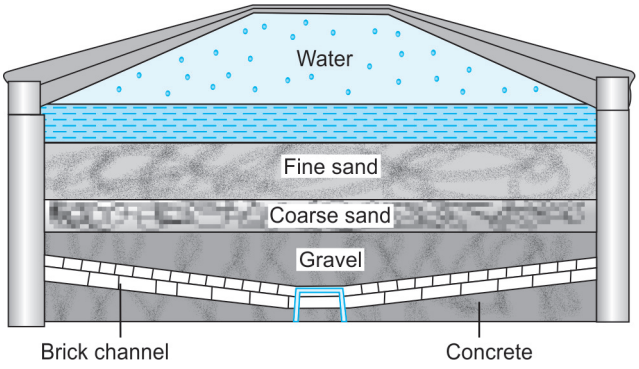


Fig. 5.4 Diagrammatic section of a slow sand filter
Source: Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.

layer is known as 'ripening' of the filter. The effective filtration starts only after ripening of the filter.

The zoogleal layer absorbs the colloidal particles, arrests the pathogens, oxidizes the organic matters and ammoniacal substances thereby killing the pathogens, bleach color partially by removing/arresting the color producing substances and absorbs carbon dioxide, nitrates and phosphates. The water becomes bacteria-free. Thus, the biological layer is considered as the 'Heart' of the filter. Until this layer is formed, the water is run to waste.

The rate of filtration of water is 0.1 to 0.4 m^3/hour/m^2 area of the sand bed surface. 99.9 percent of the bacteriae are removed. The filtered water is drained through under drainage pipes.

The zoogleal layer being a living mass, keeps on growing, becomes thicker and thicker, ultimately clogs the filter, affecting the rate of filtration and quality of filtration. To start with the 'control valve' is slightly opened. As the rate of filtration is slowed down, the valve has to be opened more and more to maintain the rate of filtration.

The frictional resistance offered by the vital layer and the sand bed, is called, 'Loss of hydraulic head' **(Fig. 5.5)** which is being measured by 'Venturimeter', another important component of the filter. When the loss of hydraulic head measures 1.3 meter, the valve is kept fully open. That means the rate of filtration is so less that it is the time to clean the filter-bed.

Cleaning of the filter bed: The supernatant water is drained off and the sand bed is cleaned by 'scraping' the top layer of the sand bed. The remaining sand bed is washed and cleaned. Such scraping is done once in 6 to 8 weeks. Every time the bed is scraped about half-an inch of thickness of sand bed is removed. Thus, by repeated scraping, the sand bed becomes thinner and thinner. When it is reduced from 1.2 to 0.8 meter, the filter is thrown out of action and the bed has to be renewed to its original depth. Thus, the filter is rebuilt once in 3 years.

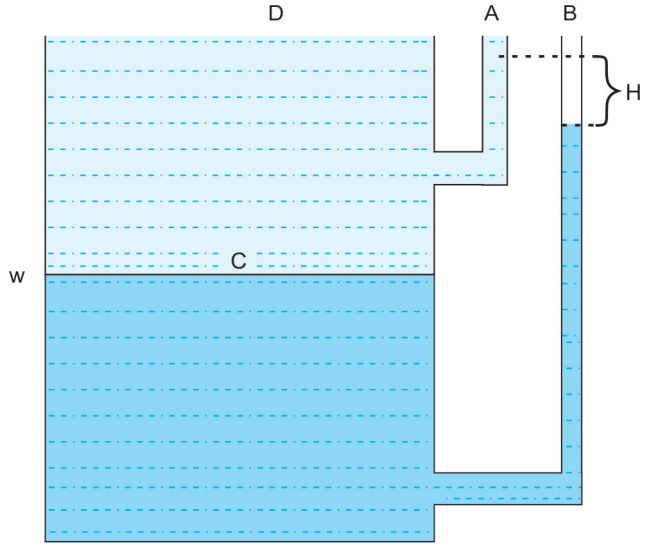


Fig. 5.5 Explaining loss of head: W. Well with two openings; A and B. Side tubes; D. Water level; H. Loss of hydraulic head
Source: Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.

The period during which the filter is in continuous service without scraping, is known as 'Filter-run'. In slow sand filters, the filter-run may vary from 3 weeks to 3 months, depending upon the quality of water.

Advantages of slow sand filters:
- Simple to construct, easy to operate
- Cheaper to construct than rapid sand filters
- Physical, chemical and bacteriological quality of filtered water is very high (99.9% of bacteriae are removed).

Disadvantages:
- Filters occupy large area
- Rate of filtration is slow (0.1 to 0.4 m^3/hour/sq m area)
- Not very efficient in removing colloidal matters and color
- Some standard of efficiency cannot be maintained from the beginning to the end of filter-run
- The long period of about 18 hours, required for filtration of water may result in an anaerobic condition, depletion of oxygen and establishment of undesirable conditions at the bottom of the filter.

Rapid sand filters: These are also called 'Mechanical filters'. After about 50 years of introduction of slow sand filters, it was found that the pretreatment of water with a coagulant (alum) to remove the turbidity followed by sedimentation process would not only improves the quality of water but also increases the rate of filtration. Rapid sand filters were installed in USA in 1885.

There are two types of rapid sand filters:
- Paterson's gravity type wherein water gets filtered through the sand-bed under its own weight.
- Candy's pressure type, wherein water is passed through the bed under pressure, which is higher than the atmosphere pressure.

Gravity filters: These filters require an area of about 90 sq meters. These rapid sand filters also contain the same filtering bed, i.e. a bed of graded sand (fine sand supported by coarse sand). The height of sand bed is about 1.0 meter. This is supported by coarse gravel, which is about 0.5 meter height. The height of the water column on the top of the sand bed is about 1.5 meter. At the bottom, are perforated pipes which not only support the gravel bed but also drain the filtered water **(Fig. 5.6)**.

The rate of filtration is 5 to 15 m^3/m^2 area/hour.

But, before the water is allowed to pass through the sand filter, the raw water is subjected for preliminary treatment as follows:

a. *Aeration:* Water is first run through fountains, so that oxygen of the air mixes with water and partially removes

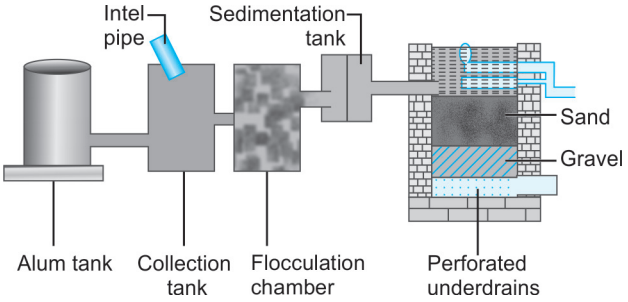


Fig. 5.6 Rapid sand filter

taste and odor producing compounds and oxidizes iron and manganese. Meanwhile carbon dioxide and hydrogen sulfide are removed.

b. *Coagulation and rapid mixing:* The raw water is allowed to pass through a 'mixing chamber', wherein water mixes with a coagulant, alum, dose varying from 5 to 40 mgms per liter, depending upon the turbidity, temperature, color and pH of the water. The water is subjected for violent agitation for a few minutes, thereby alum mixes thoroughly throughout the bulk of the water, provided with baffle plates.
c. *Flocculation:* The water is then flown to next chamber, 'Flocculation chamber', wherein the water is stirred slowly but gently for about 30 minutes, with the help of paddles. The slow stirring helps in the formation of thick, copious, white floccules of aluminum hydroxide.
d. *Sedimentation:* The water is then flown to the next chamber, wherein the water is detained for about 5 to 6 hours. During this period, the aluminum hydroxide floccules entangle the bacteriae, colloidal particles, coloring matters, algae, fungi, etc. and settle down at the bottom of the chamber to form sludge.
The supernatant water is then flown to rapid sand filters.

Filtration: The aluminum hydroxide floccules that have escaped from sedimentation tanks, are held up by the sand bed and form a slimy layer, similar to zoogleal layer of slow sand filter and helps in purification of water by not only adsorbing the bacteriae but also by oxidation of organic and ammoniacal substances. As the filtration proceeds, the layer becomes thicker and thicker and clogs the filter. The resistance to the flow/filtration of water steadily increases, which is measured in terms of 'loss of hydraulic head', which when approaches 7 to 8 feet, it is the time to stop filtration and clean the filters.

Cleaning: The clogged filter-bed is now subjected for cleaning not by scraping (unlike in slow sand filters) but by reversing the flow of current of water from the bottom, so that the filter-bed of sand is elevated, particles become loose, the impurities are dislodged and washed away. This is called 'Back-washing'. The back-washing is stopped when clear sand is visible

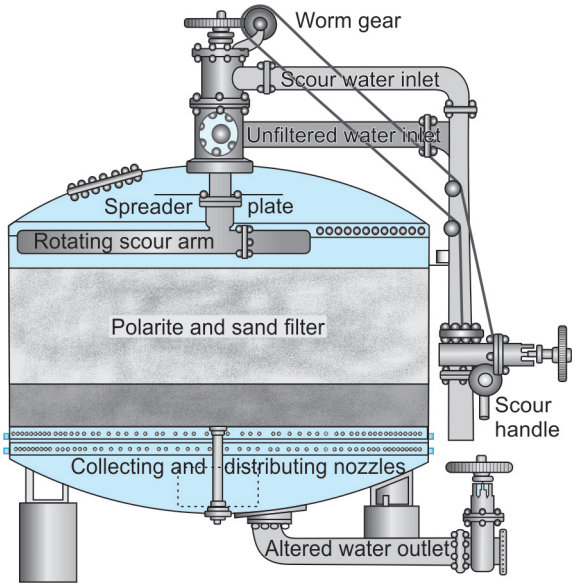


Fig. 5.7 Section of a Candy single-bed pressure filter
Source: Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.

and water looks clear. The washing process takes about 15 minutes. The filters are washed several times a day.

Candy's pressure filter: In Candy's pressure filter, the filtering media is divided into 3 layers. The top layer is of sand and gravel, middle layer of polarite, below which is the finishing layer of fine grit. The lower layer is again that of sand and gravel **(Fig. 5.7)**.

Advantages of rapid sand filters (Compared to slow sand filters):

- Preliminary storage is not necessary
- Can deal with raw water directly
- Filters occupy less space
- Filtration is continuous and rapid
- Cleaning is easy
- Cheap and efficient filters
- Specially suitable for turbid waters.

Disadvantages of rapid sand filters:

- The water requires preliminary treatment
- It requires the services of skilled persons
- The troubles that can occur are formation of mud-balls, cracking of filter-bed, air-binding, loss of sand and displacement of gravel.

Modified Filters

- *Coal filters:* In this type, the filtering medium is anthracite coal. They give longer filter-run
- *Anthracite filters:* In this type, the sand bed is covered by coarse anthracite. By virtue of lower specificity, the anthracite stays on top in back-washing

- *Multimedia filters:* These includes a combination of garnet, sand and anthracite
- *Diatomite filter:* The filtering medium is diatomaceous earth. The loss of hydraulic head allowed is greater and the rate of filtration is higher. However, bacterial removal is not so good. They are used for swimming pools and industrial water supply
- *Catridge filters:* These are disposable filters.

Differences between Slow Sand Filters and Rapid Sand Filters

		Slow sand filters	Rapid sand filters
1.	Area (900 m^2)	Requires large area	Requires small area.
2.	Sand bed	Height is 1.2 m.	Height is 1.0 m.
3.	Effective size of the sand	0.15 to 0.3 mm	0.6 to 2.0 mm
4.	Preliminary storage	It is necessary	Not necessary
5.	Preliminary treatment	It is not necessary	is a must
6.	Rate of filtration/ hour	0.1 to 0.4 m^3/m^2/ hour	5-15 m^3/m^2/hour
7.	Mechanism of action	It is mainly biological	is by physical and chemical
8.	Operation	It is less skilled	is highly skilled
9.	Suitability for turbid water	Not suitable	Suitable
10.	Loss of hydraulic head allowed	2 to 4 feet	8 to 10 feet
11.	Filter run	3 weeks to 3 months	1 to 3 days
12.	Cleaning	By scraping the sand bed	By back-washing
13.	Wasting of water	Water is not wasted during cleaning	2 to 3 percent of filter is wasted
14.	Cost	Capital cost is high but cost of operation is low	Capital cost is low but cost of operation is high
15.	Use of sludge	Sludge obtained after scraping is used as manure	Sludge is not obtained and wash water also is not of economic use
16.	Removal of turbidity	Is by vital layer	Is by alum coagulant
17.	Removal of color	Fair	Good
18.	Removal of bacteria	99.99%	99%
19.	Post-treatment chlorination	It is not necessary	Is a must

Chlorination

This is the process of disinfection of water by adding chlorine, as a final step in the purification of water following filtration. This serves as a final barrier to the passage of any pathogenic organisms.

It was Mr GA Johnson (1908) who initiated the use of chlorine compounds for disinfecting water.

Chlorine is a greenish-yellow colored, highly toxic gas. Exposure to 60 ppm in air for 30 minutes is dangerous and to 1000 ppm produces death within a few minutes.

Chlorine is an effective disinfectant, deodorant and an oxidizing agent. As a disinfectant, it destroys almost all the pathogens present in the water. However, it has no effect on the spores ova, cysts and certain viruses like poliovirus, hepatitis A virus, except in high concentration. It acts as a deodorant by destroying algae and fungi which produce bad odor and taste in the water. As an oxidizing agent, it oxidizes the organic substances like excreta, sewage, etc. and also oxidizes ammoniacal substances. It also oxidizes iron, manganese and hydrogen sulfide.

Chlorine is available in gaseous, liquid and solid forms.

Gaseous form: Being a highly toxic gas, it is liquefied and kept under pressure in cylinders. Gas is released slowly while disinfecting water by using a regulator called 'Chloronome apparatus'. This is used in big water purification plants in big cities.

Liquid form: Liquid chlorine is chloramines, i.e. chlorine is mixed with ammonia. The advantage is that ammonia releases the chlorine slowly over a long period of time providing a prolonged action. Thus ammonia prevents the chlorine from being used up too rapidly by the organic and ammoniacal substances, thereby simultaneously chlorine controls algae and fungi.

Disadvantage is that chloramines use becomes more expensive.

Solid forms: In the form of solid, chlorine is available in three forms:

- Monohypochlorite of calcium
- Dihypochlorite of calcium
- High test hypochlorite.

a. *Monohypochlorite of calcium (CaClOCl):* This is the classical bleaching powder. It is the chlorinated lime or oxychloride of lime. It is prepared by passing chlorine gas over hydrated lime. It is an amorphous, hygroscopic, white powder having chlorine smell. It readily absorbs moisture and carbon dioxide from the air and releases chlorine. Thus, bleaching powder is an unstable com-pound. Fresh bleaching powder contains 33.3 percent available chlorine (i.e. 100 g of bleaching powder contains 33.3 g of chlorine). The entire chlorine content is last over a period

of 3 months. Therefore, the bleaching powder should always be stored in brown colored bottles with air-tight lids and placed in cool, dry and dark place to minimize the deterioration of bleaching powder. Older the sample of bleaching powder, lesser will be the chlorine content.

Roughly 2.5 g of bleaching powder is required to disinfect 1000 liters of water. However, exact amount can be calculated by using 'Horrock's apparatus.'

Bleaching powder releases chlorine, which acts as a disinfectant. It releases nascent oxygen, which oxidizes the organic and ammoniacal substances. The chlorine of the bleaching powder combines with ammonia of water to form chloramine which controls algae and fungi and prevents the development of bad odor and taste. Calcium oxide of the bleaching powder acts as a bleaching agent and therefore used in paper and textile industries. Thus, bleaching powder is a disinfectant, deodorant, oxidizing agent and a bleaching agent as well.

Bleaching powder is not only widely used for disinfection of water for drinking purposes, but also to disinfect sputum, saliva and excreta of the infected patients. Fifty gram of 8 percent strength chlorine of bleaching powder is required for 1 liter of feces and urine.

The loss of chlorine from the bleaching powder can be reduced by adding excess of lime to the bleaching powder in the ratio of 4:1, which stabilizes the chlorine content of bleaching powder. Such a mixture is known as 'Stabilized bleach' which are sold in the market as pittchlor, penchlor, etc. The stabilized bleaching powder retains its potency up to 1 year.

b. *Dihypochlorite of calcium [Ca $(OCl)_2$]:* This contains twice as much available chlorine. It has less tendency to loose its chlorine content on exposure to air.

c. *High-test hypochlorite (HTH) (Perchloron):* This is also a calcium compound which provides 75 percent available chlorine. It is highly stable than bleaching powder. In other words, it is purer form of bleaching powder. Penchlor contains 70 percent available chlorine. Dose is 1 g per 1000 liters of water. Deterioration of chlorine is very very less on storage. Solutions prepared from perchloron are also used for water disinfection.

Action of Chlorine

When chlorine is added to water, it hydrolyzes immediately and completely into hydrochloric acid (HCl) and hypochlorous acids (HOCl). The HCl is neutralized by the alkalis present in the water and the hypochlorous acid ionizes to form hydrogen ions and hypochlorite ions as follows:

$$H_2O + Cl_2 \rightleftharpoons HCl + HOCl$$

$$HOCl \rightleftharpoons H^+ + OCl^-$$

The amount of ionization is governed by the pH and temperature of the water. Low temperature and high pH reduces the efficiency of chlorine.

The disinfecting action of chlorine is mainly due to hypochlorous acid (HOCl) and to a small extent due to hypochlorite ions. Chlorine acts best as a disinfectant when the pH of the water is around 7. If the pH of water increases, the hypochlorous acid very soon gets ionized to hypochlorite ions, thereby it is not available as a disinfectant. The disinfecting action of HOCl is rapid but short-lived.

Principles of Chlorination

Following are the principles:

- The water to be chlorinated should be clear and free from turbidity.
- 'Chlorine demand' of the water should be estimated. It is defined as the amount of chlorine demanded by the water for its purification (i.e. destruction of pathogens and oxidation of organic and ammoniacal substances). It is estimated indirectly by calculating the difference between the amount of chlorine added to the water and the amount of residual chlorine remaining at the end of contact period, because there is no practical method of determining beforehand the quantity of chlorine requirement to purify a certain volume of water, except by actually adding chlorine and testing the water for free residual chlorine.
- *Breakpoint chlorination*: The point at which the chlorine demand is met, is called the break-point chlorination. If chlorine is added beyond the break-point, it remains in the free state as 'free chlorine' (or free residual chlorine; FRC).

  As the chlorine is added it combines with ammonia to form chloramine. This is combined residual chlorine. This is also bactericidal. The peaking coincides with the oxidation of all organic matters. Addition of further chlorine then oxidizes ammoniacal compounds. Addition of next increments of chlorine results in destruction of chloramine, resulting in the release of free residual chlorine. The point at which the chlorine demand is met and the free residual chlorine starts appearing in the water, is called 'Break point chlorination.'

  The chlorine combined with ammonia is 'combined residual chlorine' and chlorine released after breakpoint chlorination is 'free residual chlorine' **(Fig. 5.8)**.
- *Contact period:* It is the period (time) required for the chlorine to disinfect the water. For optimum disinfection, the presence of free chlorine for a contact period of one hour is essential. The free chlorine that remains at the end of one hour is called 'Free residual chlorine' (i.e. after breakpoint chlorination).

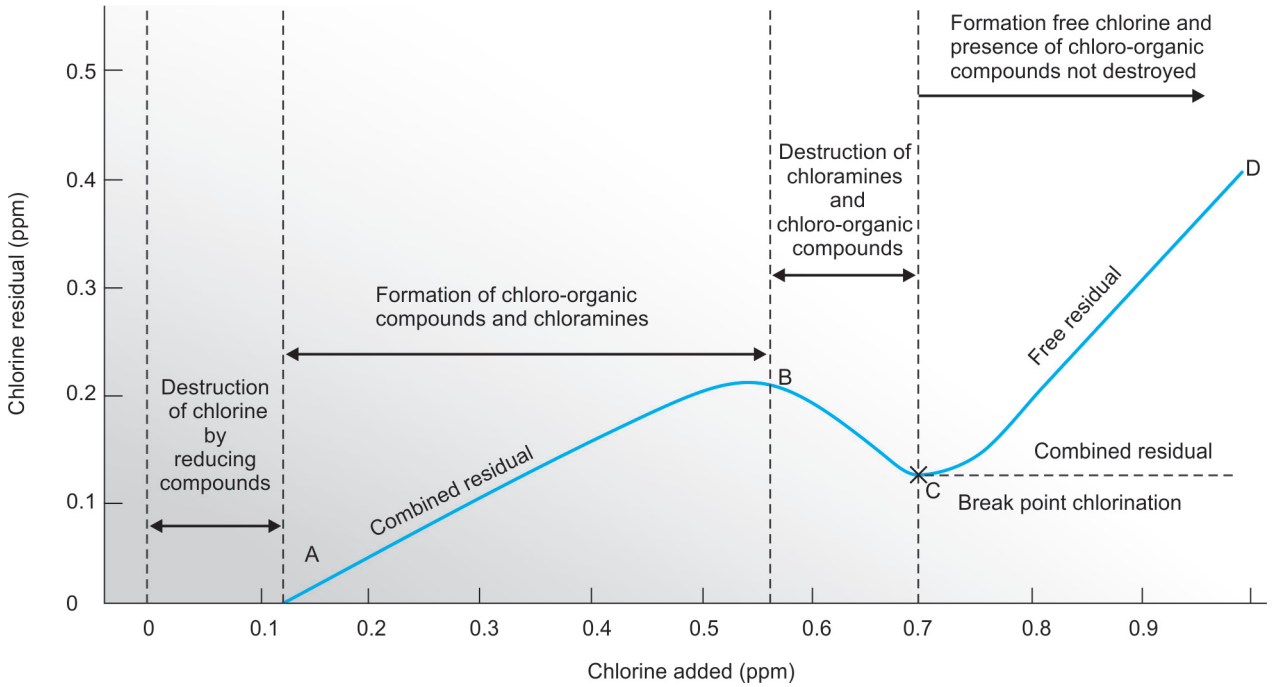


Fig. 5.8 Phases of break-point chlorination
Source: Dhaar GM, Robbani I. Foundations of Community Medicine. Elsevere, 1st edn, 2006.

- The minimum concentration of free residual chlorine for drinking purposes (in drinking water) should be 0.5 mg per liter (i.e. 0.5 ppm = part per million parts of water. 1 mg of chlorine in 1 liter of water provides 1 ppm concentration of chlorine).
- The purpose of providing free residual chlorine in the drinking water is to provide a margin of safety against further contamination of water which is likely to occur during storage and distribution.
- *Applied chlorine dosage:* It is the correct dose of chlorine required to disinfect the water, so as to get free residual chlorine concentration of 0.5 mg per liter (0.5 ppm). This is also called as 'Marginal chlorination' (simple chlorination). It is the sum of chlorine demand of the specific water plus free residual chlorine of 0.5 mg per liter (i.e. the dose required for break-point chlorination + marginal chlorination, as to get frc of 0.5 mg per liter)
- *Superchlorination:* This is a process of chlorination, wherein double the usual dose of chlorine is added to water, as to get frc of more than 2 ppm at the end of contact period. This is resorted to when the water is heavily contaminated or when there is threatening outbreak of water-borne epidemic. But the disadvantage is that such superchlorinated water will have the smell of chlorine and it irritates throat, nose and eyes while drinking. Therefore, super-chlorination is followed by dechlorination.
- *Dechlorination:* This consists of removal of excess of chlorine by controlled addition of reducing substances such as sulfur dioxide, sodium sulfite, sodium bisulfite, sodium thiosulphate or activated carbon. The frc is reduced to less than 2 ppm.

For chlorination to be fully effective, the pH value of the water must be maintained between 7.2 and 7.6. Under no circumstances it should be allowed to fall below 7 or to exceed 8. Where the pH value is less than 7, sodium carbonate is added and where it is higher than 8, hydrochloric acid is added. In either case only small quantities are added periodically at hourly intervals until the correct pH is obtained.

Orthotoluidine test: This is a test done to measure rapidly, the free chlorine in the water. The apparatus used for the purpose is called 'Chloroscope' (or chlorotex apparatus). It comprises reagent, two graduated measuring cylinders, a pipette, a stirring rod and a chart showing a range of colors, each color representing the concentration of free chlorine in the water. The reagent consists of orthotoluidine dissolved in 10 percent hydrochloric acid **(Fig. 5.9)**.

Procedure: One mL of the reagent, measured accurately with the help of a pipette, is taken in one of the graduated cylinders. In another cylinder 10 mL of the water to be examined, is taken. The water is then poured over the reagent and not vice versa, mixed well with a stirring rod and allowed to stand exactly for one minute. The yellow color produced

Fig. 5.9 Chlorotex apparatus

is compared with the color chart. The intensity of the color varies with the concentration of free chlorine.

Yellow color is produced by both free chlorine and combined chlorine of the water. The reagent reacts with free chlorine immediately and slowly with combined chlorine. So if the yellow color appears immediately (within 10–15 seconds) it indicates the presence of free chloride. If the color appears slowly after 15 to 20 minutes, it indicates the presence of both free and combined chlorine.

Yellow color also appears if the water contains iron, manganese and nitrites. The error caused by the presence of such substances can be overcome and the free and combined chlorine levels can be estimated by a modified orthotoluidine test called 'Orthotoluidine Arsenite test' (OTA test). In this test, instead of orthotoluidine reagent, orthotoluidine arsenite reagent is used.

Water on large scale can also be purified by using ozone and ultraviolet radiation.

Ozonation: This consists of passing ozonized air through the water. Ozone is an unstable gas. It is a powerful oxidizing agent. It not only destroys the pathogens including viruses but also destroys the phenolic substances producing bad color, odor and taste.

The limitation of this process is that the ozone gas does not persist in the water in the free residual form unlike chlorine gas. Other limitations are it involves electrical and engineering difficulties. It is expensive.

Since ozone also destroys the undesirable organo-chlorine compounds, which are produced following chlorination of water, ozonation and chlorination of water is now thought be complementary processes of water purification. Dose of ozone is 0.2 to 1.5 mg per liter of water.

Ultraviolet irradiation: This process consists of direct exposure of a film of water, of about 1.5 cm thick, to the U-V rays of mercury vapor quartz lamp, emitting the rays of wavelength 2538 A (Angstrom units) (i.e. 200 to 300 mm). These destroy not only the vegetative form of the bacteriae within a few seconds, but also spores over slightly longer exposure. Thinner the water film, rapid will be the absorption of rays. Over exposure has no residual effect, nor it is harmful.

The shortcomings of this method are high cost of operation, maintenance of operation and even the small quantities of color, turbidity and iron in the water diminish the effectiveness by absorbing the U-V rays.

PURIFICATION OF WATER ON SMALL SCALE

A. Household purification of water
B. Disinfection of wells.

Household Purification of Water

Household purification of water is by three methods—physical, chemical and mechanical.

Physical Methods

These are boiling, ozonation and ultra-violet irradiation.

a. *Boiling:* This is the cheap and best method of purification of water for domestic use. Not only the organisms are destroyed but also the spores, ova, cyst, viruses, etc. To be effective, the water must be brought to a 'rolling boil' for 5 to 10 minutes. The water is sterilized.

   Other advantage is that the temporary hardness is also removed by driving out carbon-dioxide and precipitating calcium carbonate.

   The only disadvantage is that the water becomes tasteless and there is no residual protection in the water.

   Water should be boiled preferably in the same container in which it is to be stored to avoid contamination during storage.

b. Ozonation
c. U-V radiation] already explained

Chemical Methods

The different chemical substances employed for purification of water for domestic use are chlorine, iodine and potassium-permanganate.

Chlorine:

- In the form of gas is employed for purification of water on large scale
- In the form of powder (as bleaching powder, high test hypochlorite, tablets) is employed for domestic use.
- Is also employed in the form of solution.
  i. *Bleaching powder:* Fresh bleaching powder containing 33.3 percent of available chlorine, required is 2.5 g per 1000 liters of water (per cubic meter) in other words, if 100 g of bleaching powder containing 33 percent available chlorine is added to the water, it liberates 33 g of chlorine, the remaining 67 g becomes inert.
  ii. *High test hypochlorite:* HTH is a calcium compound containing 70 to 75 percent available chlorine. It is a more stable and purer form than bleaching powder. Dose—1 g per cubic meter of water. HTH can also be employed in the form of solution.
  iii. *Chlorine tablets:* They are marketed under the trade names halazone, chlor-de-chlor, hydroclonazone, etc. They are quite costly. They disinfect the water but do not remove the turbidity. Recently the National Environmental Engineering Research Institute (NEERI), Nagpur has developed a double action chlorine tablets, capable of not only removing the turbidity but also disinfects the water effectively. Each tablet of 0.5 g is required to disinfect 20 liters of water. These tablets consists of alum, bleaching powder, sodium bi-carbonate and talc mixed in appropriate proportions.
  iv. *Chlorine solution:* This is prepared from bleaching powder. 4 kgs of bleaching powder of 25 percent available chlorine, when mixed with 20 liters of water, gives 5 percent solution of chlorine. Different strengths of chlorine solutions are available in the market. It is also an unstable preparation. It looses chlorine on exposure to air and light.

Iodine:

- Two drops of 2 percent ethanol solution of iodine (Lugol's solution) is sufficient for one liter of clear water. Contact period of 30 minutes is necessary. This can be employed during emergency conditions.

  It is not used as a routine because it is physiologically active and interferes with thyroid activity. Another demerit is that iodine does not react with ammonia or organic compounds to great extent, eventhough it is in free form and persists longer than chlorine. It is high cost also.

  Iodine tablets are marketed as Nesfield's tablets and Bursoline's tablets.

Potassium permanganate:

- This is a powerful oxidizing agent. It oxidizes and destroys the organic matter on which bacteriae thrive. Eventhough it is capable of destroying *Vibrio cholerae* organisms in the water, it is of little value and unreliable against routine pathogens present in the water because it looses oxygen for oxidizing organic matters before killing the bacteriae and also it alters the color, smell and taste of water. Therefore, $KMnO_4$ is not recommended for disinfection of water. However, it is used to disinfect fruits and vegetables.

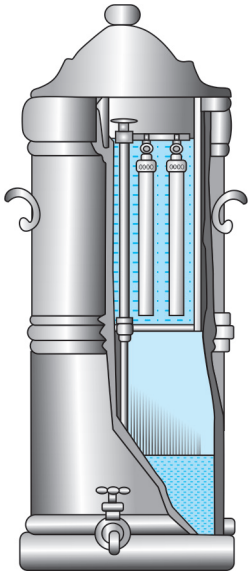


Fig. 5.10 Pasteur-Chamberland filter

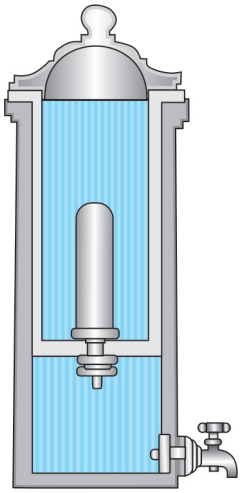


Fig. 5.11 Berkefeld filter

Source: Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.

Mechanical Methods

This consists of using the ceramic filters, such as Pasteur-Chamberland fitter, Berkefeld filter **(Figs 5.10 and 5.11)**, Katadyn filter, carbon and pad filter, acquaguard and reverse osmosis treatment.

The essential part of the first three filters, is called 'Candle', or 'Tube', which is made up of porcelain in the P-C filter and of kieselgarh or infusorial earth in the Berkefeld filter and a coat of silver catalyst on the candle in Katadyn filter.

The 'Candle' is fitted in the upper chamber of the filter. As the water passes through the candle, all the bacteriae, protozoa and helminthes and turbidity are arrested. They are not allowed to pass through. However, viruses like poliovirus, hepatitis A and E viruses pass through.

In Katadyn filter silver, ions are released from the silver catalyst coat of the candle, which absorb the oxygen of the water and destroys the bacteriae. This is called 'Oligodynamic action' of the silver-ions.

Merits: These domestic filters are handy, used to purify the water for individual houses.

Demerits: The candles do not arrest the filter passing viruses. The turbid impurities clog the filters. Filters require frequent

cleaning (by scrubbing with a hard brush under running water and boiled at least once a week). Therefore, candles are liable for damage, while cleaning. The clogged candle can act as nidus for the pathogens to grow. So it has to be cleaned.

Eventhough ceramic filters are reliable, they are not quite suitable under the existing conditions in our country.

- *Carbon and pad filter:* This filter is screwed on the tap. The water passes through the filtering pad, encounters with the activated carbon, which absorbs the organic matter rendering the water clean. In due course of time, it looses its efficiency.
- *Acquaguard domestic filter:* This purifies the water in three stages:
  - It filters, i.e. traps the dirt, mud and such other turbid impurities.
  - It removes the organic impurities (thereby removes the color and odor)
  - It inactivates the pathogens by U-V treatment in the U-V chamber.

It has the built in electronic monitoring system whereby it monitors the quality of purified water and stops the flow if the purification level falls below the predetermined levels **(Fig. 5.12)**.

- *Reverse osmosis treatment:* Invention of this technique is a milestone in man's creation for drinking resource. Reverse osmosis is based on water reverse theory in nature. NASA in US first applied this theory in purifying the astronaut's urine as a resource for drinking water in space.

In this process, water is purified in five stages as follows:

Stage 1: 5µ sediment filter. This removes sand, silt, dust and rust particles (i.e. suspended impurities)

Fig. 5.12 Acquaguard filter

Stage 2: Activated carbon block filter. Removes chlorine, organic matters, colors and bleaches (Removes chemical impurities).

Stage 3: Gag filter. Removes harmful chemicals and color, taste and odor producing substances (Removes bad taste, color and odor).

Stage 4: TF composite membrane with 0.0001 mm pore (reverse osmosis membrane).

Removes dissolved salts, organics, germs, bacteria, virus, compound metals and minerals. Allows only water molecules to pass through.

Stage 5: Bacteriostatic silver impregnated activated carbon.

Prevents growth of bacteriae at the point of use and removes color and odor, thereby restores (or improves) the natural taste of water **(Figs 5.13A and B)**.

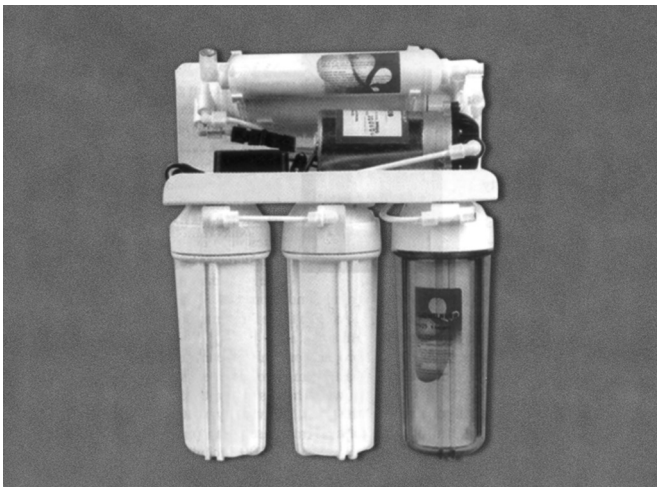


Fig. 5.13A Standard model for domestic use

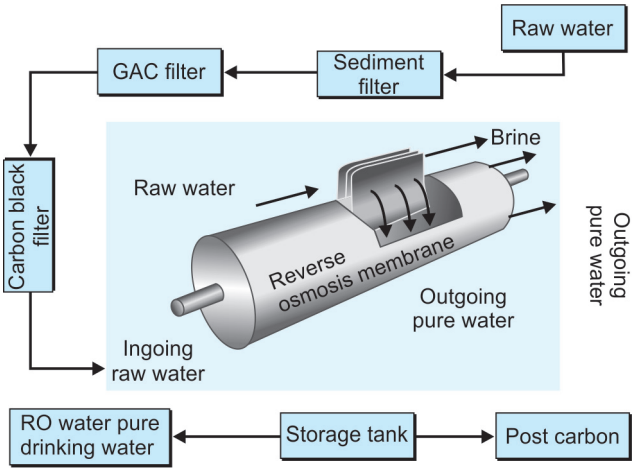


Fig. 5.13B RO purification technology

Demerits of Reverse Osmosis (RO) Purifiers

- Many naturally occurring minerals in the water get lost in the process.
- It is a slow process and requires long time to purify water.
- For every liter of water purification, about four liters of water is wasted.
- Initial investment is heavy but works out to be economical in the long run.
- These need a reasonable degree of maintenance.

Ultraviolet Purifiers

This works with a UV light source of higher intensity than that of sun light. The UV rays kill the biological contaminants. Since the UV lamp is of very high intensity, when the water passes by it (after removal of solid pollutants with a carbon filter catridge) the pathogens are killed and made harmless. It draws the same amount of electricity as a standard light bulb, but the UV lamp should be replaced annually. Nevertheless the chemical composition of water is not altered **(Fig. 5.13C)**.

Chemical Purifiers

Chemical purifiers do not need electricity and are much cheaper than RO and UV water purifiers. These purifiers run on the carbon method. In this method, the carbon filter catridges trap the particulates and impurities of the water. The charcoal has positive charge and it captures the negatively charged ions of the impurities and contaminants of the water **(Fig. 5.13D)**.

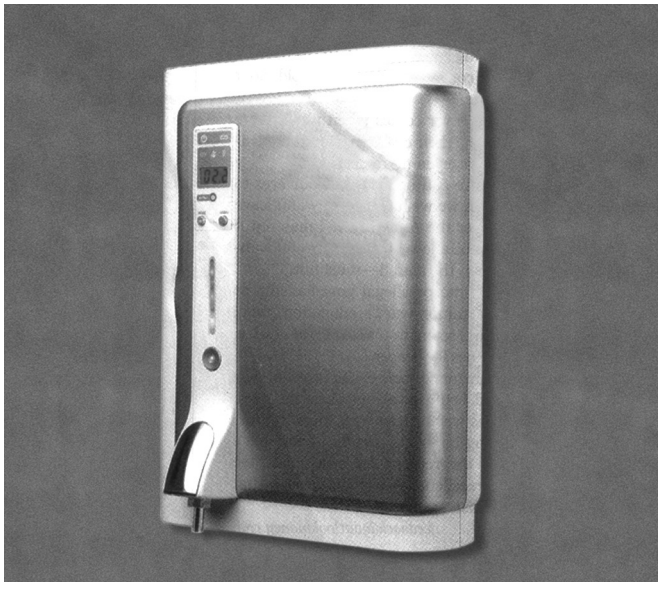


Fig. 5.13C Ultraviolet purifier

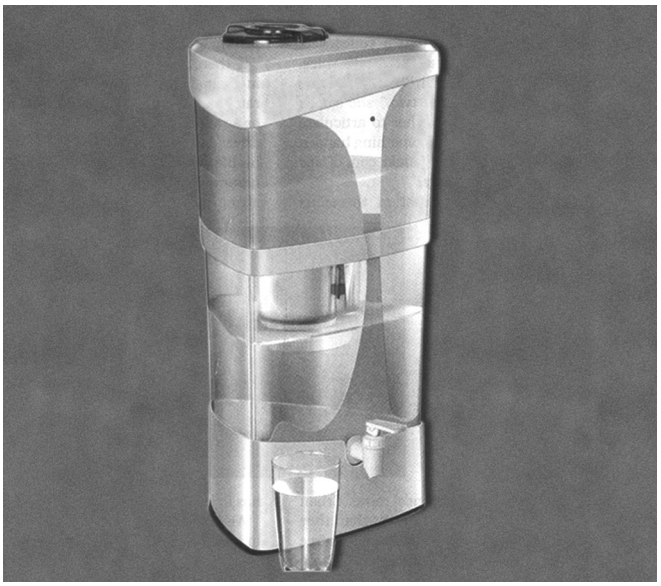


Fig. 5.13D Chemical purifier

Thus, these filters can reduce the organic chemicals like pesticides, herbicides, chlorine, radon and such other common chemicals found in water. However, these filters do not remove fully the heavy metals present in the water.

Disinfection of Wells

Wells constitute the main source of water supply in rural areas. Since most of the wells are shallow wells, liable for contamination, need to be disinfected periodically, more so during epidemics of acute gastroenteritis, cholera, etc. Wells are best disinfected by bleaching powder.

The various steps of disinfection of wells are:

- Finding the volume of water in the well
- Estimating the quantity of bleaching powder required
- Preparation of the chlorine solution
- Delivery of the chlorine solution
- Contact period
- Orthotoluidine test.

a. *Finding the volume of water in the circular well*: By using the formula,

If it is circular well,

$$\frac{3.14 \times d^2 \times h}{4}$$

The volume is expressed in cu meters. 1 cu meter = 1000 liters.

∴ Volume of water in cu meters × 1000 = X liters

Which is derived from

$\pi r^2 h$, where $\pi = \frac{22}{7} = 3.14$

r = Radius of well in meters.
= Half of diameter
= d/2

$$r^2 = \frac{d}{2} \times \frac{d}{2} = \frac{d^2}{4}$$

h = Height of water column in meters.

If it is rectangular well,
the formula is l × b × h
× 1000 = X liters
Where l = Length of well in meters.
b = Breadth of well in meters.
h = Height of water column in meters.

b. *Estimation of quantity of bleaching powder required*: The quantity of bleaching powder required to disinfect a particular well can be estimated by using 'Horrock's apparatus.'

Horrock's Apparatus

Contents:

- 6 white cups, each of 200 ml capacity,
- 1 black cup with a white circular margin inside, near the brim.
- 2 metal spoons, each level spoonful holds 2 g of bleaching powder
- 7 glass stirring rods
- 1 special pipette
- 2 droppers
- Starch iodide indicator.

Procedure

Preparation of stock (standard) chlorine solution: One level spoonful (2 g) of bleaching powder is taken in the black-cup and made into a thin paste by adding little water. Then more of water is added gradually with stirring till the level reaches the white circular mark. It is stirred well and allowed to settle, so that calcium of the bleaching powder settles down. This is the stock chlorine solution.

All the six white cups are now filled with water from the well, to be tested for 'bleaching powder estimation' up to a cm below the brim.

With the help of the pipette, one drop of standard chlorine solution is added to first white cup, two drops to second cup, three drops to third cup, so on and six drops to sixth cup.

The water in each cup is stirred well with separate stirrers for each cup.

Then waited for half an hour for the action of chlorine in the water (Chlorination).

Then three drops of Starch-iodide indicator is added (Starch-cadmium/potassium-iodide) for all the six cups and stirred again.

Development of blue color indicates the presence of free residual chlorine. The intensity of the blue color is directly proportional to the quantity of free residual chlorine in the water—suppose the fourth cup shows distinct blue color first, the intensity of color increases subsequently in fifth and sixth cups.

Mechanism: When chlorine solution is added to the white cups, it is utilized by the organic and ammonical substances for oxidation purposes. Once the oxidation process is over, free chlorine is left. This is acted upon by starch-cadmium/potassium-iodide, resulting in the formation of cadmium/potassium chloride and iodine is set free, which then acts upon the starch giving rise to blue color. So development of blue color indicates the release or presence of free residual chlorine in that cup.

Suppose blue color is not obtained even in 6th cup, the first cup is considered as 7th cup and counted subsequently as 8th, 9th, 10th cup and so on and the test is continued by adding chlorine solution, 7 drops, 8 drops, so on respectively to all the remaining cups (i.e. 6 drops to each of the cups in second round).

The first cup showing distinct blue color is noted. That cup number indicates the number of level spoonfuls of bleaching powder for disinfecting 455 liters of water, so as to give 0.5 ppm of free residual chlorine concentration. Suppose 5th and 6th cups turn blue, then 5 (the number of the first cup showing distinct blue color) level spoonful (or 10 g) of bleaching powder is required to disinfect 455 liters of water of that particular well, for simple or marginal chlorination. For X liters of water in the well, quantity of bleaching powder is estimated.

Procedure of Disinfection of Well

The estimated amount of bleaching powder is taken in a bucket and made into a thin paste by adding little water. Then more of water is added till the bucket is three-fourths full. It is stirred well and allowed to sediment for 1 minute, so that lime settles down. The supernatant chlorine solution is transferred to another bucket and the chalk or lime is discarded and not poured into the well, because it increases the hardness of well-water.

The bucket containing chlorine solution is lowered into the well, below the surface of the water and agitated vertically and horizontally, so that chlorine solution mixes with the well water uniformly.

Then contact period of one hour is allowed before the water is drawn for use.

To verify whether water has been properly chlorinated or not, orthotoluidine test is done. If free residual chlorine level is less than 0.5 ppm after contact period of one hour, the chlorination procedure should be repeated.

During the epidemics of water borne diseases, wells are superchlorinated everyday, preferably twice a day, once in the early morning and once in the late afternoon in case of heavily used wells.

Continuous Method of Chlorination

To ensure a constant dose of chlorine to the well-water, under the circumstances of epidemic of water borne disease, the National Environmental Engineering Research Institute, Nagpur has recommended 'Double pot method' (Double jar diffusion method) of chlorination of wells **(Fig. 5.14)**.

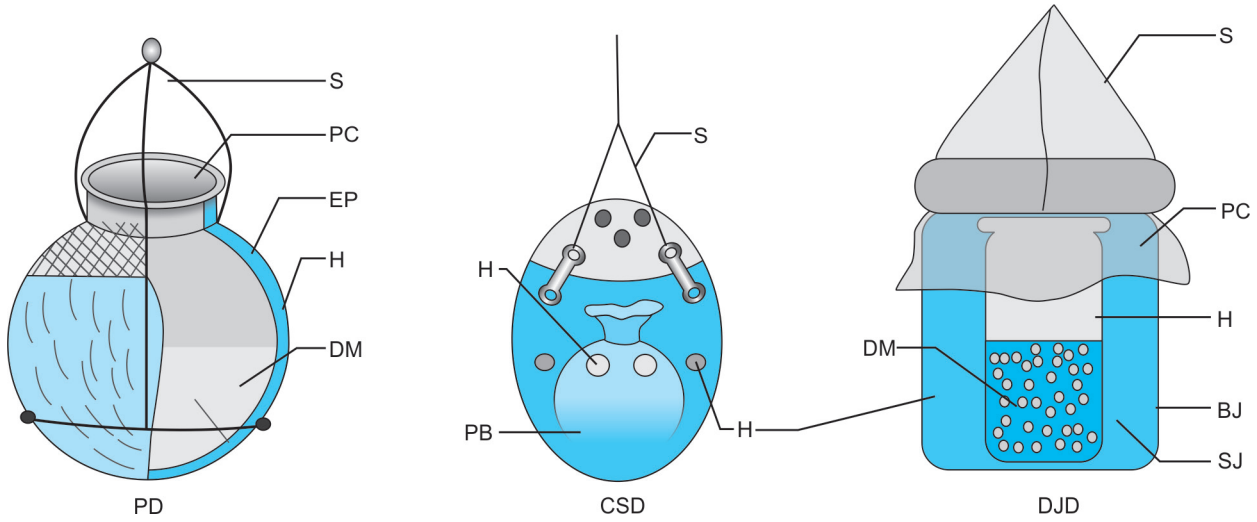


Fig. 5.14 Chlorine diffusers, PD-pot diffuser, CSD-coconut shell diffuser, DJD-double jar diffuser, EP-earthenware pot, CS-coconut shell, BJ-big jar, SJ-small jar, H-hole, DM-disinfectant mixture, PB-polythene bag, PC-polythene cover, S-string.
Source: Dhaar GM, Robbani I. Foundations of Community Medicine. Elsevere, 1st edn, 2006.

This method consists of two cylindrical pots, one placed inside the other. The size of the cylinders being 30 cms height and 25 cms diameter for the outer pot and 28 cms height and 16 cms diameter for the inner pot. Both the pots have an opening on the side. The outer pot has an opening of about 1 cm diameter near the bottom and the inner pot has the opening near the brim.

A mixture of 2 kg of coarse sand and 1 kg of bleaching powder is put in the inner pot and moistened with water. It is then put inside the outer pot. The surface is then closed with a polythene foil.

The double pot is then lowered into the well by means of a rope, for about 1 meter below the water surface, to prevent the damage caused by the buckets used by the public. The water from the outer pot enters into the inner pot, mixes with bleaching powder mixture. The chlorine solution comes out slowly over a long period of time, thus ensuring constant chlorination over a long period of about 15 to 20 days, for a well containing about 4500 liters of water, having a draw-off rate of about 400 liters per day. After 15 to 20 days, it needs to be removed, emptied, refilled and replaced for further chlorination. The other types of chlorine diffusers are pot diffuser and coconut shell diffuser **(Fig. 5.14)**.

Sanitation of the Swimming Pool

The diseases transmitted through swimming pool water are conjunctivitis, sinusitis, otitis-media, infectious sore throat and athlete's foot. Rarely diseases like typhoid, dysentery, vulvo-vaginitis, trachoma have also been traced. All these diseases occur due to the contamination of the swimming pool water from the skin, nasopharynx, urination by the users.

The regulations regarding the construction of the pool, its use, disinfection procedures, and instructions to the users are all adopted.

Sanitation Measures

- *Construction*: It should be away from the traffic and dusty roads.
- *Area*: It should be 2.2 sq m per person swimming.
- *Water*: There must be continuous circulation of water, coming from deep end of the pool, passing through a purification plant, (where it undergoes clarification, filtration and chlorination) and enters the pool from the shallow end. The free residual chlorine is maintained at a level of about 0.5 ppm, as recommended for drinking water. More than 1.0 ppm of frc results in smarting of the eyes. The pH of water is maintained around 7.5.

The results of bacteriological examinations of samples of water taken from the inlet and outlet of the purification plant, gives an indication of the effectiveness of the water treatment. The bacteriological quality of water should approximate to that of pure drinking water.

About 15 to 20 percent of the water of the pool should be replaced by fresh water every day in order to remove the nitrates, albuminoid ammonia and organic substances derived from the users, because they reduce the effectiveness of chlorination. Entire water is changed once a week.

Maintenance of Cleanliness

For this purpose, following measures are strictly enforced:

- No one with cutaneous lesions or discharges from body orifices should enter the pool.

- Before entry into the pool, the user should empty the bladder and bowel, and clean the nose and throat.
- This is followed by thorough scrub-bath with soap and water.
- After the bath, the user should dip his feet in 'foot-bath' (consisting of chlorine solution) then only should enter the pool.
- Swimming pool dress only should be worn.
- Once inside the pool, spitting, blowing of the nose, gargling and urination is forbidden.
- After leaving the pool, thorough bath should be taken again.

HARDNESS OF WATER

Definition

A hard water is a one which does not readily form lather with soap (In other words, it is soap destroying quality of water).

Causes

The hardness of water is due to the presence of certain mineral salts in the water such as bicarbonates, chlorides, sulfates and nitrates of calcium and magnesium, which form insoluble, sticky precipitate with soap.

Types

There are two types of hardness of water: temporary and permanent hardness:

- Temporary (or carbonate) hardness is due to the presence of carbonates and bicarbonates of calcium and magnesium.
- Permanent (or noncarbonate) hardness is due to the presence of sulfates, chlorides and nitrates of calcium and magnesium.

Measurement

Hardness of the water is measured or estimated by using a standardized titrant, 'Ethylene diamine tetra acetic acid (EDTA). The results are expressed as mgm of $CaCO_3$ per liter of water, i.e. milli equivalents per liter (mEq/L) 1 mEq/L of hardness is equal to 50 mgms of $CaCO_3$ [calcium-carbonate] (or 50 ppm) per liter of water, as suggested by WHO in its 'International Standards for Drinking Water'.

Grading of Hardness of Water

- *Less than 1 mEq/L (i.e. < 50 ppm):* It is soft water
- *1 to 3 mEq/L (50–150 ppm):* It is moderately hard water
- *3 to 6 mEq/L (150-300 ppm):* It is hard water
- *More than 6 mEq/L (> 300 ppm):* It is very hard water.

Drinking water should be moderately hard (1–3 mEq/L). The question of softening the water arises if the hardness exceeds 3 mEq/L.

The degree of hardness can also be measured by 'Clark's method'. According to him, the same four grades are expressed respectively as <10 percent, 10 to 15 percent, 15 to 30 percent and > 30 percent.

The hardness of water is not only dependent on the geology of the region in which the water is found but also by the pollution with sewage and many other waste. Limestone regions produce water containing considerable hardness. Granite areas produce soft waters.

Advantages of Hard Water

Recent studies have shown an inverse correlation between the hardness of water supplied to the community and its cardiovascular mortality rate. The areas supplied with soft drinking water showed a higher prevalence rate of cardio-vascular mortality rate proving that hard water is cardio-protective.

Disadvantages of Hard Water

- It causes great wastage of soap
- It causes precipitation of carbonates and forms scales in the boilers, leading to greater fuel consumption, loss of efficiency and even explosions of boilers resulting in industrial economic loss
- It affects cooking adversely
- It causes irritation of skin and gastrointestinal system
- It reduces the life of clothes washed with soap in hard water.

Removal of Hardness

- Temporary hardness (due to carbonates and bicarbonates of Ca and Mg) can be removed by processes like boiling of water, addition of lime, addition of sodium carbonate and permutit process.
- Permanent hardness (due to chlorides and sulfates of Ca and Mg) can be removed by last two processes, i.e. by addition of sodium carbonate and permutit process.

Removal of temporary hardness:

a. *Boiling*: By boiling the water CO_2 gas is driven off, precipitating the carbonates. The main principle is to remove CO_2 gas. Water becomes soft. The reaction is as follows:

$$Ca(HCO_3)_2 \rightleftharpoons \downarrow CaCO_3 + \uparrow CO_2 + H_2O$$

Since it is not practicable to boil the water on large scale, next method is preferred.

b. *Addition of lime*: For example, calcium hydroxide, when added to water, absorbs carbon dioxide gas and

precipitates insoluble calcium carbonates, resulting in softening of water. Meanwhile it accomplishes magnesium reduction.

$$Ca(OH)_2 + Ca(HCO_3)_2 \rightleftharpoons \downarrow 2CaCO_3 + 2H_2O$$
$$Ca(OH)_2 + Mg(HCO_3)_2 \rightleftharpoons MgCO_3 + CaCO_3 + 2H_2O$$
$$Ca(OH)_2 + Mg(CO_3) \rightleftharpoons Mg(OH)_2 + CaCO_3$$

c. *Addition of Sodium carbonate (soda ash)*: Addition of sodium carbonate not only removes the temporary hardness but also permanent hardness, as follows:

$$Na_2CO_3 + Ca(HCO_3)_2 \rightleftharpoons 2\,Na_2HCO_3 + CaCO_3$$
$$Na_2CO_3 + Ca(SO_4) \rightleftharpoons CaCO_3 + Na_2SO_4$$
$$Na_2CO_3 + CaCl_2 \rightleftharpoons CaCO_3 + 2NaCl$$

d. *Permutit process*: Synonyms are ion exchange process; base exchange process; zeolite softening.

In this process also not only the temporary hardness but also the permanent hardness is removed. Zeolite is a mineral consisting of sodium, aluminum and silica. It is also called as sodium permutit (or sodium zeolite) Na_2Z. When this is added to hard water, the Ca and Mg ions exchange with NaZ and forms Ca and Mg permutit and the water is softened to zero hardness **(Fig. 5.15)**. The reaction is as follows:

$$Na_2Z + \begin{matrix} Ca \\ Mg \end{matrix}\left\{\begin{matrix} (HCO_3)_2 \\ SO_4 \\ Cl_2 \end{matrix}\right. \rightleftharpoons \begin{matrix} Ca \\ Mg \end{matrix} Z + \begin{matrix} 2NaHCO_3 \\ Na_2SO_4 \\ 2NaCl \end{matrix}$$

Since the soft water of zero hardness has a corrosive property on pipes, raw water is again mixed to the soft water to secure the desired level of hardness, i.e. 1 to 3 mEq/L.

When all the zeolite is utilized, it can be regenerated again by passing a strong solution of sodium chloride, so that it becomes ready to soften more of water, as follows:

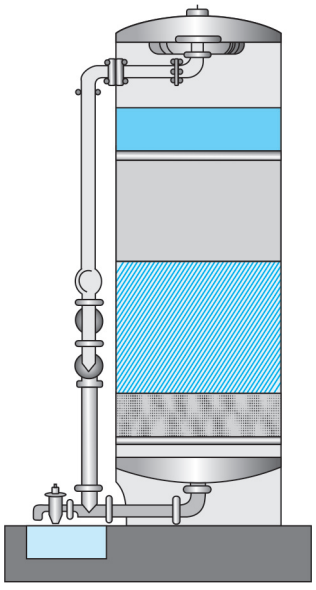


Fig. 5.15 Permutit water softener

Source: Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.

$$2NaCl + \begin{matrix} Ca \\ Mg \end{matrix} Z \rightleftharpoons \begin{matrix} Ca \\ Mg \end{matrix} Cl_2 + Na_2Z$$

The operation can be made completely automatic.

CONSERVATION OF WATER RESOURCES

Because of industrialization, urbanization, deforestation which in turn supplemented by population explosion in our country, has resulted in the shrinkage of surface waters like rivers, ponds, lakes, etc. resulting in increasing demand for water, thereby seeking for the subsoil resources of water. There has been an alarming fall in the ground-water sources also because of the dependency of irrigation on tube-wells. Therefore, before it is too late, urgently the underground water resources should be conserved. The term 'conservation' means protection of water resources and further building up the reserves. Conservation has thus two components.

Protection of Water Resources

This can be done by preventing the wastage of water. This requires extensive education of the public about the economical use of water and to consume minimum requirement for daily use.

Building-up of Subsoil Water Reserves

This is also called as 'Water harvesting'. This can be done by draining the rain water by using PVC pipes, from top of the buildings and courtyards into soaking pits or trenches, instead of drains, followed by filtration by using sand and gravel and then letting into existing tube-wells or wells. Various economic designs are suggested by agencies like UNICEF, Central Ground Water Board, etc.

SANITARY ANALYSIS OF WATER

This consists of information obtained from two sources, i.e. field surveys of the water source and laboratory examination report of the water samples.

Field Survey

This includes the collection of data on the nature and source of water supply, likely sources of water pollution, mode of

filtration, mode of distribution and such other information, as would be relevant from the sanitary point of view.

Laboratory Examination of Water Samples

This indicates whether the collected sample of water contains substances indicative of pollution or that are themselves harmful or undesirable.

Collection of Sample of Water

The method of collection of sample and quantity requirement of water are different for different types of analyses. For routine physical, chemical and biological examination, 2 liters sample should be collected in a clean glass bottle, recommended is Winchester Quart bottle. For bacteriological analysis, 200 cc of water should be collected in a sterile bottle, sterilized in an autoclave. For radiological analysis, polythene bottle is preferred.

Sampling Technique

The sample of water must be thoroughly representative of the water to be analysed. In collecting from a river, stream or lake, the sample should be obtained from a mid-stream and not too near the bank and the surface pollution should be avoided, by placing the bottle well under the surface of the water.

If the water has to be collected from the taps, the water is allowed to run to waste for a few minutes and then collected. Meanwhile the temperature of the water, at the time of collection, is also recorded.

The bottle containing water sample is closed with stopper and sealed. It is sent preferably in an ice-box to the laboratory for examination purpose. Shorter the time elapsing between collection and analysis, more reliable are the results.

LABORATORY EXAMINATION OF WATER

This includes the following:

- Physical examination
- Chemical examination
- Biological examination
- Bacteriological examination
- Radiological examination
- Virological examination.

Physical Examination of Water

This is done to determine the presence of those substances in the water which affect the physical or aesthetic quality of water, such as odor, taste, color and turbidity. These tests are arbitrary. It is difficult to express the results in terms of amounts of specific compounds present.

a. *Odor and taste*: The drinking water should not have disagreeable odor and taste. The odor and taste in the water is due to growth of algae, fungi, diatoms, chrystophata, decaying organic matters, hydrogen sulphide gas, etc.

   The odor of the water should be observed at room temperature. The odor may be aromatic, grassy, fishy, earthy, musty, peaty, disagreeable, sweetish, etc. The intensity of odor may be estimated by serial dilution with odor free water—the so called 'Threshold-odor test.' The recommended threshold odor number for drinking purposes is not over 3 units. For example, when one part of water is added to two parts of odor free water, odor should be barely detectable.

b. *Color*: Drinking water should be free from any color. Pure water is colorless. Most surface waters exhibit a color varying from green to yellow and brown. The color is usually of vegetable origin. Colors may also be due to the presence of industrial waste. Ground water is usually colorless.

   The natural color of the water is determined by matching 50 mL of sample of water in a Nessler tube with a standard solution of platinum and cobalt salts. This standard is diluted to give subsidiary standards of suitable range for comparison with the sample.

   The instrument used to determine the color is called 'Colorimeter.' The optimum limit is 5 units. The prescribed upper limit is 15 true color units (TCU).

c. *Turbidity*: Drinking water must be free from turbidity. The turbidity or muddiness is due to the presence of mud, clay, silt and such other particulate matters. Turbidity interferes with disinfection of water. Usually surface waters are turbid and ground waters are clear.

   The turbidity of water is measured by 'Jackson Candle Turbidimeter.' The prescribed upper limit is 5 units.

   To sum up, from aesthetic point of view (Physical parameters), a clear, nonsmelling, highly aerated water is fit for human consumption. However, further examinations are necessary for complete assessment.

Chemical Examination of Water

The chemical components of water have been grouped into four groups, depending upon whether they lead to acute health problems or potentially hazardous or hazardous after prolonged exposure or have cumulative toxic properties.

a. Toxic substances
b. Substances affecting after prolonged exposure
c. Substances affecting the potability of water
d. Chemical indicators of pollution.

- *Toxic substances*: None of these elements are commonly found in natural waters. Their presence suggests pollution with mining, smelting, etc. It is easier to eliminate their source of pollution than to remove them from water.

  The toxic substances and their upper permissible limit, in mg/liter concentration is shown in **Table 5.1**.

Table 5.1 The toxic substances and their upper permissible limit

Toxic substances	Prescribed upper limit (in mg/L) ppm
Arsenic	0.01
Cadmium	0.003
Cyanide	0.07
Lead	0.01
Mercury	0.001
Selenium	0.01

Other toxic chemical substances are barium, berrylium, cobalt, molybdenum, thiocyanate, tin, uranium, vanadium, etc.

- *Substances affecting after prolonged exposure*: These are fluorides, nitrates and polynuclear aromatic hydrocarbons (PAH):
  i. *Fluorides*: Exposure to fluoride consumption occurs not only through water but also from food, toothpaste, air pollution, etc. Fluorides are usually present in higher concentration in ground waters than surface waters. Its concentration is closely related to dental and skeletal health. Excess fluoride level results in dental and skeletal fluorosis and decreased level in the water results in dental caries. Therefore, fluoride in water is called often as 'A double edged sword.' The optimum concentration for drinking purpose is 0.5 to 0.8 mg/L (ppm) but the permissible upper limit is 1.5 mg/L (1.5 ppm).

     The methods recommended for estimation of fluorides in water are:
     - Colorimetric method, using zirconium-alizarin reagent
     - Electrochemical method using orion electrode
     - SPADNS—colorimetric method.

  ii. *Nitrates and nitrites*: Eventhough these are the naturally occurring ions of the nitrogen cycle, they are considered as the indicators of pollution of water (described below).
  iii. *Polynuclear aromatic hydrocarbons (PAH)*: These are known to be carcinogenic. They are benzene, benzpyrene, benzpyrelene, benzfluoranthene, etc. Since they are closely associated with suspended solids, effective removal of turbidity will ensure the removal of PAH also. However, the upper permissible limit in water is 0.2 μ g/L.

- *Substances affecting the potability of water*: The substances affecting the potability of water and their prescribed upper limits are shown in **Table 5.2**.

Table 5.2 Substances and their prescribed upper limit

Substances	Prescribed upper limit
• Substances affecting the color	5 units (by colorimeter) or 15 true color units (TCU)
• Substances affecting the odor	3 units (by threshold odor test)
• Substances affecting the taste	Unobjectionable
• Optimum – pH	7.5 (range of pH = 7 to 8)
• Total dissolved solids (affecting turbidity)	1000 mg/L (< 600 mg/L is very safe)
• Total hardness	3 mEq/L (1 to 3 mEq/L of $CaCO_3$) (50 to 150 mg of $CaCO_3$/L)
• Iron	0.3 mg/L.
• Calcium	75 mg/L.
• Magnesium	30 mg/L.
• Sulfate	200 mg/L.
• Chlorides	200 mg/L.
• Zinc	5 mg/L.
• Copper	0.05 mg/L.
• Manganese	0.05 mg/L.
• Phenolic substances	0.001 mg/L.

- *Chemical indicators of pollution*:
  i. *Chlorides*: All waters contain chlorides, more so in coastal areas, thus chloride concentration varies from place to place. Therefore, the normal range of chlorides of unpolluted surface and ground-water should be determined in that locality. Once it is present in the water, it rarely undergoes any change. Hence presence of chlorides in water is a permanent indicator of pollution (with sewage or sea water).

     It is determined by titration with silver-nitrate solution with appropriate indicator. The silver nitrate combines with chloride and forms white precipitate of silver-chloride.

     The standard prescribed limit of chloride for drinking purpose is 200 mg/liter. The maximum permissible limit is 600 mg/liter. Above 250 mg/L, the water becomes salty and becomes undesirable. Excess NaCl causes cardiovascular disease.
  ii. *Free and saline ammonia*: Ammonia is a result of decomposition of organic matter. So its presence indicates organic pollution (sewage contamination) of recent origin. The prescribed upper limit in drinking water is 0.05 ppm (mg/L).
  iii. *Albuminoid ammonia (Organic ammonia)*: It is a measure of decomposable organic matter yet to be

oxidized. This should not exceed 0.1 ppm (mg/L) in potable water. This is detected by adding Nessler's solution, which gives yellow or brown color.

iv. *Nitrites*: This should be 'Zero' in potable waters. Its presence indicates water pollution of recent origin, due to putrefaction of organic matter by the action of bacteriae.

However in deep well waters, nitrites may be found as a result of reduction of nitrates by ferrous salts. Therefore, water containing nitrites, except in case of deep well waters, (which contain iron also), must be viewed with suspicion. Nitrites are soon converted into nitrates and therefore, nitrites should never be present in drinking water. Therefore, water containing nitrites (indicating recent contamination) without the presence of iron, should always be condemned.

Nitrites in the water can be detected by adding sulphuric acid and a few drops of metaphenylenediamine to 100 cc of water sample. Development of yellow color indicates the presence of nitrites.

v. *Nitrates*: These are the end products of oxidation of all animal matters. If nitrates are present in large amount and ammonia in very small amount and nitrites being absent, it indicates the remote contamination (or of long standing, old contamination).

Nitrates in water should not exceed 1.0 mg/L (1 ppm). The presence of nitrates in water is detected by adding phenol-disulphonic acid and 12N-potassium hydroxide solution to the dried residue of a sample of water. Appearance of yellow color indicates the presence of nitrates.

vi. *Oxygen absorbed*: It is the amount of oxygen in the water utilized for oxidizing the organic matter. This should not exceed 1 mg/L (1 ppm). However, iron salts, sulphuretted hydrogen and peaty waters also absorb oxygen. Therefore, determination of 'oxygen absorbed' alone is not a reliable index of the real amount of pollution present. It has to be considered alongwith the concentration of free ammonia and albuminoid ammonia for assessing the purity of water.

vii. *Oxygen dissolved*: This should not be less than 5 mg/L (5 ppm). Depletion of dissolved oxygen encourages reduction of nitrate to nitrite and sulfate to sulfide, giving rise to odor.

Biological Examination of Water

This includes examination of water under the microscope for the presence of microscopic substances (excluding bacteriae) such as algae, fungi, protozoa, ova, cyst, yeast, rotifers, crustacea, small worms, insect larvae, etc. which are all collectively called as 'Plankton'. These are responsible for the production of objectionable color, odor and taste in the water. Therefore, their presence is an index of pollution or sewage contamination.

A sample of water is centrifuged (foerst centrifuge) and the sediment is examined under the microscope on Sedwick rafter cell, a slide, equipped with Whipple micrometer. The result is expressed as total number of biological substance of each kind per mL of water or as an estimate of the total volume of biological substance expressed as cubic microns per mL of water.

Bacteriological Examination of Water

The bacteriological examination of water is a very delicate and sensitive test for detecting the contamination of water by sewage or human excreta.

The bacterial indicator of contamination of water, is the coliform group of organisms, which consists of both fecal and nonfecal organisms. The typical example of fecal coliform group is *E.coli* and nonfecal coliform is *Klebsiella aerogenes* (or *Enterobacter aerogenes*). This nonfecal type is found in soil, fruits, leaves, grains, etc.

The supplementary bacterial indicators of fecal contamination are fecal streptococci and *Clostridium perfringens*. These indicators also help in assessing the efficiency of water purification processes. Because of the difficulty in differentiation between fecal and nonfecal coliforms for all practical purposes. It is assumed that all coliform group of organisms are of fecal origin unless the nonfecal origin is proved.

The reasons for exclusively choosing the coliform organisms (specially *E. coli*) as an indicator of fecal pollution are:

- They are present in large numbers in the human intestine
- A person excretes on an average about 200 to 400 billion of these organisms per day
- They can easily be detected by cultural method—as small as one bacteria in 100 mL of water can be isolated
- The methods for detecting other human intestinal organisms like *Salmonella, Shigella,* etc. are complicated and time consuming,
- They tend to live longer than pathogens
- They have greater resistance to the forces of natural purification than other pathogens.

If the coliform organisms are present in a water sample, the assumption is the probable presence of intestinal pathogens. So, consequently the assumption is justified that if coliform organisms have been eliminated from water, the pathogens also have disappeared.

Fecal Streptococci

This is considered as a supplementary indicator of fecal pollution of water because it also regularly occurs in feces but in much smaller numbers than *E. coli*. Therefore, its detection in a water sample is considered as a confirmatory evidence of recent fecal pollution of water.

Clostridium perfringens

They also occur regularly in feces but in smaller numbers than *E. coli*. The spores of *Cl. perfringens* are capable of surviving for a longer period than *E. coli* and are resistant to chlorine while chlorination. So, their presence is an indicator of fecal pollution. Their presence in the absence of *E.coli* in a sample of water suggests that contamination had occurred at some remote time.

The bacteriological tests carried out are:

a. Plate count
b. Standard tests
c. Tests for the presence of fecal streptococci and *Clostridium perfringens*.

Plate Count (Colony Count)

This is done to find out the total number of bacteriae in the water. This also gives a measure of efficiency of disinfection of water.

Procedure: Two sterile petri-dishes each with 1 cc of water to be tested is taken, over which 10 cc of nutrient agar is poured. One incubated at 37°C for 2 days and the other at 22°C for 3 days. Saprophytes develop (grow) in the second one. They do not have any significance. At the end of 3 days, all the colonies appearing in the plates are counted with a hand-lens and expressed as numbers of bacteriae per mL of water, with the assumption that each such colony has developed from one bacteria. Since the saprophytes develop at 22°C and not 37°C, it is obvious that the number of colonies are more in the second one.

The plate counts are generally much higher in the surface water than ground water. The disinfected water should have 'Zero' count.

A single count is of little value, but the counts from the same source, at frequent intervals, may be of considerable value. A sudden increase in the colony count may give the earliest indication of contamination.

Standard Tests for Members of Coliform Group

There are three tests:

i. Presumptive coliform test
ii. Confirmatory test
iii. Completed test.

***Presumptive coliform test*:** There are two methods—multiple tube method and membrane filtration technique.

Multiple tube method: The test is carried out by inoculating measured quantities of water, into 16 test tubes (0.1 mL in 5 tubes, 1 mL in 5 tubes, 10 mL in 5 tubes and 50 mL in 1 tube), containing McConkey's lactose bile-salt broth with bromcresol purple as an indicator in Durham's tubes, which are in the inverted position. All the 16 tubes are incubated at 37°C for 48 hours. The number of test-tubes showing acid and gas are taken as positives and compared with the Standard McCardey's table, which gives the results expressed as Most Probable Numbers (MPN) or Presumptive Coliform Count per 100 ml of water, the presumption being, each tube showing fermentation with the production of acid and gas, contains coliform organisms and in the absence of fermentation, coliform organisms are absent. Acid and gas are produced due to the fermentation of lactose of the media by *E. coli*. Production of acid is indicated by the change in color of the media (from purple to yellow) and production of gas is indicated by the downward displacement of the indicator in Durham's tubes.

The assumption may be misleading because there may be organisms, other than coliform group, capable of fermenting lactose. Therefore, it is necessary to do a confirmatory test, before it is labeled as a member of the coliform group. Such confirmation is generally not required in case of unchlorinated water, but is required in case of chlorinated water.

Membrane filtration technique: The measured volume of water is filtered through a highly porous membrane, made of cellulose ester, the pore structure of which enables the water to pass through under pressure but prevents the passage of any bacteriae, present in the sample. The bacteriae are retained on the surface of the membrane. The membrane is then brought into contact with absorbent pads containing culture media, incubated at 35°C for 20 hours. The bacteriae diffuse upwards through the pores and each organism develops into a visible colony, characteristic of coliforms. The colonies are counted.

This method is more precise than the older method and gives results within 20 hours, as compared to minimum of 48 hours in the other method. This method is also useful in isolating the pathogens from aqueous solutions other than water and sewage such as cerebrospinal fluid, saliva, sputum, etc. for the demonstration of Tubercle bacilli.

However, this method fails with waters of high turbidity, high algal content, noncoliform bacterial content because the turbidity and algae clog the membrane and the noncoliform bacteriae interfere with the growth of coliform group of organisms, giving rise to false positive results.

***Confirmatory test*:** This is done for those Durham's tubes showing positive test with production of acid and gas, with the smallest amount of water.

The confirmation is done by subculturing each presumptive positive tube (with the smallest amount of water) into two tubes of Brilliant Green Lactose Bile Broth or Eosin Methylene Blue Agar. One is incubated at 37°C for 48 hours to confirm the presence of coliform organisms and the other is incubated at 44°C and inspected after 6 and 24 hours for the production of gas because *E. coli* is the only organism capable of fermenting lactose and producing gas at 44°C. Production of gas constitutes a confirmed test.

***Completed test*:** From the eosine methylene blue agar plates of partially confirmed test, one or more colonies are transferred to an agar slant (or lactose broth fermentation tubes) and incubated at 35°C for 24 hours and 48 hours respectively.

Demonstration of gram negative, nonspore forming bacilli from the colonies of the agar slant or formation of gas in lactose broth, constitutes a positive completed test. Failure in either of these steps constitutes a negative test.

A positive completed test gives assurance of the presence of a member of coliform group in the original sample of water.

Interpretation of Results of Disinfected Water

- No coliforms in 100 cc of water—Excellent water
- 1–3 coliforms in 100 cc of water—Satisfactory water
- 4–10 coliforms in 100 cc of water—Suspicious water
- More than 10 coliform in 100 cc of water—Unsatisfactory water.

Tests for the Presence of Fecal Streptococci and Cl. perfringens

1. *Detection of fecal streptococci*: There are three methods:
   - *By using glucose—azide broth*: Multiple portions of water are inoculated into tubes of glucose azide broth and incubated at 37°C for 3 days. Production of acid confirms the presence of fecal streptococci.
   - *By using BAGG medium*: Multiple portions of water are inoculated into the tubes containing buffered azide glucose glycerol broth and incubated at 45° C for 2 days.
     Production of acid confirms the presence of fecal streptococci.
   - *Membrane filtration technique*: The technique is the same as described for coliform count, except that a different medium and a different incubation procedure are used. After filtration the membrane is placed on a well dried plate of glucose azide agar. This is then incubated at 37°C for 4 hours, then at 44°C for 44 hours. All red and maroon colored colonies are counted as fecal streptococci.
2. *Detection of Cl. perfringens*: There are two methods:
   - *By using DRC medium*: *Cl. perfringens* being an anaerobic spore forming organism, the water is heated at 75°C for 10 minutes to destroy the non-spore forming organisms. It is then inoculated into differential reinforced *Clostridium* medium (DRC medium) in a screw capped bottle and incubated at 37°C for 2 days.

A positive reaction will be shown by blackening of the medium due to reduction of ferrous sulfite and precipitation of ferrous sulfide. Any Clostridium may produce this reaction.

So, a loopful from each positive bottle should be sub-cultured into tubes of litmus milk that has been freshly steamed and cooled. The tubes are then incubated at 37°C for 2 days. Those contaning *Clostridium perfringens* will produce a 'Stormy clot.'

Sulfite reduction method: Volumes of water mixed with melted medium is incubated at 37°C for 2 days. Development of black colonies indicates contamination with *Cl. perfringens*.

Some workers prefer to heat the water to 75°C for 10 minutes before adding the medium in order to destroy the nonspore forming organisms.

Radiological Examination of Water

Pollution of water with radioactive materials causes health hazard. The radioactivity is expressed as micro-micro curies (i.e. picocuries—pci) per liter of water.

1 pc = 2.22 radioactive disintegrations per minute. WHO has proposed the following standards as acceptable upper limit:

Gross alpha activity = 3 pci/L.

Gross beta activity = 30 pci/L.

Virological Examination of Water

Enteroviruses, reoviruses and adenoviruses have been found in water, the first being more resistant to chlorination. If enteroviruses are absent from chlorinated water, it can be assumed that water is safe to drink.

An exponential relationship exists between the rate of virus inactivation and the redox potential. A redox potential of 650 mV (measured between platinum and calomel electrodes) will cause almost instantaneous inactivation of even high concentration of virus. Such a potential can be obtained even with a low concentration of free chlorine of 0.5 mg/L for 1 hour, to inactivate the viruses.

WHO has fixed the upper limit for viruses as 1 PFU (Plaque forming unit) per liter of water.

BIBLIOGRAPHY

1. Dhaar GM, Robbani I. Foundations of Community Medicine. Elsevere, 1st edn, 2006.
2. Ghosh BN. A Treatise on Hygiene and Public health. Scientific Publishing Co, Kolkata, 15th edn, 1969.
3. Indian Council of Medical Research. Manual of Standards of Quality for Drinking Water. Spl Rep Ser 44, 1975.
4. Indian Standards Institute. Indian Standard Specification for Drinking Water No 15: 10500, 1983.
5. Rosenau. Preventive Medicine and Public Health. Edited by Maxcy, 1956.

CHAPTER 6

Air and Ventilation

INTRODUCTION

Air constitutes the immediate physical environment. It is such an important environment that without air, life would not have existed on earth. The public health importance of air is that not only it is necessary for breathing purposes, cooling of the body, hearing and smelling but also it acts as a vehicle of transmission of diseases, resulting in even epidemics and pandemics.

Air is a mixture of gasses, mainly nitrogen (78%), oxygen (21%) and carbon dioxide (0.03%), remaining by other gasses such as argon, neon, helium, xenon, etc. Strictly speaking there is no pure air. Air always contains foreign substances in the form of solid, liquid (moisture) and gasses, at all times, in all places. Air is said to have become polluted when it contains these foreign substances such as dust, becteriae, spores gasses etc in excessive concentration, so as to affect the health of human beings and animals and causes damage to plants and properties.

CHANGES IN THE AIR DUE TO HUMAN OCCUPANCY

Due to human occupancy, the air in the room is vitiated. The changes that take place in the air of such an occupied room are physical and chemical.

The physical changes are:

i. Rise in the temperature due to emanation of body heat.
ii. Rise in the relative humidity due to expiration and perspiration.
iii. Decrease in the air movement.
iv. Occurrence of unpleasant odors arising from expiration, perspiration, bad oral hygiene, dirty clothes and other sources.
v. Bacterial pollution by the infected droplets.

The chemical changes are:

i. Increase in the CO_2 concentration
ii. Decrease in the O_2 concentration.

The vitiation of air affects the health, comfort and efficiency of occupants mainly due to physical changes in the air.

EFFECTS OF VITIATED AIR

They are divided into acute and chronic.

- *Acute effects* are lassitude, head ache, nausea, vertigo, vomiting and even collapse. Death may occur in extreme cases.
- *Chronic effects* are anemia, debility, digestive disturbances, nutritional and metabolic disorders, lowered vitality and decreased resistance to infections. The working efficiency is decreased and the output of the work falls.

The effects of vitiation of air was first observed by Sir Leonard Hill.

INDICATORS OF THERMAL COMFORT

Air Temperature

This alone is not an adequate indicator.

Air Temperature and Humidity

This is a better indicator than air temperature alone but still this is unsatisfactory.

Air Temperature, Humidity and Air Movement

These three together is called 'Cooling power' of the air, which can be measured by a device called 'Kata thermometer'. A dry kata reading of 6 and above and a wet kata reading of 20 and above are regarded as an index of thermal comfort.

Effective Temperature

Effective temperature (ET) is the combined effect of air temperature, humidity and air movement (cooling power) on the sensation of warmth or cold felt by the human body. But this does not include the effect of radiation from the surrounding structures.

The response of the volunteers exposed to combined effect of air temperature, air humidity and air movement was used in developing a nomogram, which represents the scales of dry bulb temperature, wet bulb temperature and velocity of air **(Fig. 6.1)**. The point where a straight line joining the dry bulb and the wet bulb temperature of an occupied area cuts across the velocity of air of that area represents the 'effective temperature' which in turn represents the thermal comfort of the occupants. Thus, by holding the other two factors, i.e. air humidity at 100 percent level and air movement at zero level, effective temperature measures the thermal comfort of occupants of a given area in terms of dry bulb temperature reading.

Corrected Effective Temperature

In this index, instead of dry bulb reading of the temperature, the reading of Globe thermometer is employed, which allows the radiant heat, thereby all the four factors, namely air temperature, humidity, air movement and radiant heat, are taken into consideration.

In otherwords, the effective temperature ignores the impact of radiation. In order to overcome this drawback, dry bulb temperature scale in the nomogram was replaced by globe thermometer scale to include mean radiant heat. The index obtained from the revised nomogram is termed as 'Corrected effective temperature', which represents the impact of all the four meteorological factors related to thermal comfort **(Fig. 6.1)**.

CET is interpreted by the following scales to relate the subjective feelings of comfort/discomfort experienced by the occupants.

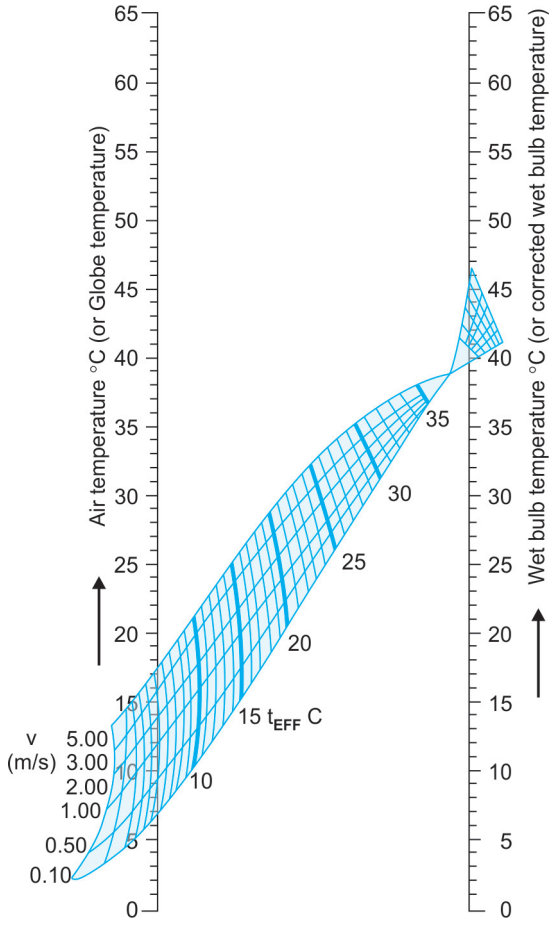


Fig. 6.1 Effective temperature/corrected effective temperature nomogram for lightly clothed men. V = Velocity of air in meter/second, $t_{EFF}C$ = Corrected effective temperature
Source: Dhaar GM. Robbani I. Foundations of Community Medicine, Elsevier, 1st edn, 2006.

Corrected effective temperature	Subjective feeling of occupants
69°F	Pleasant and cool
69–76°F	Comfortable and cool
77–80°F	Comfortable
81–82°F	Hot and uncomfortable
83°F +	Extremely hot
86°F +	Intolerably hot

McArdle's Maximum Allowable Sweat RATE

It is recorded as 'Predicted four-hour sweat rate' (P_4SR). It is the rate at which a person sweats in hot environment and is expressed for four hours. It is an indicator of heat stress.

The upper limit of P_4SR is 3 liters. Range is 1-3 L. AV – 2 liters (i.e. A sweat rate of 2 liters in 4 hours in considered optimal for a man working in a hot environment). ET and CET are explained under meteorology.

Comfort Zone

It is the range of corrected effective temperature in which the individual or the worker in an industry, feels comfortable. The criterae of comfort zone are:

- Corrected effective temperature—25 to 27°C (77–80°F)
- Relative Humidity—30 to 65 percent
- Dry kata—6 and above
- Wet kata—20 and above
- Predicted four hour sweat rate (P_4SR)—1 to 3 liters

P_4SR is applicable only in that situation where sweating occurs.

AIR POLLUTION

Air pollution is a constant and menacing problem throughout the world, due to man's own activities like industrialization and urbanization. It is increasing progressively during the past few decades. Air pollution is not only a public health problem but also an economic problem.

Air Pollutants

These may be chemical or biological.

Chemical Pollutants

These may be particulate matters, gasses or metals.

- *Particulate matters:* Dust, smoke, soot, sand, grit, etc.
- *Gasses:* CO, CO_2, H_2S, CH_4, NO_2, SO_2, MIC (methyl isocyanide), fluorohydrocarbons, etc.
- *Metals:* Arsenic, berrylium, copper, zinc, lead, carcinogens, etc.

Biological Pollutants

Pathogens (microbes), spores, etc.

Although the Earth's atmosphere extends to several kms above the surface, it is only the first 30 kms that hold the major portion of the atmospheric gasses. Man is concerned only with the first 8 to 10 kms of the atmosphere.

Degree of air pollution is influenced by topography, i.e. atmospheric temperature, humidity, atmospheric pressure and air movement.

Pollutants are affected by sunlight and temperature inversion.

Sun Light

The U-V rays of the Sun act on the oxides of nitrogen and other hydrocarbons and form photooxidants, which are irritant to conjunctiva, nose, throat and respiratory mucous membrane.

Temperature Inversion

Normally, the air near the surface of the earth is warmer than the air higher up. So warmer air, being lighter, moves up, expands and becomes cool. Thus, the pollution is diluted and dispersed, while the air of the upper layer being cool and heavy, comes down (turbulent flow).

Under exceptional conditions, as in deep valleys, the temperature gradient is reversed, i.e. the air near the surface of the earth absorbs infrared radiation and remains cool and the upper layer becomes warm. The temperature rises with increase in altitude. So, the normal upward movement of air is impeded. Pollutants become locked up and their concentration rises steeply.

If fog is present under such conditions of temperature inversion, water vapor condenses around the smoke particles and forms 'Smog' (Water vapor + Smoke = Smog). Intense smog is lethal. Such temperature inversion often persists for several days, resulting in acute episodes of respiratory illness, suffocation and death. Highly susceptible population groups are young children, elderly people and those suffering from lung diseases and heart diseases.

The famous episodes of acute illness and deaths due to general atmospheric pollution by temperature inversion are Muse valley disaster (Belgium) in Dec 1930, lasted for 5 days, killing 63 people and many cattle. Donora (Pensylvania) disaster in 1948 took the life of 20 people and hundreds became ill. London disaster in 1952 (England) was the deadliest smog history, due to domestic coal burning, when more than 4000 people died. Bhopal gas tragedy in India in 1984 killed thousands of people and it was due to leakage of methyl isocyanide gas in unicarbide industry, an example of toxic pollution of air and not due to photo-oxidants.

Sources of Air Pollution

- *Domestic sources*: Burning of fire wood, kerosene oil, coal, etc.
- *Industrial sources*: Factories of iron and steel, paper, cement, fertilizers, thermal power plant, petroleum refineries, etc.
- *Vehicular sources*: Motor vehicles, railways, ships, aeroplanes, etc.
- *Miscellaneous*: Tobacco smoking, nuclear explosions, forest-fires, volcanoes, burning of refuse, dust-storm, ocean spray, etc.

Hazards of Air Pollution

Immediate and Acute Effects

These are due to photochemical oxidants. There will be irritation of conjunctiva, nose, throat and respiratory mucous membrane resulting in conjunctivitis, allergic rhinitis, acute

pharyngitis, acute bronchitis and episodes of bronchial asthma (acute attacks). It may result in suffocation and death. For example, London disaster in England and Bhopal gas tragedy in India.

Delayed and Chronic Effects

These are chronic bronchitis, bronchiectasis, emphysema, chronic obstructive pulmonary disease (COPD), bronchial asthma and even lung cancer.

Global Effects of Air Pollution

i. *Acid rain*: It is the end result of several processes occurring in the atmosphere. Sulfur dioxide emitted from combustion of coal produces sulfuric acid by getting dissolved in water vapor of the atmosphere. Similarly, carbon-dioxide produces carbonic acid and nitrogen dioxide produces nitric acid. Thus, the rainfall containing sulfuric acid, carbonic acid and nitric acid produces devastating ecological effect by causing acidification of soil and water. Trees killed by acid rain results in deforestration, desertification and erosion of soil, thus, disturbing the ecosystem. Acidification of water bodies destroys aquatic life including fish. Destruction of food crops effects food production also.

ii. *Global warming*: It is a phenomenon occurring in the troposphere. Normally, the atmospheric gasses have a 'green-house effect,' i.e. like the glass of a green-house, allow light and warmth to reach the earth but they do not allow warmth to be lost, thus maintaining life on earth (Described elsewhere).

With air pollution, the gasses like carbon-dioxide, methane and chlorofluorocarbons and accumulation of ozone, all in the troposphere elevate the global temperature beyond the desirable level resulting in global warming and affecting the ecosystem.

In the past 10 years, a rise of 0.3 to 0.6 celsius has been noticed. This results in the following effects:

- Increase in the dryness of the climate
- Reduction in the world food production
- Melting of polar icecaps
- Increase in sea level resulting in floods
- Smog formation
- Increased incidence of skin cancer and cataract
- Spread of tropical diseases to temperate regions.

iii. *Effects of depleted ozone shield*: Normally, ozone layer of the earth, filters the harmful ultraviolet rays of the sun and prevents them from reaching the surface of the earth. Because of air pollution, ozone layer begins to thin out and results in the following effects:

- Inhibition of photosynthesis, (due to burning of leaves, retardation of growth of plants, fall in the crop yield, ageing of plants etc, all due to air pollution).
- Disruption of marine food chain.
- Impairment of human immune mechanism, predisposing for infections.
- Ocular damage (cataract).
- Skin cancers (melanotic and nonmelanotic).
- Ultraviolet rays also cause damage of small forms of life such as plankton, pollen grains and nitrifying soil bacteriae.

iv. *On animals*: Cattle become weak and cachexic. Yield of animal products become less.

v. *Miscellaneous hazards*: (Socioeconomic hazards)

- Damage to buildings, like old monuments.
- Damage to metals, alloys, textiles, rubber and works on wood, bronze and stone (like painting, carvings).
- Repairs of these cost millions of rupees. (Thus, time, money and energy are wasted).

Indicators of Air Pollution

Following indicators are employed for monitoring of air pollution:

- *Sulfur-dioxide index*: This is estimated by lead-peroxide device.
- *Smoke index (soiling index)*: A known volume of air is filtered through a disk of filter paper. The discoloration produced is measured against the standards in photo-electric meter. Result is expressed as Coh units/1000 linear feet of air.
- *Suspended particles (measurement of dust and grit concentration):*
  The amount of dust particle present in the given volume of air is measured by using an instrument, 'Midget impinger' and is expressed in mgm per cubic meter of air.
- *Air pollution index*: It is an arbitrary index, considering one or more pollutants as a measure of severity of pollution.
  Ex (Employed in USA): Ten times SO_2 concentration, plus twice CO concentration plus twice the coefficient of haze. It is considered as an alarm when this value becomes more than 50.
- *Coefficient of haze*: It is the amount of smoke or other aerosol per cubic metre of air.
- Other parameters are lead, carbon monoxide, nitrogen dioxide, oxidants.

Prevention and Control of Air Pollution

By three measures:

1. Engineering technology
2. Legislations
3. General measures.

Engineering Technology

a. *Location of the industries*: Industries must be located far away from the human habitations and where topography of the soil is favorable.
b. *Replacement measures*: Within the industries, the processes causing air pollution should be replaced by the processes preventing air pollution.
   For examples: Using electricity instead of fuels, using LPG (smokeless fuel) in the place of coal, etc.
c. *Containment measures*: such as
   - Controlling the production of dust by wet method
   - Prevention of the escape of dust into the atmo-sphere by using enclosures hood, exhaust pipes for removal
   - Increasing the height of smoke-vent, etc.

Legislations Measures

To control air pollution, Govt of India has enacted some Acts like Indian Factories Act, Prevention and control of Air Pollution Act, Smoke nuisance Act, etc.

General Measures

a. Control of traffic by construction of bypass roads.
b. Maintenance of vehicles by periodical servicing, mixing of petrol and oil in proper proportions, use of unleaded petrol to the vehicles, fitting the catalytic converter to the exhausts pipes of four wheelers, which convert the harmful gas into harmless gas.
c. Establishment of 'Green-belts', i.e. growing plants and trees between the industries and the residential areas, so that the leaves absorb carbon-dioxide and give out oxygen.
d. Health education of the people about hazards of air pollution and their role in the prevention and control of air pollution.
e. Population stabilization.

VENTILATION

Ventilation means not only the replacement of vitiated air (stagnant, warm and moist air) by the drier, cooler and moving air but also control of the quality of incoming air with reference to temperature, humidity and purity in order to provide a comfortable environment without the risk of infection. Internal ventilation is with reference to the ventilation of the rooms and external ventilation is with reference to outside air. External ventilation is done by making the streets broad, building houses with sufficient gap in between and to sufficient height, watering the streets to lay the dust, by keeping plenty of open spaces and parks, etc.

Standards of Ventilation

Fresh Air Supply

De Chaumont has recommended 3000 cu. feet of fresh air per hour per person, based on a point that a person entering a room from outside should not perceive any smell or stuffiness. The stuffiness occurs in a room when the CO_2 concentration exceeds 0.02 percent.

The amount of fresh air that should be delivered per hour to an occupied room, can be calculated by the formula:

$d = \frac{e}{p}$, where d = amount of fresh air to be delivered to a room,

e = CO_2 exhaled per hour per person (A person at rest gives off 0.6 cu ft of CO_2 per hour)
p = limit of respiratory CO_2 per cu foot of air (i.e. 0.02 cu ft per 100 cu ft of air, i.e. 0.0002 in one cu ft)

therefore, $d = \frac{0.6}{0.0002}$

= 3000 is the number of cu. feet of air required per person per hour, CO_2 being taken as an indicator.
A child requires about 200 cu. feet of air per hour. However, this standard of ventilation is no longer followed.

- *Air change*: For a person to get 3000 cu.ft of air per hour and occupying a room of 100 cu.ft, the air should be changed thirty times per hour or if he occupies a room of 1000 cu.ft, air requires to be changed only three times. This causes a disagreeable draught specially in cold weather. Otherwise, it does not cause any perceptible draught.
- *Floor area*: This is an important standard of ventilation. The optimum floor area per person in a house recommended is 50 to 100 sq. feet. Lesser than 50 sq. feet results in over crowding favoring spread of droplet infections. In general hospital, it should be 150 sq. feet and in infectious diseases hospital, it should be 200 sq. feet per person.

Systems of Ventilation

Mainly there are two systems of ventilation, namely Natural and Artificial, depending upon the motive power, which originates them.

Natural Ventilation

This depends upon three factors:
a. Perflation and aspiration of the wind
b. Difference of temperature
c. Diffusion of gasses.

Natural ventilation helps considerably, if the buildings are constructed with sufficient open space around and by having

large number of windows, preferably opening direct into the outside air. Cross ventilation means perflation between windows and other openings placed opposite to each other. Naturally, cross ventilation becomes impossible in 'back to back' houses.

Perflation and aspiration of the wind: Perflation means blowing of the air through a room, when the doors and windows are open, which is a natural result of air movement. When air is moving, it drives the air before it, lessens the pressure around it and causes the surrounding air to move toward it by aspiration.

Effects of difference of temperature: Air always flows from high density to low density. Outer cooler air is of high density, rushes in through every opening of the room (or through the inlets placed at lower level). Inside air of the room being of lower density moves up. The greater the difference of temperature between the outer cooler air and the inner warmer air, greater will be the velocity of the incoming air, until the temperature of both outside and inside air becomes equal. Since the incoming air gets warmed up, a constant current is maintained. This is the basis of natural ventilation. The reverse process takes place in the tropics, where the outside air is better than the inside air. But in cold countries, fires are used inside the room to keep the inside air warm.

Diffusion of gasses: This means passing of the air through the smallest openings or spaces such as cracks and crevices. This is a very slow process and is very small. As a ventilating agent, it is of little value.

Artificial Ventilation (Mechanical Ventilation)

These are of the four types:

a. Vaccum system
b. Plenum system
c. Balanced system
d. Air conditioning.

Vaccum system (Exhaust system or extraction system): In this system foul, vitiated air is extracted or exhausted to the outside by using exhaust fans, operated electrically, so that vaccum is created and fresh air enters in and fill its place. They are usually provided in large halls, auditorium, cinema halls and are fixed near the roof, because vitiated air is warmer and moves up. Ventilation may be controlled by adjusting the speed of the fans. They are also employed in the industries to remove dusts, fumes and other contaminants at their source.

Plenum system (Propeller system): In this type, fresh air is pushed or propelled or blown into the room by centrifugal fans or high pressure fans. This creates a positive pressure and displaces the vitiated air **(Fig. 6.2)**.

Balanced system: In this type, there is a combination of both exhaust system and plenum systems of ventilation. This is used in large halls with extensive sitting capacity. This is also used in airconditioning system.

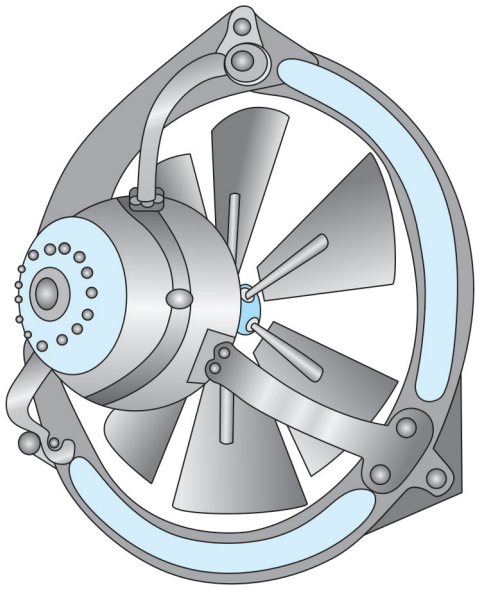


Fig. 6.2 Propeller fan with motor
Source: Dhaar GM. Robbani I. Foundations of Community Medicine. Elsevier, 1st edn, 2006.

Air conditioning: In this system, the outer air is 'condi-tioned' or 'controlled' with reference to physical and chemical conditions, such as cleaning (free from pathogens, dirt and dust), adjustment of temperature (to cool it or warm it), adjustment of humidity, which will be most comfortable and then letting into the room at a measured rate and volume of flow without producing draught and exhausted through ducts.

These are being increasingly used in operation theaters of the hospitals, in hotels, restaurants, offices, commercial firms, cinemas, aeroplanes, railways, etc.

Where the temperature difference between the outside air and air conditioned room is very large, 'transition rooms' are provided, so as to prevent sudden exposure to high or low temperature.

The advantages of artificial methods of ventilation are the constancy and the facility with which fresh air is supplied under all conditions, whereas natural ones though less costly are not under human control being subject to atmospheric conditions.

BIBLIOGRAPHY

1. Dhaar GM. Robbani I. Foundations of Community Medicine. Elsevier, 1st edn, 2006.
2. Ghosh BN. A Treatise on Hygiene and Public Health. Scientific Publishing Co, Kolkata 15th edn, 1969.
3. Manivaskan. Environmental Pollution. National Book Trust, Delhi, 1984.
4. WHO Measurement of Air Pollutants. Geneva 1969.
5. WHO Tech Rep Ser No 406, 1968.

CHAPTER 7

Noise

INTRODUCTION

Noise is an unwanted sound, causing disturbance or annoyance to the hearer. Therefore, noise is a 'nuisance'. The term 'Noise pollution' signifies the cacophony of sounds that are being produced in the modern life, leading to health hazards.

Noise has two measurable properties—frequency and intensity.

Frequency

It is the number of complete vibration cycles per second. It is measured in the units called 'Hertz' (Hz). One Hz is equal to one wave per second. This determines the pitch of the sound. The normal, human audiofrequency range (audible range) varies from 20 to 20,000 Hz. Below 20 Hz are infra-audible (infrasounds) and above 20,000 Hz are called ultrasounds (ultrasonic).

Intensity

It is the amplitude of the vibrations (i.e. loudness) of the sound and is measured in units of 'Decibels' (dB) (Bel in memory of Alexander Graham Bell). Decibels are recorded in 'noise meter' **(Fig. 7.1)**.

NOISE LEVEL VALUES

Whispering	–	20 to 30 dB
Normal conversion	–	30 to 65 dB (Maximum upper limit is 85 dB)
Street traffic	–	60 to 80 dB
Shouting	–	About 100 dB
Motor car horn, boiler factories	–	About 120 dB
Train, aeroplane engine	–	About 120 dB
Threshold of pain	–	About 140 dB
Jet plane	–	About 150 dB
Mechanical damage	–	150–160 dB

INSTRUMENTS USED IN THE STUDY OF NOISE

- *Sound level meter:* Measures the intensity of sound in decibel (dB).

Fig. 7.1 A public noise meter

Source: Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co., Kolkata, 15th edn, 1969.

- *Octave band frequency analyzer:* Indicates whether the intensity is high pitched or low pitched.
- *Audiometer:* Measures the hearing ability. Zero line at the top of the audiogram represents normal hearing.

HAZARDS OF NOISE POLLUTION

Grouped into two groups—auditory and nonauditory.

Auditory Effects

Quantifiable

Threshold shift (temporary, later permanent).

Auditory fatigue (associated with whistling and buzzing). Deafness (temporary or permanent) (occupational deafness).

The temporary hearing loss occurs in frequency range between 4,000 to 6,000 Hz. Repeated or continuous exposure to the noise around 100 dB may result in permanent deafness. Exposure to noise above 160 dB may cause rupture of tympanic membrane and cause permanent deafness.

Nonquantifiable

Tinitus (ringing or buzzing or whistling), vertigo.

Nonauditory Effects

- Interference with speech communication
- Annoyance (such as irritability, short temperedness, impatience, quarreling and decreased production in the industries)
- Decreased efficiency in the work
- Lack of concentration
- Physiological changes such as interference with sleep, rise in blood pressure, rise in intracranial pressure, increase in heart-rate and breathing, increase in sweating, headache, giddiness, nausea, fatigue, visual disturbances, etc.

PREVENTION AND CONTROL OF NOISE POLLUTION

Control of Noise at Source

By the following measures in the industries:

- Planned maintenance of the machines
- Modification of the speed of the machines
- Use of resilient materials (such as rubber between impacting surfaces)
- Enclosure of the machines
- Sound proofing of walls
- Replacement of equipment, insertion of silencer.

Increasing the Distance

This is possible, if it is in the open field.

If it is a closed room, it is made sound-proof by lining the walls with adsorbent materials. Otherwise, the reverberating sound will add to the direct sound.

Reduction of Exposure Time

By job rotation.

Acoustic Barrier

They are of two types:

- *Around the source:* Like insulation, damping
- *At the receiver:* Use of personnel protective devices like ear muffs, ear plugs.

Miscellaneous Measures

- *Careful planning of the cities:* By dividing into residential zones, industrial zone, transportation zone, widening of the roads, green-belts between the traffic and houses, etc.
- *Heavy vehicles:* Should not be routed into narrow routes and residential areas, they should pass by bypass roads.
- By adopting suitable legislations.
- Preplacement and periodical examination of the industrial workers.
- Health education of the people about the necessity of reducing the harmful noise such as prohibition of blowing of horns near the hospitals, schools, offices, etc. about the use of horns that are free from shrill and inharmonic overtones, enforcement of speed limit of vehicles, about restriction of use of loud-speakers, etc. Thus, public are educated through all available medias.

BIBLIOGRAPHY

1. Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co., Kolkata, 15th edn, 1969.
2. Manivasakan N. Environmental Pollution. National Book Trust, Delhi, 1984.
3. WHO. Noise: an occupatinoal hazard and public nuisanse. Public Health Paper No. 30, 1966.

CHAPTER 8

Light

INTRODUCTION

Light constitutes an important physical environment of human beings. It is also a form and a source of energy. Without light, living will not be comfortable. It is essential for vision. Light may be from natural source or artificial source.

Natural source of light is the Sun. The visible rays of the sunlight constitutes the solar spectrum 'VIBGYOR', which can be seen in the rainbow. The sun rays beyond the spectrum are invisible. The rays beyond the violet end are Ultraviolet rays and the rays beyond the red end are Infra-red rays. Both have got therapeutic uses.

For carrying out the work efficiently with efficient vision, following 'Day light factors' are essential:

- Sufficient illumination of 15 to 20 foot candles
- Uniform distribution in the working place
- Absence of glare (i.e. Glare is excessive contrast, e.g. headlight of a vehicle at night. The same light during day time does not cause glare because of absence of contrast)
- Absence of sharp-shadows
- Steadiness of source of light
- White color of the light
- Contrast surroundings.

MEASUREMENT OF LIGHT

The luminous intensity or power of artificial light is measured by the standard 'Candle'. The amount of light given off by the burning of a spermwax candle burning 120 grains per hour is called one candle power. The illumination received from one candle at a distance of 1 foot, is known as 1 foot candle. The illumination is measured by an instrument called photometer. A minimum of at least 6 feet candle illumination is required for clear visibility for performance of work.

The light is also measured by other parameters such as:

- Luminous flux (flow of light), expressed in lumens
- Illumination (amount of light reaching a surface) expressed as lux per unit area
- Luminance (brightness, i.e. amount of light reflected from a surface) expressed as lamberts.

NATURAL LIGHTING

This is obtained not only from the sky but also from reflection. Natural lighting depends upon the time of the day, season, weather and atmospheric pollution.

Measures to Improve Natural Lighting

- The buildings should be directed towards North and South, so that there will be uniform lighting from morning to evening.
- Construction of windows must be properly planned. A tall narrow window gives greater penetration of light and a broad window gives greater diffusion of light.
- Inside the rooms, the ceiling should be white, the upper portion of walls should be light colored and lower portion should be slightly dark colored.

ARTIFICIAL LIGHTING

Electric light is the best method of providing artificial illumination. There is no combustion, nor there is any reduction in

the oxygen content of atmosphere. It gives good, steady and bright light. The different types of electric lights are:

- *Filament lamps (Incandescent lamps):* In this type, the tungsten filament is heated and light is emitted. Only 5 percent of the current is available for lighting and remaining 95 percent is expended as heat.
- *Fluorescent lamps (Vapor lamps):* Different types are:
  - *Neon filled sodium discharge lamp*: This gives yellow light.
  - *Mercury vapor lamp*: The lamp consists of a glass-tube, filled with mercury vapor and an electrode fitted at each end. The inside of the tube is coated with fluorescent chemicals, which absorbs ultraviolet radiation and remits the radiation in the visible range.
  - *Cold cathode neon lamps*: They are used for decorative purposes.
  - *Shadowless lights*: They are specially necessary in operation theaters.

Other Sources of Artificial Light

- *Gas light*: In this type, there is burning of the coal gas in an incandescent burner having a mantle. The light is steady and bright but it produces too much heat and emits disagreeable smell.
- *Gas burner*: Oil lamps, candle and acetylene gas.

HEALTH HAZARDS OF LIGHTING

Excessive bright light or glare results in glaring, blurring of vision, discomfort and accidents and poor lighting results in nystagmus, headache, accidents, visual strain, etc.

Biological Effects

The observation that day light causes degradation of bilirubin is now employed as a therapeutic measure among premature newborns with physiological jaundice. Other biological effects of light are stimulation of melanin synthesis and synthesis of vitamin D in the skin.

BIBLIOGRAPHY

1. Gorodischer R. The New English Journal of Medicine (282) 375, 1970.
2. Koenigsberger OH, et al. Manual of Tropical Housing and Building. Orient Longman, Mumbai, 1973.

CHAPTER 9

Radiation

INTRODUCTION

Radiation also constitutes an important physical environment. Radiation is defined as a form of energy, emitted from a matter, in all directions, in the form of waves, each wave carrying a quantum of energy or emitted in the form of fast moving sub-atomic particles or nucleotides. Such energy is emitted from a matter as a result of electrical excitement or internal changes. The energy that is emitted depends upon the wave-lengths. Shorter the wave-length, greater is its energy value and vice-versa. Wave lengths are expressed as α.

Radiations are grouped into two groups—namely ionizing and nonionizing radiations, depending upon the ability to penetrate the tissue, deposit its energy and cause destruction of the tissue or not respectively.

NONIONIZING RADIATIONS

These do not penetrate the body tissues but they are absorbed by the superficial tissues like skin and eyes. Depending upon their increasing wave length (or decreasing frequency) they are classified in **Table 9.1**.

Table 9.1 Nonionizing radiations

Rays	Wavelengths (in millimicrons or nanometer 1 nm = 1/1000 micron)
• Ultraviolet rays	20–400 nm
• Visible light	400–700 nm
• Infrared rays	700–1000 nm (=1 mm)
• Microwaves	1 mm–1 meter
• Radiofrequency waves	1 m–1 km
• Laser radiations	

Ultraviolet Rays

Sources

Natural source is Sun. As they are coming from Sun, maximum rays are absorbed by ozone of the atmosphere. But still the effects are more at higher altitudes than at sea level and in summer than in rainy days.

Artificial sources are many, such as mercury vapor tubes, carbon-arc, electric welding, etc.

High-Risk Persons

For natural sources, are farmers, shepherds, sailors, road builders, fishermen and those skating on snow. For artificial sources, are electric welders, cinema projector workers.

Hazards

Since the UV rays do not penetrate the tissues but are absorbed, the effects are primarily on the skin and eyes. From the natural sources, the effects are more on the skin and from the artificial sources, the effects are more on the eyes. The effects depends upon the duration of exposure, intensity of exposure and the individual susceptibility.

On the Skin

i. Short-term effects
ii. Long-term effects.

- *Short-term effects*: These are immediate effects as follows:
  - Melanin pigment which is normally present in malphigian layer migrates upwards into the corneum causing darkening of the skin (Suntan)
  - Histamine is released resulting in erythema, edema, blisters and even ulcers depending upon the quantity released.
  - Thickening of all layers of epidermis, a protective mechanism.
  - Synthesis of vitamin D takes place and rickets is prevented (the last two are useful to the body).
- *Long-term effects*: These are delayed effects, as follows:
  - Degeneration of skin
  - Decrease in elasticity
  - Cancer of the skin (squamous cell carcinoma, rodent ulcer).

  For all these effects, black individuals are less susceptible than white persons.

On the Eyes

From the natural source, the effects are:
- *Snow-blindness*—common among those skating on the snow, because UV rays reflect from the snow causing keratitis.
- *Burns*—on the inside of the nose, common among skaters, because of the reflection from the snow.
- *Eclipse blindness*—due to direct gazing at the Sun, specially on the solar eclipse.

From the artificial sources, the effects are:
- Conjunctivitis, keratitis, photophobia
- Flash burns (Welder's flash) from arc welding
- Corneal ulcer (in later stages).

Prevention

- Education of workers about hazards and prevention
- Personal protection by clothing, goggles, visors, etc.
- Regulation of exposures.

Visible Light

- *Natural source*: Sun
- *Artificial sources*: Bulbs, candles, neon-tube lights, oil lamps, etc.

Hazards

Poor lighting: Results in eye strain, visual fatigue, accidents, nystagmus (in the mines)

Bright lighting: Direct light results in glaring, blurring of vision and accidents.

Direct light from the Sun on the eyes results in scotoma, (a blind-spot) conjunctivitis, keratitis and photophobia.

Infrared Rays

- *Natural source*: Sun.
- *Artificial sources*: Fire, molten metal, red-hot objects, etc.
- *High risk groups*: Blast-furnace workers, blacksmith, kiln and oven workers, stokers, etc.

Hazards

On the skin, it causes flushing, burns and even ulcers. On the eyes, it may cause cataract.

Microwaves

These are used in radar communications in ships and airplanes.

Prolonged exposure may result in cataract and microwave sickness characterized by headache, giddiness, loss of memory, fatigue, etc.

Radiofrequency Waves

These are used for wireless transmission. They are also employed in radios, television stations and from satellites. They are not absorbed and therefore they are harmless to the body.

Laser Radiations

(LASER—Light amplification of stimulated emission of radiation).

Laser is an instrument, which generates extremely intense, monochromatic, coherent light, passing in an unidirectional beam, carrying intense heat. Skin and eyes are susceptible. It causes thermal burns of the skin and corneal damage, opacification of the lens and burning of the retina, thus resulting in cataract and/or blindness.

IONIZING RADIATIONS

These are capable of penetrating the body tissues, deposit the energy and cause destruction of the tissues. Such ionizing radiations are emitted from the atomic particles.

An atom is the smallest unit of an element, which cannot be split further. Such an atom has definite proportion of electrons and protons and is then said to be a stable atom.

Such a stable atom, when subjected to the electrical excitement or fission or bombardment, the proportion of electrons and protons become dissimilar and is said to have become unstable. Such an unstable atom tries to attain stability. In such an attempt, it emits energy in the form of rays and particles, carrying intense energy, which have got ability

to penetrate the body tissues, deposit the energy resulting in destruction of the tissues. This is called 'Ionization' or 'Ionizing Radiation.'

'At-risk' group are persons working in radiotherapy, radiology, nuclear medicine and soldiers exposed to nuclear explosions in the war.

Depending upon the type of the energy emitted from an unstable atom, whether it is in the form of waves or sub-atomic particles, the ionizing radiations are of two types:

a. Electromagnetic radiations (or photon radiations)
b. Corpuscular radiations (or particulate radiations).

Electromagnetic Radiations

In this type, the energy is emitted in the form of very short frequency waves, each wave length measuring one crorth of a mm, carrying intense energy. These are not liberated in continuous waves but in discrete units called quanta. For example, X-rays and gamma rays.

X-rays are artificially produced, emitted from intact atoms, they are of lower intensity, capable of penetrating about 25 cm into the tissues, used for diagnostic purposes.

Gamma rays (γ-rays) are naturally produced, emitted spontaneously during disintegration by the atom, which are more intense than X-rays and are capable of penetrating about 50 cm into the tissues, used for sterilization of plastic materials, IUDs, catgut, sutures, bandages, etc. However, electromagnetic radiations are thousand times weaker than corpuscular radiations.

Corpuscular Radiations (Particulate Radiations)

They are made up of subatomic particles or nucleotides. Depending upon whether they are positively charged or negatively charged or not charged at all, they are called as Alpha (α) particles, Beta (β) particles and neutrons respectively.

- *Alpha particles*: They are made up of helium nuclei, consisting of 2 protons and 2 neutrons. They are positively charged. They are the most intense form of ionizing radiations. They do not have the penetrating capacity (hardly 0.05 mm) unlike that of electromagnetic radiations but they are hazardous when inhaled, ingested or implanted sub-cutaneously. They are emitted spontaneously from an unstable radioactive elements such as uranium, thorium, radium, plutonium. Alpha particles are nearly ten times more harmful than X-rays.
- *Beta particles*: They are negatively charged, consisting of electrons. They have more penetrating capacity than alpha particles, i.e. 0.06 to 4 mm, but the intensity of ionization is 1/100th of alpha-particles. They are also emitted spontaneously from the radioactive elements.
- *Neutrons*: They are neutrally charged, i.e. uncharged. They do not act directly. They impart energy to other atoms, which then become unstable and release beta-particles causing ionization.

The period after-which the emitting power of an atom is reduced to half, is called 'Half-life.' Longer the half-life of an atom, greater is its health hazard.

Some of the other ionizing radiations are photon rays, meson rays, Proton-anti-proton collisions, neutron-antineutron collisions, etc.

Radiation Units

The potency of radiation is measured in three ways:

- *Roentgen*: That is the amount of energy absorbed in 1 mL of air.
- *Rad (Radiation absorbed dose)*: That is the amount of energy absorbed by 1 g of tissue.
- *Rem (Roentgen equivalent man)*: That is the product of rad and the modifying factors.

These radiation units are now being replaced by the new international system of units, namely:

- Coulomb per kg—replacing roentgen,
- Gray (Gy)—replacing Rad (1 Gy = 100 rads)
- Joule per kg (Sievert)—replacing Rem (1 Si = 100 rems).

'Curie' is the unit of radioactive disintegrations per second. 1 pico-curie = micro-micro curie, i.e. 3.7×10^{-2} disintegrations per second.

Sources of Ionizing Radiations

These are two Natural and Artificial

1. *Natural sources*: These may be external or internal.

a. *External sources are Sun, atmosphere and the Earth.*
   i. *Sun*: The radiations coming from the Sun are called 'Cosmic radiations' (Cosmos = Sun). They originate from the Sun. They are positively charged protons. Their penetrating capacity is minimal. As they pass through the atmosphere, they are weakened. Their effect is 35 m rads per year. Maximum permissible limit is 5 rads per year.
   ii. *Atmosphere*: These are called atmospheric or environmental radiations. They originate from the atmospheric gasses like radon and thoron. They have an impact of 2 m rads per year. Their effect is minimal. Environmental pollution with these gasses occur through the processes like processing of uranium and thorium ores, operation of nuclear reactors, testing of nuclear weapons, etc.
   iii. *Earth*: These are called 'Terrestrial Radiations.' They originate from the radioactive substances such as ores of radium, actinium, uranium and thorium present in the earth's crust (soil) or rocks and buildings. Their effect is 50 m rads per year. But in Kerala, it is about 2000 m rads per year because of the monozoite sand.

b. *Internal sources*: They originate from the radioactive elements stored in the body tissues, such as radioactive isotopes K^{40}, I^{131}, C^{14}, Sr^{90}, Cs^{137}, etc. These internal radiations inflict about 25 m rads per year. The last two, Sr^{90} and Cs^{137} remain active for many years.

2. *Artificial sources*: These are man-made sources. These radiations are used for medical purposes such as X-rays, radioactive isotopes and also for nonmedical purposes such as television and watch industries, agriculture, atomic power generation, nuclear explosions (warfare), etc. The radiations from the sources of non-medical purposes are too small.

Health Hazards of Ionizing Radiations

These are acute and chronic effects.

1. *Acute effects*: These occur when the body is exposed to heavy (1 Gy) or very heavy (1 to 9 Gy) doses of radiation for short period of time. This is usually accidental. The condition is called 'Acute radiation syndrome', which occurs in the following four stages:
   a. *Prodromal stage*: Characterized by anorexia, nausea, vomiting, prostration, fatigue and sweating. Diarrhea and oliguria may occur in fulminating cases. Lasts for 8 to 48 hours.
   b. *Latent stage*: This is an asymptomatic stage, lasts for 1 to 2 weeks.
   c. *Stage of overt illness*: Symptoms reappear characterized by fever, anemia, leukopenia, pancytopenia, thrombocytopenic purpura, diarrhea, paralytic ileus, parasthesia, motor disturbances, ataxia, disorientation, autonomic collapse indicating involvement or injury to CNS. Lasts for 3 weeks.
   d. *Recovery stage*: Lasts for about 15 weeks.

   Exposure to massive doses of more than 10 Gy may cause death, in a day or two from cerebral edema or cardiac failure.

   Treatment
   - Strong supportive care by prophylactic antibiotics
   - Bone marrow transplantation
   - Ion exchange carriers or chelating agents to be applied to facilitate the excretion of inhaled or ingested radioactive nucleotides.
2. *Chronic effects*: These are the delayed effects. Grouped into two groups—somatic and genetic.
   a. *Somatic effects*: Earliest effect is on the eyes, resulting in cataract. Skin lesions appear late. They include erythema, edema, blisters and ulcers. Still later hyperkeratosis and atrophy of the sebaceous glands occur. Skin lesions are common with β-particles and cataract with neutrons.

      The other delayed somatic effects are cancer of the lung, skin, blood, aplastic anemia and tumor induction. These delayed somatic effects are seen among those exposed to less than 1 Gy over a long period of time.

      Fetal somatic effects are malformation and microcephaly.
   b. *Genetic effects*: These occur when gonads are exposed and chromosomes are injured.
      - Chromosomal mutations result in still-births, congenital defects, neonatal deaths and even sterility
      - Point mutations are due to injury to genes resulting in Down's syndrome, Huntington's chorea, polycystic kidney, hemophilia.

      Thus, somatic effects are seen within the life-span of the affected individual, whereas genetic effects are seen in the next generation.

   Factors influencing radiation hazards:

a. *Type of tissue involved*: Tissues like gonads, lymph nodes, bone marrow and thyroid glands are highly susceptible.
b. *Type of ionizing radiation*: Electromagnetic radiations are less harmful compared to corpuscular radiations, but they are more frequently used than latter. Among the electromagnetic radiations, X-rays are more commonly used than gamma (γ) rays.
c. *Area of the body exposed*: Larger the surface area of the body exposed, more will be the bone marrow depression and therefore severe will be the hazard.
d. *Protective clothing*: Reduces the effect.
e. *Other factors*: These are intensity of the radiation, duration of exposure and individual susceptibility are other influencing factors.

Epidemiological Points

- During pregnancy, both the mother and the fetus are at risk
- Children are ten times more susceptible than adults to radiation hazards
- Malnourished and debilitated individuals are at a greater risk than the healthy counterpart
- Drugs like metronidazole and brom-uridane increases the susceptibility to radiations
- People living at high altitudes are at a greater risk than those at sea level
- Keralites living in coastal areas are at a greater risk because of monozoite sand
- Persons working in the following occupations are at a higher risk—uranium mines, atomic power generation, radiology department, watch and television factories, jet navigation, nuclear submarines, laboratories of radioactive isotopes, sterilization of drugs, bandages, sutures, etc.

PREVENTION AND CONTROL OF RADIATION HAZARDS

By primary and secondary prevention.

Primary Prevention

Primary prevention is by the following measures:

Safety of the machine, man, environment and other measures.

Safety of the Machine

- Machine should be of approved quality and installed properly
- Periodical servicing and proper maintenance
- Use of efficient filters so that unwanted radiations are excluded
- Operated on high kilo-voltage with fast films and image intensifier so that exposure is reduced to minimal dose
- The machine is connected to the door in such a way that it should stop functioning automatically, the moment the door is opened accidentally.

Safety of the Worker

- Preplacement examination of the worker to exclude contraindications if any for fitting the job to the worker (ergonomics)
- Health education about radiation hazards and avoiding unnecessary exposure
- Regulation of exposure so that exposure is limited, by provision of holidays and recreation and also by rotation of the worker
- Personal protection by wearing:
  - Filter respirators/masks
  - Spectacles with reflecting mirrors; visors while doing arc welding **(Fig. 9.1)**
  - Lead aprons, lead gloves, (lead reduces the intensity over 90%)
  - Pocket dosimeter (This is a monitoring device, worn on the collar by the worker, same dosimeter to be worn by the same individual, which records the cumulative dose of the radiation received by that individual. It is sent to Atomic Research Center, where it is analysed and report is given about the dose of radiation received. If the individual has received radiation more than the permissible limit of 5 rads per year, clinical examination and differential count is done)
  - Use of lead boxes to keep radium needles and radio-active isotopes
  - Use of long forceps to handle radium needles
  - Use of shield between the source and the recipient
  - By avoiding eating or drinking in the working room.

Safety of the Environment

Air, soil and water should be clean and pure. They should be free from pollution.

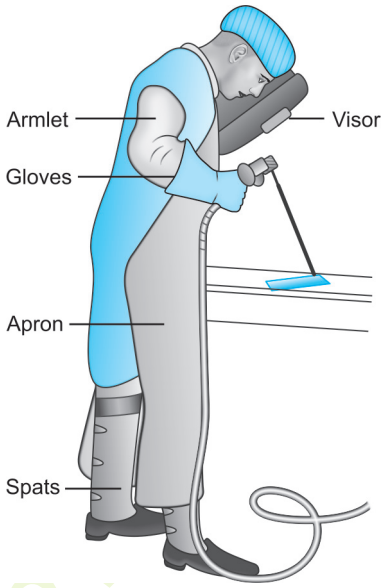


Fig. 9.1 Protective suit and devices

Source: Ghosh BN. A treatise on Hygiene and Public Health. Scientific Publishing Co. Kolkata 15th edn, 1969.

Other Measures

Such as specifications of the room of cobalt unit or X-ray machine and disposal of radioactive wastes.

i. Specifications of the room of cobalt unit and X-ray machine:
   - Walls must be thick and made of concrete
   - Roof must be high
   - Wet mopping of floor to be done (Good house keeping)
   - Vacuum cleaning of the room
   - Lead protected doors
   - Lead glasses to be used for windows
   - Exhaust system of ventilation
   - Controlling machine should be as far away as possible from the worker
   - Enclosure of the machine, ventilated hoods, splash-trays control the release of dust in the environment.

ii. Disposal of radioactive wastes:
   - By putting in a steel case and embedding deep in the sea bed at 1800 mts deep
   - By putting it in an underground concrete seal
   - By burning in a special incinerator provided with filters and very tall stacks.

Secondary Prevention

a. *Early diagnosis/detection*: It is done by periodical analysis of dosimeter.

b. Treatment
   - *For leukemia*: By predinsolone, vincristine, daunorubicin, arabinosylcytosine.
   - *For bone marrow aplasia*: By antibiotics and blood transfusion.
   - *For bone sarcoma*: By amputation followed by chemotherapy.

If the individual is accidentally exposed and the radio active material has entered the system, that person is immediately decontaminated as follows:

- If implanted, the skin is excised, the radioactive material is removed, the area is washed with hot water and soap followed by application of citric acid.
- If swallowed, the adsorbants such as Prussian blue or ion exchange agents are given followed by emetics and salt purgatives. Diethylene triamene penta acetic acid (DTPA) is effective.

BIBLIOGRAPHY

1. Donald Hunter. The Diseases of Occupation, 1962.
2. Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co. Kolkata 15th edn, 1969.
3. International Commission on Radiation Protection. Recommendation of ICRP. Publication No. 1. Oxford, Pergamon, 1966.

CHAPTER 10

Housing

INTRODUCTION

Housing is defined as a physical structure which provides safety, security and shelter to the members living in and the environment including services and facilities necessary for maintaining optimum health by those members.

It is the place where the members spend most of their life-time and are reared, thus determining the culture (social and civil life) of the family.

REQUIREMENTS OF A HOUSE

a. *Location*: The house should be located on dry, noncaving ground, having an independent unit and should be nearer to shopping place, recreational facilities, educational centers, emergency services and transport system.
b. *Construction*: The house should be so strongly constructed as to withstand the vagaries of nature such as landslide, floods or earth-quake, etc. and also it should be safe and secured.
c. *Sanitation*: From the point of view of health, there should not be overcrowding and there must be sufficient light and ventilation, sufficient water supply and proper arrangements for drainage of liquid waste in the house. Provision should be made for insect proofing and rodent proofing also. Cleanliness to be maintained in and around the house.
d. *Comfortable house-life*: For this, there must be ideally separate kitchen, store room, bed rooms, a common living room for the entire family and a corridor.

HOUSING STANDARDS

These vary from country to country, depending upon the socioeconomic status, family size and composition, cultural practices and climate conditions.

The standards recommended in India are as follows:

- *Site selection*: The site or the ground selected should be high and only to drain the water. The soil should be of gravel nature. 'Made-soil' (i.e. ground leveled by dumping refuse) and damp-sites should be avoided. It should have proper approach roads and away from traffic and industries.
- *Foundation*: This must always be solid and substantial. The foundation is laid with a bed of cement concrete over the stones to cover the trench. The object is to prevent subsidence of the building. The width of the foundation should never be less than 25 inches.

  In addition to this bed of concrete, a layer of impervious material known as 'damp proof course' should be laid horizontally, along the entire thickness of each wall at plinth level. This prevents the upward progress of the moisture.
- *Walls*: The walls are constructed with cement and bricks or stones, with a minimum thickness of 9 inches, obtained by laying the bricks lengthwise and crosswise in alternate layers.

  The walls are then plastered so that it should neither absorb heat nor it should conduct the heat. Painting of the walls renders the surface impervious and enables easy wash.
- *Floor*: Floor should be air and water tight, surface should be smooth, facilitate easy wash and should be damp-

proof. The concreted floor should be covered with patent stone slabs or in better class houses, with marble slabs or tiles.

- *Roof*: Flat roofs should have sufficient slope to drain rain water. Height of the roof should not be less than 10 feet, as the heat radiated from the roof is in inverse ratio to the square of its distance.

  Sloping roofs may be either of tiles, slates, thatch, corrugated iron, asbestos, etc. A double roof with a space between will make a very cool covering to a dwelling.
- *Rooms*: The number of living rooms depends upon the size of the family to prevent overcrowding.
- *Doors and windows*: Every living room should be provided with at least two windows and one of them should open directly to the open space. Doors and windows should be so placed as to allow crossventilation (i.e. air should pass through one end and come out at the other).

The windows should be placed at 30" (2 ½ feet) above the floor level (and not above 3 feet) and the window area should be 1/5th of the floor area of the room. Doors and windows combined should have 2/5th of the floor area.

Ventilating grills should occupy 2 percent of the floor area, placed near the ceiling and facing open space outside. Doors and windows can be made mosquito proof with wire gauze.

- *Floor area*: The optimum floor area per person in the living room should be 50 to 100 sq feet. But it should never be less than 50 sq feet (Av = 75 sq feet).
- *Lighting*: The day light factor should exceed 1 percent over half the floor area. The room is said to be adequately lighted, when one can read or write in the center of the hall without the help of artificial light during day time.
- *Kitchen*: Every house should have separate kitchen room, should not be near a privy (toilet), nor so placed as to allow the smoke and smell of cooking getting into the rest of the house. It should not be exposed to dust and impurities getting into it. It should have adequate light and ventilation. Provision must be made for storing food grain, fuel (LPG cylinders) and utensils. There should be sufficient water supply and drainage facility. The floor of the kitchen must be impervious.
- *Water closets or privies*: Minimum one sanitary privy is a must for every house, preferably on the lee-ward side. It should have good ventilation. It should always be clean and dry.
- *Bathroom*: This should also be on the lee ward side of the house with drainage facility for the sullage water.
- *Utility*: Provision should be made for washing utensils and clothes.
- *Water supply*: There must be sufficient supply of safe and wholesome water. There may be individual water source for the house with a tube well, during the time of scarcity of water supply.
- *Setback*: There must be sufficient open space all around the building for adequate lighting and ventilation. This also prevents 'back-to-back' houses. Balcony should be provided in the multistoried buildings. The question of open space becomes more a luxury than necessity in cities, where the value of land is very high.
- *Refuse and garbage*: Refuse like ash, dust, waste paper, rags and garbage like vegetable and animal matter, collected in metal receptacles at least twice daily and emptied into the public dust bin, at regular hours.

  The liquid refuse like wash water from the kitchen, bathroom and other washing places like utility and also the human excreta must be drained by underground drainage system.
- *Other provisions*: In the construction of houses, efficient space utilization, storage for household goods and personal belongings and home safety measures should be incorporated. Provisions must also be made for parking their own vehicles, if any. Provision must also be made for draining the rain water. Domestic animals if any must be away from the living rooms. Electrification must be proper and safe.

HOUSING AND HEALTH

Poor standard of housing associated with defective ventilation and overcrowding, affects the health of the residents, physically, mentally and socially, resulting in increased morbidity and mortality.

Overcrowding is said to have occurred based on the following three criteria:

- Floor area : Person ratio
- Room : Person ratio
- Sex separation

- On the basis of floor area, the accepted standards are:
  110 sq feet or more—2 persons.
  90 to 110 sq feet—1½ person (A child between 1 to 10 years is considered as half person or half unit)
  70 to 90 sq feet—1 person
  50 to 70 sq feet—½ person
  (A child below one year is not counted)
- On the basis of room–person ratio, the accepted standards are:
  1 Room—2 persons
  2 Rooms—3 persons
  3 Rooms—5 persons
  4 Rooms—7 persons
  5 Rooms or more—10 persons (additional 2 for each further room)
- On the basis of sex separation, overcrowding is considered, if 2 persons, over 10 years of age, of opposite sex, unless husband and wife, are obliged to sleep in the same room.

Overcrowding associated with poor ventilation (and poor housing) causes rise of temperature, excessive humidity

and air stagnation of the room which lowers the vitality of the inmates and makes them more susceptible to diseases. Respiratory diseases spread by droplet infection very fast such as tuberculosis, measles, influenza, streptococcal throat infections, acute rheumatic fever, common cold, diphtheria, whooping cough, bronchitis, etc. contagious diseases like scabies, impetigo, ringworm, leprosy, trachoma, conjunctivitis also spread. Overcrowding has a bad social effect especially when persons of opposite sexes occupy the same sleeping room.

On the otherhand, isolation or loneliness felt by the person, living alone in the house, may result in neurosis, psychosis, behavioral disorders and also habits like alcoholism and drug addiction.

Standards of Rural Housing

- Built up area should be about 60 percent of the total site.
- There must be sufficient space around the house for adequate lighting and ventilation.
- The area of doors and windows should be about 25 percent of the floor area.
- Preferably two living rooms at least.
- Separate kitchen with a provision for washing utensils.
- Provision for washing the clothes.
- Soakage pit for disposal of sullage water coming form bathroom and kitchen.
- House should be provided with a RCA latrine.
- The source of water should be within the reach of about 400 meters.
- Live stocks, like cattle, pigs, sheep, etc. should be away from the human dwellings.
- There must be manure pit arrangements for the disposal of kitchen waste and domestic refuse.

INDICATORS OF HOUSING

These are grouped into three groups:

Physical Indicators

This consists of type of construction, floor area, persons per room, and sanitation (like lighting, ventilation, water supply, drainage facilities, etc.)

Economic Indicators

This consists of cost of the building, rental level, taxes, luxurious fittings, etc.

Social Indicators

These are further grouped into three subgroups:

a. Indicators related to preventable diseases
   - Frequency of diseases due to overcrowding
   - Frequency of diseases due to contaminated water source
   - Frequency of domestic accidents
   - Insect borne diseases
   - Zoonotic diseases.

b. Indicators related to comfort
   - Thermal comfort
   - Acoustic comfort
   - Visual comfort
   - Spatial comfort.

c. Indicators related to mental health and social well-being
   - Frequency of suicides
   - Frequency of drug abuse including alcohol abuse
   - Frequency of psychoses and neuroses.

HOUSING PROBLEM

In India, housing problem has assumed serious proportions in recent times, due to population explosion, migration of population due to industrialization and urbanization, eruptions of slums, faulty methods of construction of houses, lack of provision of protected water supply, disposal of refuse and excreta, etc. have given rise to the following problems:

- *Nonavailability of houses*: So, the homeless are forced to live on pavements, in railway and bus stations, or among the discarded truck bodies, rail carriages, etc.
- *Substandard houses and slums*: These are poorly constructed houses with lack of lighting, ventilation and drainage facilities. New slums are constantly growing up and old ones are getting expanded.

The situation is still made worse by overcrowding, by keeping the raw materials of the domestic industry and even domestic animals.

- *Dilapidated and crumbling houses*: Frequently, these are due to use of poor construction materials by the contractor.
- *A reasonably good house in bad surroundings*: In the vicinity of cesspools, open drains, offensive trades, noisy industries, liqor shops, red light areas.
- A house with a bad social environment such as uncooperative attitude and quarreling after consuming alcohol and also prostitution, gambling, etc.

Measures to Solve the Housing Problem

- Provision of good quality houses or tenements to the poorest of poor.

- Provision of sites with loan on easy terms to the landless poor.
- Improvement of existing slums by providing basic amenities like street lights, protected water supply, drainage facilities, community latrines, etc.
- Encouragement of owners of large establishments to built quarters for their employees.
- Construction of shelters for the street children.

The programs related to above activities are Indira Awas Yojana, Ashraya Program and Nirman Kendra.

BIBLIOGRAPHY

1. Government of India. Report of Environmental Hygiene Committee. Ministry of Health, New Delhi, 1949.
2. WHO Tech Rep Ser No. 297, 1965.
3. WHO Tech Rep Ser No. 544, 1974.

CHAPTER 11

Meteorology

INTRODUCTION

Meteorology is the science that deals with the study of changes or phenomena occurring in the atmosphere.

The components of meteorological environment are:

- Atmospheric pressure
- Air temperature
- Humidity
- Air movement (Air velocity) (Direction and speed of the wind)
- Rain fall.

The net effect of all these elements on the health and wellbeing of human life, animal life and vegetable life for the period of a month or year is called 'Climate' and with reference to a particular stated period or time, is called 'Weather.'

ATMOSPHERIC PRESSURE

The atmosphere (envelope of the air) is about 200 miles thick (320 km). The air of the lower level is much denser and heavier than the upper layer.

The atmospheric pressure at sea level is 760 mm Hg. This is called 'One atmosphere of pressure.' The atmospheric pressure falls as the altitude increases as in high mountains and rises as altitude decreases as in deep mines. Thus, at an altitude of 1,00.000 feet above the sea level, the atmospheric pressure is less than 10 mm Hg and for every 33 feet below the sea level, the atmospheric pressure increases at the rate of 'one atmosphere', i.e. when a person descends 33 feet (as in mines), he is exposed to an atmospheric pressure of 2 atmospheres, i.e. 760 × 2 = 1520 mm Hg.

The instrument used to measure atmospheric pressure is called 'Barometer.' 'Kew Pattern' station barometer is widely used. Others are Fortin's barometer, Aneroid barometer and barograph.

Aneroid Barometer

The name aneroid means devoid of fluid. It does not contain mercury or any other fluid. It consists of a cylindrical metal box with partial vacuum. It has an elastic metal top which is sensitive to changes in the atmospheric pressure **(Fig. 11.1)**. The pressure changes are transmitted from the

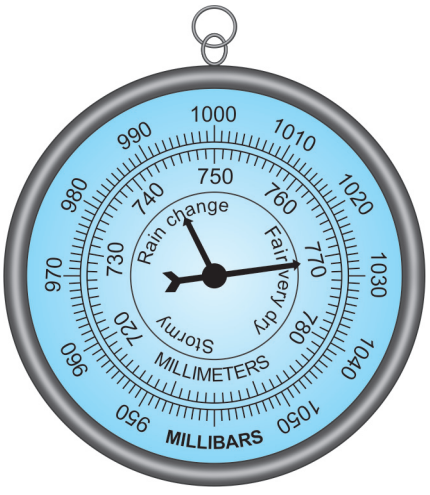


Fig. 11.1 Aneroid barometer

Source: Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.

metal top to a pointer through a series of springs. The pointer moves on a dial and indicates atmospheric pressure. It is not a precise instrument. Since it is a handy apparatus, it is used while climbing the mountains or in aeroplane.

Barograph

It is a modified aneroid barometer, in which the pointer records the pressure changes on a graph continuously.

Effects on Health

The influence of atmospheric pressure on health is considered under two headings:

1. Effects of diminished atmospheric pressure.
2. Effects of increased atmospheric pressure.

Effects of Diminished Atmospheric Pressure

This occurs in high altitudes, because air becomes rarefied (less dense), temperature of air also becomes less and the partial pressure of oxygen also becomes less. Man cannot survive at an altitude of 25,000 feet without breathing equipment. However, human body has a remarkable power of adjusting itself to low oxygen pressure provided the change is made slowly and persons can live for long period at heights of 15,000 to 20,000 feet without ill effects. This adjustment of the body is called 'Acclimatization.' The physiological changes are:

- Increase in rate and depth of respiration (to minimize the difference between the oxygen of the air and oxygen of the blood)
- Increase in the hemoglobin content of the blood
- Increase in the cardiac output.

But sudden exposure to high altitude above 10,000 feet, results in 'Acute mountain sickness' (or aviator sickness) due to rarity of atmosphere and deficiency in oxygen. This is characterized by headache, mental fatigue, irritability, irrational behavior, loss of muscular coordination, insomnia, nausea, vomiting, breathlessness, and in severe cases there may be bleeding from the nose, ringing in the ears, palpitation and even collapse. Excessive secretion of lymph results in hemoconcentration. Later, there will be chronic anoxemia, due to low oxygen tension in the blood.

Later as the pulmonary edema develops, the respiration becomes deep and irregular (Cheyne-Stokes breathing) the person also develops oliguria, mental confusion, hallucinations, later develops stupor, convulsions, coma and death supervenes.

The only treatment is to carry that person to lower altitude as soon as possible.

Effects of Increased Atmospheric Pressure

This occurs in low altitudes, as in mines and under the water in sea. The increased pressure of air produces effects of opposite nature. The effects are best observed in persons working in diving bells, compressed air chambers (Caisson's), etc. and the symptoms produced is known as 'Caisson's disease,' wherein the person exposed to high pressure, the gases in the air such as oxygen, carbon dioxide and nitrogen are dissolved in the blood and tissues, depending upon their partial pressures and the whole body is thus saturated with air. Nitrogen exerts narcotic action leading to loss of mental function and consciousness. The excess of CO_2 enhances the narcotic action of nitrogen. Excess of oxygen leads to convulsions and death.

When the person comes up to the surface, (i.e. during decompression) the process is reversed. The absorbed gases are released from the blood and tissues. Oxygen is retained and the Nitrogen is liberated causing bubbles in the tissues and gas emboli in blood vessels (air embolism) resulting in fatality.

As a rule, the workers do not suffer while they are in the caisson but grave symptoms occur after they return to the outside air. It is called 'Decompression sickness,' characterized by euphoria, sensation of increased strength, respiration becomes deeper and quicker and the heart becomes stronger and slower. These may be followed by nasal voice, disturbance in hearing, changed sense of smell or taste, rarely hemorrhages from the mouth, tympanic cavity and even from the lungs. There may be perspiration with a feeling of fatigue and weakness.

Sudden decompression results in severe pain in the muscles and joints of the extremities, called 'Bends' or 'Screws.' This is often referred to as 'Compressed air sickness.' There may be vertigo, chockes, unconsciousness or collapse. Pulmonary air embolism may result in sudden death, due to cardiac tamponade.

Management

When the symptoms occur, treatment is by recompression followed by gradual decompression. This reduces the volume of individual bubbles in the tissues and tends to make the nitrogen diffuse from bubbles into the tissues. Divers are instructed to come to the surface slowly. Haldane's method of graduated decompression or 'Stage method' has provided the beneficial results. In order to eliminate the risk of nitrogen absorption among the divers, helium gas mixture is used instead of ordinary air, because helium is less soluble, has low saturation level and higher rate of diffusion than nitrogen.

Similar to decompression sickness, nitrogen bubbles may also occur when a person ascends rapidly from the sea level to a very high altitude of about 25,000 feet. It is called 'Dysbarism.'

AIR TEMPERATURE

This is another component of meteorological environment. Not only it has a direct impact on the health of the individual but also it has an important bearing in the natural history of certain diseases, especially vector borne diseases like malaria, filariasis, Kyasanur forest disease, Japanese encephalitis, etc. For example, the malarial parasites cease to undergo development in the stomach of the female anopheline mosquito when the mean temperature remains below 16°C. Optimum air temperature for the development of malarial parasites is between 20 and 30°C, i.e. 68 and 86°F.

The temperature of the air varies in different parts of the day and also in different seasons. The factors which modify or influence the temperature of the air are latitude of the place, altitude, direction of the wind and proximity to the sea.

Measurement

Air temperature is recorded by using thermometers. There are two types—Mercury thermometer and Spirit (or alcohol) thermometers. Mercury thermometers are widely used because of its high boiling temperature and regular expansion. Alcohol has the advantage of not solidifying even at the lowest known temperature. The mercury thermometer can measure air temperature only if it is protected from direct sunlight and rain and is exposed to free circulation of air. Therefore, it is usually placed in a specially constructed box called, 'Stevenson's screen in which the thermometer is protected from the direct rays of the sun (i.e. radiant heat) with a thatched roof (to protect from rain) and has free circulation of air **(Fig. 11.2)**.

Air temperature is recorded by using the following thermometers in Fahrenheit scale/centigrade scale.

a. *Dry bulb thermometer:* This is an ordinary mercurial thermometer, placed in Stevenson's screen to protect from, direct sun and rain, at a height of about 1.5 meters above the ground level. It records the temperature of the air.

b. *Wet bulb thermometer:* It is similar to dry bulb thermometer, except that the bulb is kept wet by means of a muslin cloth, fed by water, from a bottle through a wick.

As the water from the muslin cloth evaporates, the mercury column comes down. Thus, the wet bulb thermometer shows a lower temperature reading in response to the heat lost by wet cloth through evapo-ration, than the dry bulb thermometer. The drier the air, lower the wet bulb reading. If the wet and dry bulb thermometers record the same identical temperature, it means the air is completely hundred percent saturated with moisture, which is rare or never occurs. The difference between the dry and wet bulb thermometers increases with increasing dryness of air and *vice versa* **(Fig. 11.3)**.

c. *Maximum thermometer:* This is a mercury thermometer. It is so designed that there is a fine constriction near

Fig. 11.2 Stevenson's screen
Source: Ghosh BN. A treatise on Hygiene and Public Health. Scientific Publishing Co Kolkata 15th edn, 1969.

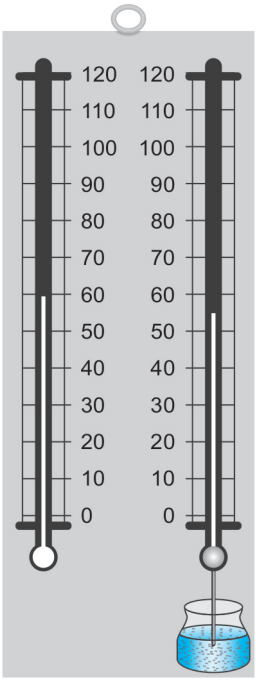


Fig. 11.3 Dry and wet bulb thermometers
Source: Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.

the neck of the bulb, which prevents the mercury from flowing back into the bulb, unless it is swung briskly. When the air temperature rises, mercury expands. When the temperature falls, mercury cannot get back into the bulb, because of constriction. Thus, it helps to record the maximum temperature of the air. When the thermometer has to set, a brisk swing is given so that mercury retreats into the bulb.

d. *Minimum thermometer:* It is an alcohol thermometer, in which a dumb-bell shaped index is immersed. When the temperature of air falls, the spirit drags the index towards the bulb end; when the temperature rises, the spirit expands and runs past the index, not displacing the index, thus recording the lowest temperature.

e. *Six's maximum and minimum thermometer:* This is a combination of maximum and minimum thermometers and gives a double reading. It is an 'U-shaped' glass tube with a bulb at each end, containing mercury in the middle portion. Both the tubes above the mercury and one bulb contain alcohol, and the part of the other bulb contains alcohol vapour and air. In each stem, there is an iron index which may be moved by a magnet. With the rise of air temperature, the alcohol expands and pushes the mercury alongwith the index recording the maximum temperature of the place in 24 hour cycle. With the fall of temperature, the alcohol contracts and the mercury falls, pushing the index in the other column recording the minimum temperature of the place in a 24 hour cycle. Thus, highest and lowest temperatures can be recorded by the indices in the right and left limb respectively. Both the indices are set again before the thermometer is placed for the next day's recordings **(Fig. 11.4)**.

Since it is not an accurate measurement, this instrument is not used in the Indian meteorological department.

f. *Vacuum or solar radiation thermometer:* This is a mercurial thermometer having the bulb coated with black color to absorb the sun's rays. The bulb is placed in a vacuum glass case in order to prevent the black paint from being washed off by the rain. The glass case also protects the bulb from loss of heat which would otherwise take place. The instrument is placed horizontally four feet above the ground level and exposed to the direct rays of the sun **(Fig. 11.5)**.

The difference between the maximum reading in the sun and minimum in the shade is the amount of solar radiation.

g. *Terrestrial thermometer:* It is a minimum shade thermometer, placed four inches above the ground on the grass or on a black board, if grass plot is not existing and temperature is recorded. Similarly, it is recorded in the shade. The difference between the minimum temperature recorded in the shade and outside the shade is the amount of terrestrial radiation.

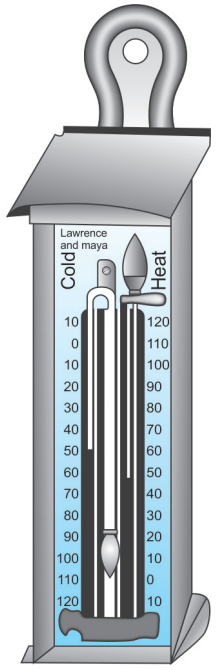


Fig. 11.4 Six's thermometer
Source: Ghosh BN. A treatise on Hygiene and Public Health. Scientific Publishing Co Kolkata 15th edn, 1969.

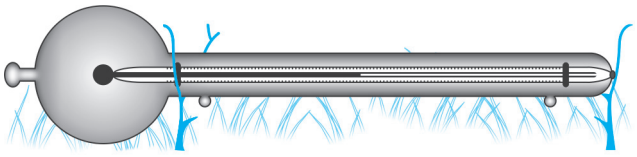


Fig. 11.5 Vacuum or solar radiation thermometer
Source: Ghosh BN. A treatise on Hygiene and Public Health. Scientific Publishing Co Kolkata 15th edn, 1969.

h. *Silvered thermometer:* Since the bright surface of the silver reflects the radiant heat, it gives the more accurate reading of the air temperature.

i. *Globe thermometer:* This consists of a hollow sphere, made up of copper, 15 cm in diameter coated with black paint on the surfaces. The hollow sphere has an opening at the top through which a mercury thermometer is inserted such that the bulb is in the center of the globe **(Fig. 11.6)**. Due to globe, the thermometer absorbs radiant heat from the surroundings. The globe thermometer records the higher temperature than the ordinary dry bulb thermometer because it is affected by both the air temperature and the radiant heat of the surroundings. Therefore, the difference between the reading of the globe thermometer and the ordinary dry bulb thermometer is a measure of the radiant heat.

The globe thermometer is also influenced by the velocity of the air movement.

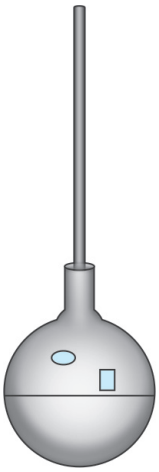


Fig. 11.6 Globe thermometer
Source: Park K. Park's Textbook of Preventive and Social Medicine. 18th edn, 2005.

Health Hazards of Air Temperature

This can be studied under two heads—of high temperature and of low temperature.

Effects of High Temperature

- Local effects—are blackening of skin, prickly heat (i.e. heat rash or miliaria rubra), sun burn and dermatitis.
- General effects—are heat exhaustion, heat cramps and heatstroke. The pathophysiological effects of heat on body system is called 'Heat–strain'.
  i. *Heat exhaustion:* This term includes heat syncope, water depletion exhaustion and salt depletion exhaustion.
     - *Heat syncope:* It is characterized by giddiness and fainting due to pooling of blood in the lower limbs following prolonged standing in the hot sun, which is common among soldiers. Due to pooling of blood in the lower limbs, there will be reduced venous return to heart, decreased cardiac output, low blood pressure and lack of blood supply to brain resulting in fainting.
       Practically, there is no rise in the body temperature.
       Treatment: Patient is made to lie in shade with the head slightly down, so that cerebral circulation should improve. Patient recovers within minutes.
     - *Water depletion exhaustion:* It is characterized by excessive loss of water due to profuse sweating. If water is not replaced, it leads to a reduction of intracellular fluid, resulting in excessive thirst, oliguria, oligemic shock and even in death.
       Treatment is by replacement of water.
     - *Salt depletion exhaustion:* Alongwith the perspiration, there will be a loss of sodium chloride, leading to reduction in the extra-cellular fluid and signs of dehydration. Patient may die of oligemic shock.
       Treatment is by replacement of normal saline.
  ii. *Heat cramps:* This is another acute clinical condition resulting from exposure to heat. It is characterized by sudden and severe painful, spasmodic contractions of the skeletal muscles, due to loss of sodium and chloride from the body. It commonly occurs among those who are doing heavy muscular work in high temperature and are sweating profusely.
       Treatment is by replacement of saline water.
  iii. *Heatstroke (Sun stroke):* It is usually due to radiant heat from the sun. It is characterized by very high body temperature of above 106°F, rapid pulse, rise of bloodpressure, dry and hot skin, delirium, convulsions, partial or total unconsciousness, stupor, coma followed by death. This condition is due to failure of heat regulating mechanism.
       Treatment is by rapid cooling of the body in ice-water bath. Chlorpromazine is recommended to prevent or to control convulsions.

Prevention of effects of high temperature

a. *Personal measures*
   - *Replacement of salt and water:* Additional 10 g of salt daily and 1 liter of water per hour is required for an unacclimatized person.
   - *Regulation of work:* This is done by alternating the period of work and rest. As soon as the initial symptoms of headache, giddiness, nausea, fatigue occurs, the person is shifted from hot environment to cooler environment.
   - *Type of clothing:* Minimum clothing should be worn by the worker in the hot environment. The clothing should be light, loose and of light color.
   - *Ventilation:* This must be proper in the working place.
   - *Protective devices:* Such as helmet, goggles and shields are helpful.

b. *Mechanical measures:* These are employed in the industries, where the workers are exposed to high temperatures.
   - Insulation of the process, where heat is produced in excess.
   - Operation of the equipment from a long distance.
   - Exhaustion of hot air or steam as soon as it is produced.
   - Replacement of hot air by cool air.
   - Circulation of cold water through radiators or pipes in the interior of the buildings.
   - Air conditioning of the rooms.
   - Painting of outer surface of the building with aluminium paint to prevent absorption of radiant heat.

Effects of Low Temperature

General effects and local effects (effects occur after prolonged exposure).

- *General effects:* Initially, there will be shivering and tensing of the muscles resulting in rise of BP, pulse rate and respiration rate followed by decrease in BP, pulse rate and respiration rate. Later, there will be hemoconcentration, oliguria and muscular weakness. With hypothermia at 80°F, coma sets in. At 75°F, death occurs following ventricular fibrillation.
- *Local effects:* Local changes occur in the extremities (hands and feet). The conditions are:
  i. Acute transient inflammatory reaction.
  ii. Trench foot.
  iii. Frost bite.
  i. *Acute transient inflammatory reaction:* When the body is exposed to cold temperature, there will be vasoconstriction of the superficial blood vessels followed by intermittent vasodilatation. This is called 'Hunting' phenomenon, due to the release of a chemical substance locally in the tissues. There will be pain, numbness and loss of sensation. These will subside within a few hours after removal from the exposure.
  ii. *Trench foot (or immersion foot):* It is so called because it used to be common among those soldiers, who used to stand in trenches for long periods during Ist World-War. Prolonged exposure to cold initially results in acute transient inflammatory reaction, later followed by vasodilatation, transudation, hemoconcentration, platelet conglomeration, tissue edema and gangrene may follow. Feet become cold, swollen, numb, anesthetic and waxy white with some cyanotic areas. Afterwards the part becomes red and hyperemic.
  iii. *Frost bite:* This occurs when exposed to temperature of 0 to – 5°C. There is actually freezing of the tissues and crystals of ice are formed between the cells. The skin appears pale, dull, opaque and yellowish. After removal from that temperature, there will be vasodilatation and so a wheal is formed around the frozen area. There may be even blister formation. Prolonged deep freezing may lead to necrosis and even gangrene of the tissues.

Treatment

- Rewarming of the patient in water at 42°C (most effective).
- Warming should last for about 20 minutes.
- Vasodilators are not necessary because the vessels are already dilated.
- Intake of hot fluids promotes general rewarming.

Preventive measures

- Proper clothing with thick clothes
- Exercise
- Environmental heating
- Regulation of exposure to cold
- Adequate food supply because of increased metabolism in cold.

Heat stress: It is the amount of heat that must be released or lost from the body in order to maintain the thermal equilibrium.

The factors which influence the heat stress (S) are metabolic heat produced in the body (M), heat lost or gained through convection (C) and radiation (R) and evaporation (E). When it is put in the form of equation, it will be S = M +C + R – E, which should be zero if the body is to remain in thermal equilibrium.

Convection depends upon the air temperature and air velocity.

Radiation depends upon the surface temperature of surroundings.

Evaporation depends upon the humidity and air movement.

Indicators of heat strain: These are heart rate, body temperature and amount of sweat produced.

Indicators of heat stress: These are:

i. *Equatorial comfort index (ECI):* It is the temperature of the air.
ii. *Heat stress index (HSI):* It is the percentage of heat storage capacity of the individual.

Value of heat stress (%)	Interpretation
0	No thermal loss
10–30	Mild-to-moderate heat strain/stress
40–60	Severe
70–90	Very severe
100	Upper limit of heat tolerance

iii. *Predicted four hour sweat rate (P_4SR):* It is the rate at which a man sweats and is expressed for 4 hours. A sweat rate of 2.5 liters in 4 hours is considered optimal for a working man. A sweat rate of 4.5 liters in 4 hours is the upper limit of tolerance in hot environment. This indictor is applicable only in situation where sweating occurs. P_4SR is a good index of heat stress and one of the parameters/criteria of comfort zone.

HUMIDITY

Atmospheric humidity means the moisture content of the air, which in turn depends upon the air temperature. Lower the temperature of air, higher the moisture content (Humidity) and *vice versa*. The temperature at which the moisture precipitates is called 'Dew point.'

Humidity may be expressed as absolute humidity or relative humidity.

Absolute Humidity

It is the actual amount of moisture (or water vapor) in an unit volume of air. It is expressed as grams per cubic meter of air.

Relative Humidity

Relative humidity (RH) is the percentage of moisture present in the air, complete saturation being taken as 100. Greater the relative humidity, the nearer the air to saturation. This is more commonly employed to express the humidity.

Eventhough humidity has no effect on the health of the individual, definitely it has an effect on the comfort. If RH is more than 65 percent, air feels sticky and uncomfortable. RH can be lowered by better ventilation. RH below 30 percent over long period results in drying of nasal mucosa predisposing for infection. Thus, it is also uncomfortable. So the RH between 30 to 65 percent constitutes 'Comfort zone' to the worker in the working place.

Measurement

The humidity of the air can be measured by an instrument called 'Hygrometer', of which there are two kinds—namely direct and indirect hygrometers.

Direct hygrometers are Danniell's Hy, Regnault's Hy and Dine's Hy.

Indirect hygrometers are dry and wet bulb hygrometer, Sling psychrometer and Assmann psychrometer.

Dry and Wet Bulb Hygrometer

This consists of two thermometers—a dry bulb thermometer and a wet bulb thermometer. Both are alcohol thermometers, mounted side by side on a stand. The former measures the air temperature. The latter is so called because the bulb is always kept moist by covering with a thin muslin cloth, kept moist with water. So, the wet bulb reading is always lower than the other.

The difference between the two thermometers is referred to psychrometric chart or slide rule and the relative humidity can be found. Greater the difference, greater is the RH.

If both the readings are the same, it indicates that the atmosphere is hundred percent saturated with moisture, which never occur in reality.

For accurate readings, the air should pass over the bulb with a speed of about 5 meters per second. The sling psychrometer achieves this when rotated rapidly.

Sling Psychrometer

This consists of two mercury thermometers dry and wet, the latter bulb is covered with a muslin cloth and kept moist with water. Both the thermometers are identical and mounted side by side on a wooden-frame, which is provided with a handle to whirle rapidly **(Fig. 11.7)**.

Principle: By rotating, both the bulbs are exposed to air at definite velocity.

Procedure: At the time of use the muslin covering should be thoroughly saturated with distilled water and the instrument is rotated or whirled rapidly, at the rate of four revolutions per second, so as to obtain a desirable air speed of 5 meters per second, for about 15 seconds, stopped and wet-bulb reading is noted. This is repeated several times till the two successive wet bulb readings are identical, showing that it has reachest its lowest temperature. Now, the dry bulb reading is also taken, which is the true temperature of the air.

The difference between the two readings (dry and wet bulb) is referred to the psychrometric chart and the percentage of RH is obtained. Greater the difference, greater is the RH. This difference not only helps to obtain relative humidity, but also the dew point and the vapor pressure of the air.

AIR MOVEMENT

The best instrument used to record the velocity of air and also the pressure of the wind is Robinson's wind anemometer **(Fig. 11.8)**. It consists of metal cross provided with hollow hemispherical cups at their ends, revolving horizontally on a vertical spindle, which by an arrangement of a screw, records the movement on a dial in the anemometer. From the number of turns made in a given time, the velocity of the wind is obtained.

Since the cups move at a rate equal to only one-third of that of the wind, allowance is therefore made in the instrument.

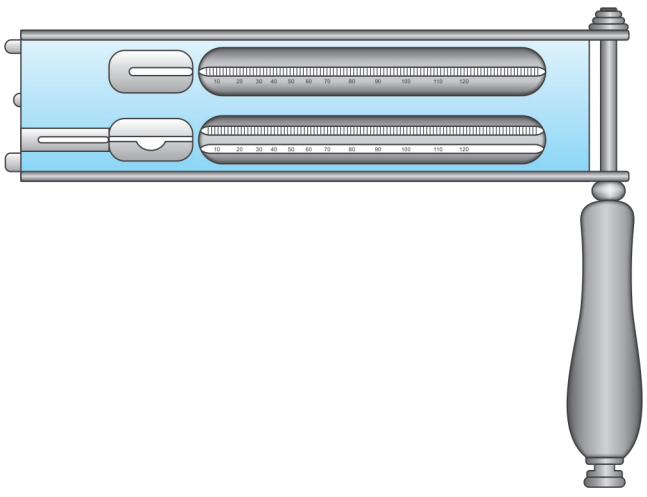


Fig. 11.7 Sling psychrometer

Source: Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.

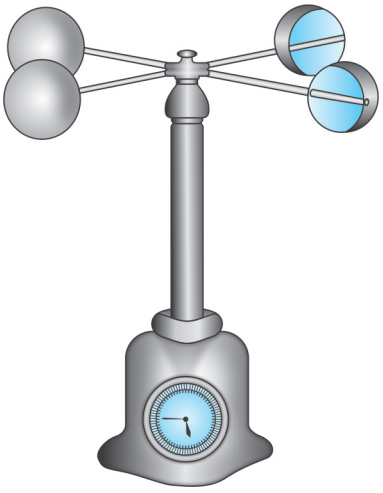


Fig. 11.8 Wind anemometer
Source: Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.

The instrument should always be kept clean periodically oiled and fixed at 10 meters above the ground for correct reading.

When the wind speed is 0.5 m/sec, it is described as 'calm' wind with smoke rising vertically. When it is 3.3 m/sec it is described as 'slight breeze' with leaves rustling. When it is 10 m/sec it is called 'strong wind' with larger branches of trees moving. When it is 15 to 20 m/sec, it is called 'Storm', when it is 25 to 30 m/sec, it is called 'Gale' and above 30 m/sec it is called 'Hurricane.'

The instrument used to observe the direction of the wind is called 'wind vane.'

Kata thermometer: To secure a comfortable atmosphere in our rooms, an instrument called 'Kata thermometer', devised by Sir Leonard Hill, is used to measure the rate of heat loss from a surface at body temperature.

It is an alcohol (spirit) thermometer having markings of 95 to 100°F on the stem. Two such instruments are used, one with the bulb uncovered—the dry kata thermometer, the other with the bulb covered with muslin cloth and kept wet the wet kata thermometer **(Fig. 11.9)**.

Directions to use: The bulbs of both the thermometers are immersed in hot water of about 150°F, so that the spirit rises to the small bulbs at the top of the instruments. Then both are removed, the excess water is shaken of the wet kata and the other wiped dry. Then the instruments are suspended in the air and the time required to cool from 100 to 95°F is recorded in seconds. Rate of heat loss is obtained by dividing the total heat loss from 100 to 95°F by the surface area of Kata in sqcm and expressed in millicalories or 'Factor' (or F).

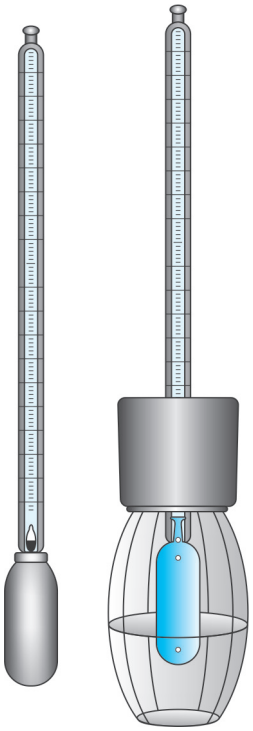


Fig. 11.9 Kata thermometer, dry and wet
Source: Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.

$$\text{Rate of heat loss} = \frac{\text{Total heat loss while cooling from 100 to 95°F}}{\text{Surface area of Kata (in sqcm)}} = \text{F (Factor) in millicalories}$$

Then the rate of cooling is obtained by dividing the factor by the time in seconds required for drop from 100 to 95°F.

$$\text{Rate of cooling} = \frac{\text{Factor}}{\text{No. of seconds taken to cool from 100°F to 95°F}} = \text{'X' millicalories per sqcm per second}$$

Example: Factor of Kata = 500 millicalories.
Dry Kata cooling time = 60 seconds
Wet Kata cooling time = 25 seconds
Therefore,

$$\text{Dry Kata cooling power} = \frac{500}{60} = 8.3$$
$$\text{Wet Kata cooling power} = \frac{500}{25} = 20.0$$

} millicalories/sqcm/sec.

Dry Kata (DK) gives the rate of cooling by radiation and convection and the wet Kata (WK) gives the rate of cooling not only by radiation and convection but also by evaporation.

High dry Kata indicates great cooling power and a low reading means the reverse (e.g. DK 15 means too cold and DK 5 means too hot).

The difference between WK and DK gives the cooling power due to evaporation only and thus helps in measuring air movement.

Wet kata is valuable in the tropics, specially in cotton-mills, where sweating occurs.

Kata thermometer is also useful for measuring the air-velocity when it is too low to be registered on an anemometer.

The rate of heat loss from the surface varies with the combined effects of air temperature, air movement, relative humidity and radiation.

Effective temperature is defined as that temperature of saturated motionless air which would produce the same sensation of coolness as that produced by the combination of temperature, humidity and air movement under observation.

Comfort zone: Is a one wherein the worker in the industry feels comfortable while doing his work. The criteria of comfort zone are:

- Corrected effective temperature (CET) → 77 to 80°F
- Relative humidity (RH) → 30 to 65 percent
- Dry Kata (DK) → 6 and above
- Wet Kata (WK) → 20 and above
- Predicted 4 hour sweat rate (P_4SR) → 1 to 3 L (Av 2.5 L)

BIBLIOGRAPHY

1. Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.
2. Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co., Kolkata, 15th edn, 1969.
3. Park K. Park's Textbook of Preventive and Social Medicine. 18th edn, 2005.
4. WHO Tech Rep Ser No 405, 1968.

CHAPTER 12

Disposal of Wastes

The waste products of the community living are refuse, human excreta and sewage.

REFUSE

It is a solid waste. It is of the following types:

- *Street refuse:* Consists of leaves, straw, papers, animal dung and litter of all kinds.
- *Market refuse:* Consists of putrid vegetables and animal matters.
- *Domestic refuse:* Consists of ash, rubbish (pieces of papers, clothes, wood, metal, glass and dust and dirt) and garbage (waste arising from the kitchen, such as peelings of vegetables, waste food, rotten fruits and vegetables, etc.).
- *Industrial refuse:* Consists of wide variety of toxic chemical compounds.
- *Stable litter:* Consists of mainly animal dung and left over animal feeds from animal stables.

Health Hazards

- Pollution of water, soil
- Contamination of food and drinks through dust and flies
- Decomposed refuse favors propagation of house files
- Attracts rodents and vermin
- Nuisance by sight and smell.

Storage of Refuse

Dustbins made of galvanized iron sheets are suitable receptacles, placed at a fair distance from the house. If it is covered with a lid, people will not open it but throw the refuse around it. If not covered, the dogs, pigs and other animals scatter the contents, thus creating nuisance.

In the developed countries, the dustbins will have 'paper sack'. When the paper sack is filled, it is removed from the bin and a new sack is placed inside.

The municipal workers remove the refuse periodically.

Collection of Refuse

House to house collection of refuse is the best method but that is not done. Dumping the refuse in the public dustbin is also not done properly. As a result, refuse is dispersed all along the street. The Environmental Hygiene Committee (1949) recommends:

- House to house collection of refuse
- Open refuse carts should be replaced by enclosed vans
- Mechanical transportation is more practical and economical.

The collection and transportation of refuse should be carried out during the early hours of the morning to minimize the nuisance.

Wheel barrows are small hand pushed carts used to collect refuse from narrow lanes where big carts cannot go. The refuse collected by wheel barrows is deposited in dustbins.

Collection and removal of domestic and town refuse, apart from human excreta, by means of manual labor is called 'scavenging'.

METHODS OF REFUSE DISPOSAL

There are many methods but choice depends upon the cost factor and the availability of land and labor. The different methods are:

- Dumping
- Controlled tipping
- Composting
- Manure pits
- Burial
- Incineration.

Dumping

In this method, the refuse is dumped in the low lying areas and later reclamation is done and used for cultivation purpose. Since it results in all the health hazards mentioned above, the land selected for dumping should be as far away from human habitation as possible or outside the limits of the town.

WHO Expert Committee (1967) condemned dumping as 'a most insanitary method of disposal of refuse because of the health hazards', to be replaced by sound procedures.

Controlled Tipping (Sanitary Landfill)

This is nothing but dumping or burial of the refuse in a sanitary way as to prevent the health hazards.

The dumping site should be away from the human habitation or outside the city limits and sources of water, so that water pollution due to leaching from refuse dumps is avoided. After dumping the refuse, it is covered with a layer of earth on the top daily, so that nuisance by sight and smell, and also breeding of flies is prevented. 'Modified sanitary landfill' term is applied to those operations, where compaction and covering with earth is done once or twice a week.

There are three methods of controlled tipping—the trench method, the ramp method and the area method.

i. **The trench method:** This is preferred in those areas, where low lying area are not available. A trench of about 2 to 3 mts deep and 4 to 12 mts wide is dug. The refuse is placed and covered with excavated earth. It is estimated that one acre of land per year will be required for 10,000 population.
ii. **The ramp method:** This is suitable in those areas where the terrain is moderately sloping.
iii. **The area method:** This differs from trench method in that the trench is not dug but land depressions like dried ponds and clay pits are utilized for filling with refuse and covered with mud. Such a built-up area is called 'made-soil.'

After about one week of burial of refuse, temperature rises to about 60°C, killing all the pathogens followed by decomposition process. After another 2 to 3 weeks, it cools down. Within 4 to 6 months, all the organic matters are decomposed into innocuous mass.

The 'made-soil' is suitable for gardening. It can also be utilized for construction purposes, but after several years.

Composting

In this method, the refuse is disposed off alongwith the night-soil or sewage. There are two methods—biological and mechanical.

i. **Biological:** This is also called Bangalore method or anaerobic method or hot fermentation process.

   In this method, trenches are dug measuring 5 to 10 mts length, 2 mts breadth and 1 mt depth, away from the city limits. Alternate layers of refuse and human excreta (night-soil) are put into the trench, in the thickness of 15 cm and 5 cm respectively, the first and last layer being that of refuse. The trench is then covered with excavated earth.

   Within about a week intense heat is generated to about 60°C, persisting for about 2 to 3 weeks killing all the pathogens and the parasites. The lignins and cellulose are broken down. The end products of decomposition are acted upon by fungi and anaerobic bacteriae, resulting in harmless, odorless, innocuous humus mass, called 'Compost', which has high manurial value. It is sold as organic manure, without causing any nuisance. It is ready for application to the land.
ii. **Mechanical:** This is also called 'Aerobic method.'

   In this method, the refuse is first cleared of salvageable materials such as rags, bones, pieces of metals, woods, glasses, etc. and then powdered in a pulverizer. It is then mixed with human night soil in a rotating machine and incubated for 4 to 6 weeks, at the end of which the entire process of composting is complete by the action of temperature, moisture, pH and aerobic bacteriae. The mixture gets changed to compost. This method is in vogue in developed countries.

Manure Pits

This method is preferred in rural areas, where collection and removal system of refuse is absent. The individual householder should have a 'manure pit' where in the daily domestic refuse is dumped and covered with earth after each day's dumping. When one is filled other pit should be used. After about 4 to 6 months, the refuse is converted into compost, which can be used to the field as manure. This is a simple and effective method.

Burial

This is suitable for small camps. This is also the same as trench method, but in the trenches, only the refuse is dumped and not the human excreta. At the end of each day, the refuse is covered with earth. When the trench is filled, new trench is dug out. After 4 to 6 months, the compost is removed and used as manure.

Incineration

This is the process of burning the solid waste and is the most sanitary method of disposal of refuse, especially the hospital refuse because of its dangers.

The incinerator consists of the following features:

- A furnace or combustion chamber lined with fire-bricks, where the fire is built with firewood or electricity.
- A platform for tipping the refuse.
- Stokers (through the openings) to bring the refuse together for burning completely.
- A baffle plate to drive of all the fumes **(Fig. 12.1)**.

By this process of burning the refuse, the refuse is reduced to about one fourth of its original weight and the organic matter is transformed into innocuous vapors—carbondioxide and nitrogen. The residuum left after the combustion is a mass of hard material called 'clinkers', which are utilized for making the roads. It is also used as cement by powdering the clinkers and mixing with lime.

This method is feasible in those city areas where considerable quantity of refuse is produced daily but sanitary land-fill sites are not available.

The incinerators built of mud or iron without bricks do not give satisfactory results. However, they are suitable for fairs and melas of short duration. The 'Beehive incinerators' have been found useful under such conditions **(Fig. 12.2)**.

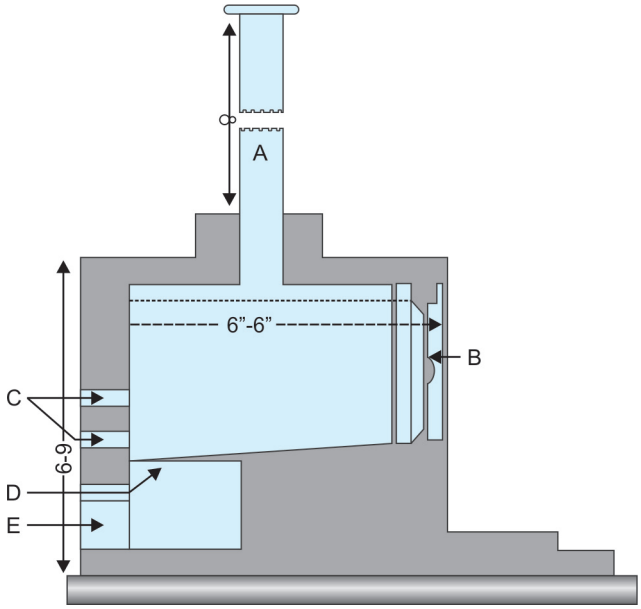


Fig. 12.1 Incinerator—longitudinal section. A = Chimney; B = Charging door; C = Openings for stoking; D = Iron grating; E = Opening for removing ashes

Source: Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co Kolkata 15th edn, 1969.

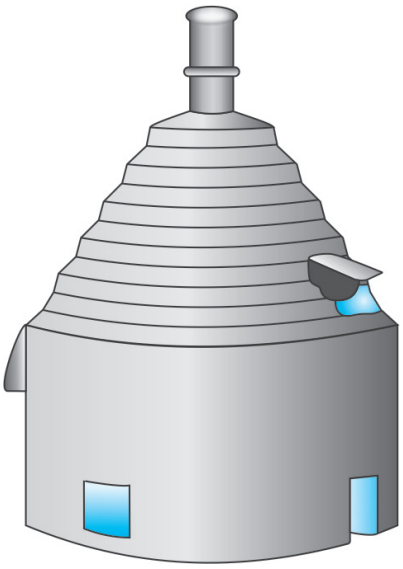


Fig. 12.2 Beehive incinerator

Source: Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co Kolkata 15th edn, 1969.

The drawback in many incinerators is that the draught is not sufficient. Therefore, they give off offensive smoke creating nuisance. To overcome this, the temperature in the furnace should be more than 1250°F, for which the chimney should be tall and draught of air adequate.

RECYCLING OF REFUSE

All reusable materials are separated from the refuse and used. Paper and rags are used for paper production. Plastics are sorted out by type and recycled separately for the manufacture of plastic buckets, pots, mugs, etc. glass, rubber, aluminium, copper, iron, brass, etc. are melted and put to their respective uses. Discarded tube lights are used for the manufacture of laboratory glassware. Garbage and plant wastes are used for composting. Animal excreta are separated and used for producing biogas.

DISPOSAL OF EXCRETA

Human excreta is a source of pollution. It causes pollution of the physical environment such as food, water and soil and results in many diseases, such as typhoid, paratyphoid, diarrheal disease, dysenteries, amoebiasis, ascariasis, viral hepatitis, poliomyelitis, ankylostomiasis and such other infections and infestations, all resulting in increased morbidity and mor-

tality in the community, which is thus a threat to public health.

In India, nearly 50 million people are suffering from such disease every year and nearly 5 million of them are dying. This is because of the following reasons:

- Eighty percent of the population live in rural areas.
- Rural people go to the fields for defecation because of the belief that filth should not be inside the house.
- Rural people have lack of knowledge about the importance of using sanitary latrines.
- Excreta is an excellent breeding place for house flies.
- Excreta is nuisance by sight and smell.
- Lack of amenities of sewerage system.
- Nonavailability of any kind of latrine whatsoever.
- Availability of ill maintained community latrines, so that all the filth over flows on the street.
- Endemicity of water borne and soil borne disease, often resulting in epidemics.

Sanitation Barrier

Transmission of all the above mentioned diseases, which are all prevailing as endemic diseases in the country, can be prevented and controlled, by preventing the contamination of physical environment such as food, water and soil, by construction of a barrier called 'Sanitation barrier', which is nothing but construction and use of sanitary latrines, which prevents the access of the pathogens from Feces (F) through 6 Fs such as Fluid (Water and milk), food, fruits and vegetables, fomites (utensils), Flies (vectors) and Fingers, to the mouths of susceptible persons **(Fig. 12.3)**.

The construction and use of sanitary latrines will be more effective, when supplemented by the following procedures such as chlorination of water supply, pasteurization of milk, adoption of food hygienic measures, disinfection of fruits and vegetables, disinfection of utensils, control of house-flies and adoption of personal hygienic measures like trimming of the nails and washing the hands with soap before eating food and after using toilet.

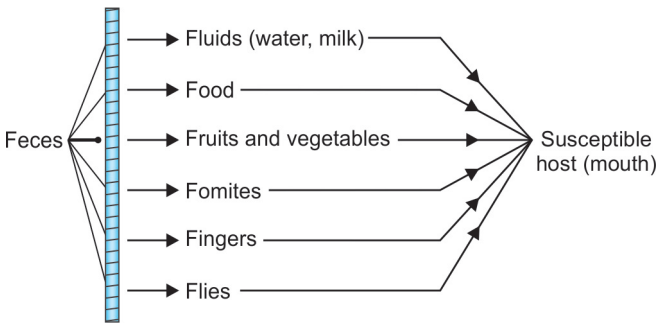


Fig. 12.3 Sanitation barrier

Methods of Disposal of Excreta (Night Soil)

This depends upon the availability of underground drainage system (sewerage system).

A. Unsewered areas (Disposal is made *in situ*).
   The different types of sanitary latrines are:
   a. Bore hole latrine.
   b. Dug well (pit) latrine.
   c. Waterseal type of latrine.
      i. PRAI type
      ii. RCA type
      iii. VIP latrine
      iv. Sulabh Shauchalaya.
   d. Septic tank latrine.
   e. Aqua privy.
   f. Sanitary latrines for fair, *mela*, camp, etc.
      i. Shallow trench latrine.
      ii. Deep trench latrine.
      iii. Pit latrine.
      iv. Bore hole latrine.
   g. Biogas plant.
   h. Composting.

B. Sewered areas.
   In this type, the night-soil is transported by water carriage system to the point of disposal.

Disposal of excreta starts with latrine, which is a provision made for passing and collecting the excreta. The collection and removal of night soil from the bucket by the human agency is called 'Service type' and 'conservancy system', which is not consistent with human dignity and is no longer pardonable. Therefore, Environmental Hygiene Committee (1949) has recommended that in unsewered areas, the service latrines (or bucket latrines) should be replaced by sanitary latrines, in which the excreta is disposed off *in situ* in a hygienic way.

A sanitary latrine is the one which fulfils the following criteria:

- The night soil should not contaminate the ground or surface water.
- It should not pollute the soil.
- It should not be accessible to house flies, rodents and animals like pigs, dogs, cattle, etc.
- It should not create nuisance by sight and smell.
- It should be cheap, easy to construct and acceptable to the people.

Bore Hole Latrine (Earth Pit Deep Latrine)

This was first introduced by Rockefeller Foundation during 1930's to control hookworm.

The latrine consists of a circular hole of about 30 to 40 cm diameter, dug vertically to a depth of about 6 meters into the

earth by using a special equipment known as auger, lined with bamboo matting to prevent caving in of the soil. A squatting plate with a central opening and two foot-rests are placed over the hole. An enclosure (superstructure) is put up for privacy.

When the contents of bore-hole reach within 50 cm of the ground level, the squatting plate alongwith the foot-rest is removed and the hole is covered with earth. A new hole is dug and used similarly. The night soil undergoes purification by anaerobic digestion (biological disintegration) and is converted into a harmless humus.

Such a bore hole latrine serves the purpose for a family of about 6 persons for about an year.

Merits

- The pit is dark and so not suitable for fly breeding.
- If located beyond 15 meters from a source of water supply there is no danger of water contamination.
- Recommended in the rural areas.
- Cheap to construct. Disposal is *in situ*.

Demerits

- Fills up rapidly because of small capacity.
- The special equipment 'auger' may not be available readily.
- Difficult to construct if the soil is loose.

Because of the limitations and improvement in the literacy level, living conditions, health consciousness and innovations of better latrines, bore-hole latrines have become outdated.

Dug Well or Pit Latrine

This differs from bore hole latrine in that the diameter is bigger, i.e. 75 cm and about 3 meters deep.

Merits

- Easy to construct
- Auger is not necessary to dig
- It is larger than bore hole latrine.
  (It lasts for about 5 years for a family of 5 members).

The biological disintegration of night soil and its conversion into manure is same as in borehole latrine. When the pit is filled-up, a new pit is constructed. It is also outdated.

This was first introduced in Singur, West Bengal during 1949. Since the pit is directly below the squatting plate, the bore hole and dug well latrines are also called 'Direct types'.

Waterseal Type of Latrines

These are the latrines, which have a bend-pipe (trap) below the squatting plate, always holding some amount of water, providing 'Waterseal'. Waterseal is the distance between the level of water in the trap and the lowest point on the concave upper part of the trap. The bend pipe is called 'trap', because it traps certain amount of water, as to provide waterseal. This waterseal prevents the access of flies and also prevents the escape of foul smell from the drainage pipe into the house, thus eliminating the nuisance. Because of these two merits these latrines have been accepted by the people, compared to bore hole and dug well latrines.

If the pit is directly underneath the squatting plate it is called 'Direct type' and if away from squatting plate it is called 'Indirect type' of latrine.

There are different types of waterseal latrines:

i. *PRAI type:* Planning Research and Action Institute, Lucknow (Uttar Pradesh).
ii. *ICMR type:* Evolved by Indian Council of Medical Research, in which the pit is directly underneath the squatting plate.
iii. *RCA type:* Designed by Research Cum Action Project in Environmental Sanitation, under the Ministry of Health, Government of India. This is widely accepted all over.
iv. *VIP latrines:* In RCA type, the superstructure containing the squatting plate, is permanent and is away from the pit **(Fig. 12.4)**. Thus, it is an indirect type. Therefore, the pit can be of any dimension. When one pit is filled, the latrine can be connected to another pit.

The features of RCA latrine are:

- **Location:** It should be located at least 15 meters away from a source of water supply.
- **Squatting plate:** The squatting plate or slab including the foot rest should be made up of an impervious, cement concrete material, so that it can be washed and kept dry and clean, measuring 90 cm square, 5 cm thick with a slope of ½ inch towards the pan, as to drain the ablution water or water used for cleaning purpose.
- **Water closet (Pan):** A pan having a smooth finish, sloping from front to back is fitted just below the squatting plate to receive the night soil, urine and wash water. The water closet has the connection with the dug well through the soil pipe (or connecting pipe). It removes the nightsoil through the agency of the water immediately, thus preventing smell and fly nuisance.

Trap

It is a bent pipe of 7.5 cm diameter, the vertical portion being connected to lower part of the water-closet and the bent portion being connected to connecting pipe. It is called trap because it traps certain amount of water and provides 'waterseal'. Depending upon the direction of the outlet outwards, it is named as 'P-trap', 'S-trap', 'Q-trap', 'Floor tap', 'Intercepting trap' and 'Gully trap' **(Fig. 12.5)**.

Waterseal of the trap is the distance between the level of the water in the trap and the lowest point on the concave upper surface, when the trap is in proper position. It is about 2 cm. Waterseal acts as a barrier for the escape of foul smelling air from the sewer or connecting pipe into the house and also it prevents access by flies to the night soil.

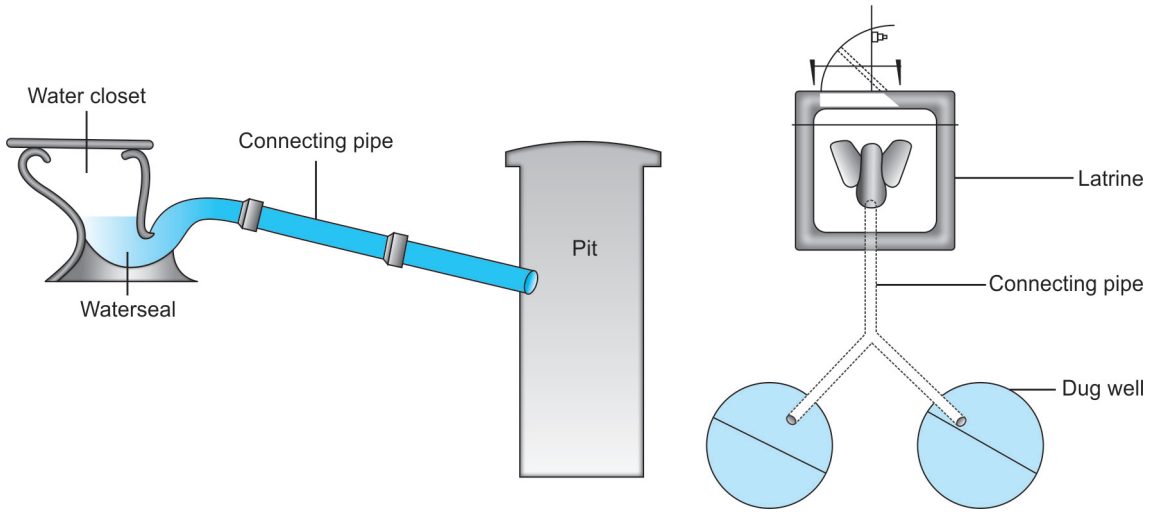


Fig. 12.4 RCA latrine (Indirect type)

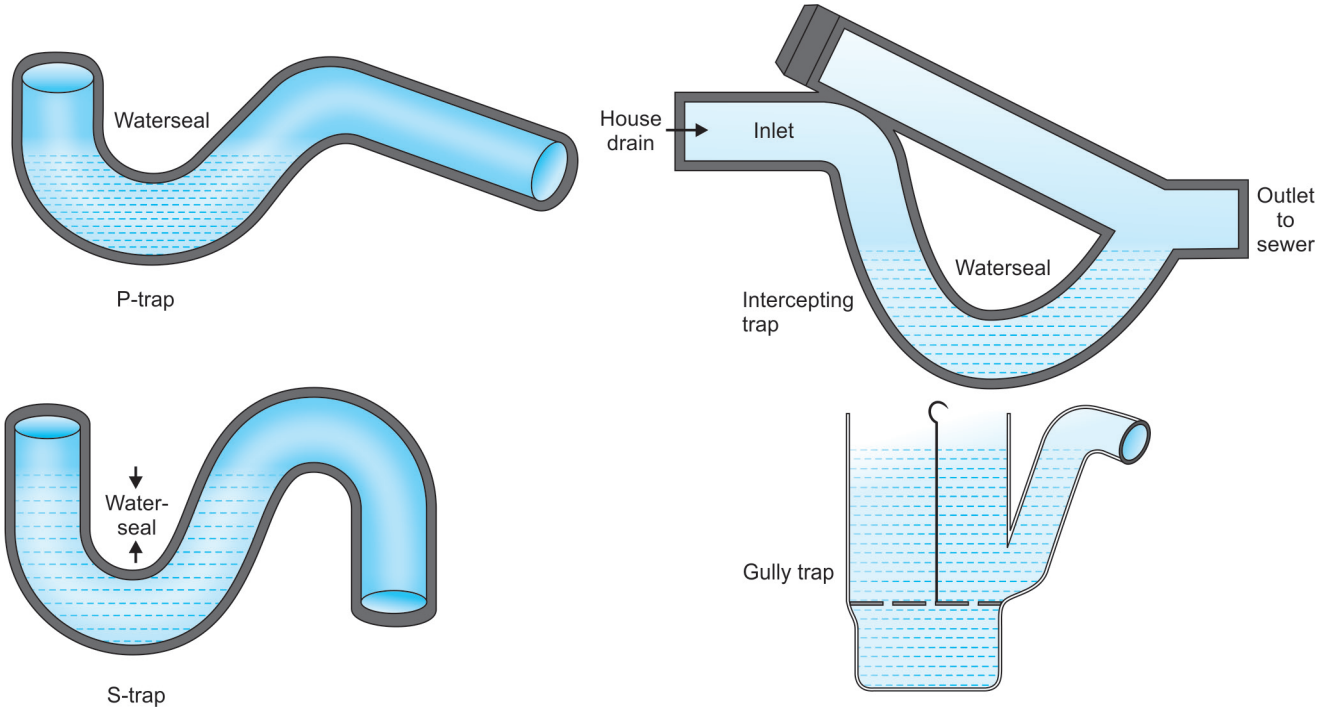


Fig. 12.5 P-trap, S-trap, intercepting trap and gully trap

A trap should be self-cleansing with every flush of water and it should have no angles, corners, cracks or projections inside, which might impede the onward flow of night soil or any solid matter in the drainage system. It should not be liable to 'silt' and it should have an opening for cleansing purposes in the drainage system.

The traps are usually placed in the following positions:

- Under each water closet, bathroom, urinal, sink, etc.

- Near the junction of the house drain with the sewer (public drain) (i.e. intercepting trap).
- In the open air, at the level of the ground to receive slop water from bathrooms, lavatories, etc. (i.e. where rain or surface water and waste water pipes open (Gully–trap).

(As it is possible that mud, other debris and solid particles may be swept into the gully with the inflowing surface water, the Gully trap is so made that these settle at the bottom which may be removed periodically).

The trap may fail to perform its functions when there is evaporation of water-seal or when it is being blocked with deposit of solid matter due to inefficient flushing.

- *Connecting pipe:* Since the pit is away from the superstructure, the trap is connected to the pit by means of a connecting pipe of 7.5 cm diameter and about 1 meter length.

  Since the pit is away from the superstructure, RCA latrine is also called 'Indirect type' of latrine.
- *Dug well:* This is the pit of about 75 cm diameter and 3 meters deep, lined by damboo matting if it is loose soil to prevent caving in of the pit. When the pit is filled up, a second pit is dug nearby and the direction of the connecting pipe is changed **(Fig. 12.4)** to the second pit. When the second pit is filled up, the first one is emptied and used.
- *Superstructure:* Since it is a permanent one and it provides privacy and shelter, it is constructed with good quality materials and maintained well for cleanliness and dryness.

Health education: It is given to the people to keep the latrine clean and dry. They should use sufficient water to flush the pan after use.

VIP latrine: These are the ventilated improved pit latrines designed to overcome the disadvantages of the traditional pit latrines such as foul smell and breeding of flies. It differs from the traditional ones in that has a tall vertical vent pipe fitted with a fly screen at the top, which performs three functions **(Fig. 12.6)**.

- *It eliminates odor:* In the traditional pit latrine, foul air enter the super structure from the pit. In VIP type, the odor escape via the vent pipe.
- *It prevents fly entry:* Often the pit latrines become a breeding place for the house flies, which are attracted by the foul smell. Since the foul air is absent in the superstructure of VIP latrine, it prevents entry of flies.
- *It prevents fly escape:* Even if some flies manage to enter the pit and breed there, they cannot escape because the vent pipe is fitted with a screen. Thus, the vent pipe controls flies.

PRAI type latrine: It is modified type of traditional pit latrines developed by Planning Research and Action Institute, Lucknow, wherein the trap below the pan is turned in and opens directly into the pit. There is no lead off pipe (or connecting pipe) because the pit is directly under the squatting plate and not away from it. Thus, it is cheaper than RCA type of latrine **(Fig. 12.7)**. It is a direct type.

It is simple, cheap, sanitary, hand-flush (or Pour flush) waterseal latrine, needs about 1 to 2 liters of water per user to flush out the excreta.

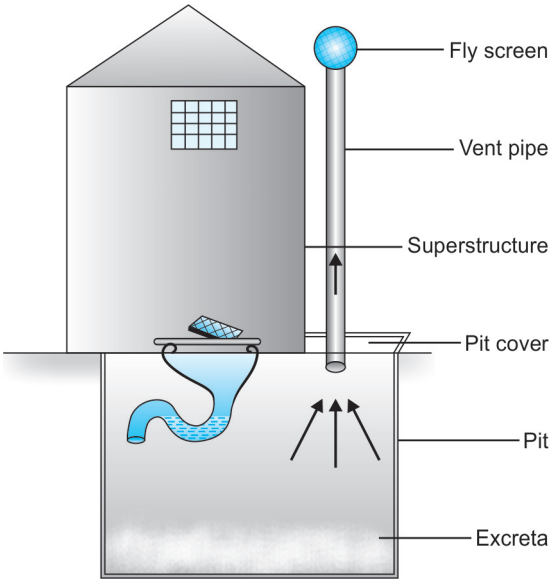


Fig. 12.6 Ventilated improved pit (VIP) latrine

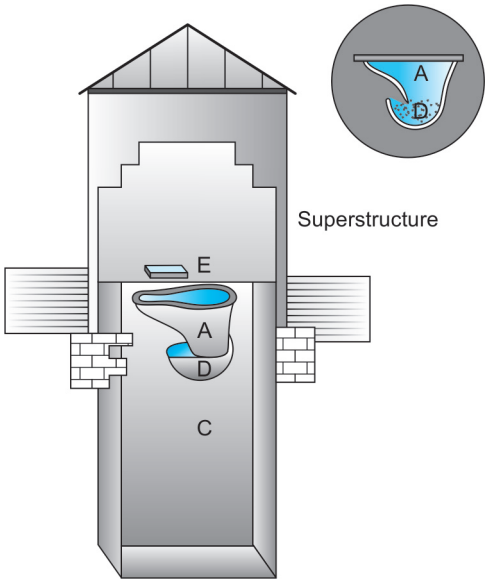


Fig. 12.7 Handflush waterseal latrine—PRAI type

Source: Gupta MC, Mahajan BK. Textbook of Preventive and Social Medicine. Jaypee Brothers Medical Publishers, 3rd edn, 2003.

The disadvantage is that it is difficult to empty or clean the pit unless the superstructure is temporary and moveable.

Sulabh Shauchalaya: It is a low cost, pour-flush, water-seal type of community latrines installed in public places. It is an improved version of RCA type of latrines, consisting of especially designed pan and a water-seal trap, connected to a pit of 1 meter square and 1 meter deep. It is well lighted and ventilated, maintaining the privacy and cleanliness.

Such latrines are maintained through the nominal fee collected from the users.

'Sulabh International' are the investors of such community latrines. They construct adjoining bathrooms also and charge nominally.

These latrines are eco-friendly. These are now being used in all parts of our country. It was first invented by Patna based firm.

Septic Tank Latrine

It is an ideal sanitary waterseal latrine which can meet the requirements of families in towns and cities having piped water supply but no sewerage system.

The tank is an underground, rectangular, cement concrete tank, having an inlet, outlet, cover and a vent pipe, into which the household sewage, which is a mixture of night soil, urine and wash water, is drained.

The tank should have a capacity of about 2000 liters for a family of about 5 to 6 members (Septic tank is not recommended for large communities). It should be about 3 to 4 times as long as it is broad. Depth should be about 2 meters, out of which about 1.2 meters should be liquid depth. It is the deepest at its inlet end sloping up evenly towards outlet end. The air space, above the waterline should be about 30 cm **(Fig. 12.8)**.

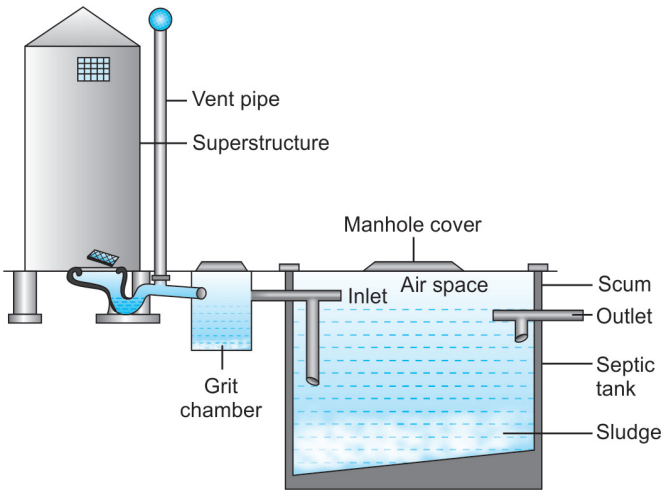


Fig. 12.8 Septic tank latrine

The inlet and outlet pipes should have standard T fittings, with the lower limbs immersed in the sewage. The septic tank is covered by a concrete slab and provided with a manhole for cleaning purpose. The vent pipe should have a screen to control flies and mosquitoes. It is better to have one or two baffle walls to prevent straight current of sewage from inlet to outlet. The chamber is so designed that the content is retained for about 24 hours for its anaerobic decomposition (digestion). Therefore, the chamber is also called 'Digestion chamber' of sewage. The ventilatory shaft projects upwards and establishes connection between the interior of the tank and the outside atmosphere.

As the sewage enters, the septic tank through the inlet pipe, the nonputrescible black semisolid particles settle down to the bottom of the tank to form 'sludge' and the grease, fat and light solid matter floats on the surface to form 'scum', which is an air-tight layer and cuts off air to the fecal matter. Under the scum the anaerobic bacteriae are actively at work breaking down the solid masses into simpler substances of fine suspension. The complex protein molecules are broken down into amines, amino acids, evoluting gasses like methane, carbon dioxide, carbon-monoxide, hydrogen sulphide, etc. The colloids in suspension become crystalloids in solution and are ready to take up oxygen. This is the first stage of purification.

In the next stage, the effluent (the liquid coming out of the outlet pipe periodically) which contains numerous bacteriae, ova, cysts and organic matter, is turbid but translucent with a sickly but otherwise offensive smell. Since the effluent still contains nitrogen as ammonia, should be oxidized by aerobic bacteriae present in the soil to nitrites and nitrates. Therefore, it is subjected to further purification by the action of aerobic bacteriae by subsoil irrigation into the surrounding earth through perforated pipes. This is the second stage of aerobic oxidation.

The sludge is much reduced in volume as a result of anaerobic digestion. It becomes stable and inoffensive. When the sludge grows to a certain height it interferes with the action of septic tank. It is time for removal. Meanwhile the scum is also removed. The sludge and the scum are disposed off by trench method. Cleaning is done through the manhole.

Since septic tank is recommended for individual families cleaning is required once in 5 years. However, in large installations, cleaning is done every alternate years.

The following are the requirements of a septic tank installation:

- There must be abundant supply of water, so as to flush out the excreta to the tank.
- No disinfectant or detergent to be used in the tank, because of the destruction of the putrefactive bacteriae.
- There must be sufficient space, between the fluid level and the cover to accommodate the 'Scum' and the gas.
- There should be a ventilator pipe to let off the foul gas.
- The sludge to be removed periodically (i.e. desludging)

Aqua Privy (Aqua-Water; Privy-Latrine)

This is also an another type of sanitary latrine, wherein the night soil or sewage (domestic) is disposed off in the anaerobic biological method.

The pan of the latrine seat is made into a shape of funnel and the tank part underneath is designed like a septic tank, filled with water and the drop pipe from the latrine pan dips into the water. A vent is provided for the escape of foul gasses into the air and an outlet pipe for the effluent.

The nightsoil undergoes purification by anaerobic digestion. The effluent is disposed underground in a trench or soakage pit. Foul gasses escape into the atmosphere. The digested sludge accumulates in the tank and removed periodically and disposed off by trench method.

A capacity of 1 cu. meter of aquaprivy is recommended for a family of 5 to 6 members for about 5 to 6 years.

The objectionable points are:

- The scum is disturbed and the gasses are released into the superstructure
- The scum is visible from the top
- The detention period is not sufficient
- The fecal matter may also escape in the effluent.

Chemical Closet

This consists of a metal tank containing a disinfectant, placed underneath the pan of the toilet **(Fig. 12.9)**. The disinfectant used is a solution of caustic soda and phenol and covered with a layer of crude oil. The excreta falls into this solution, where the alkali disintegrates and dissolves the excreta, phenol kills the bacteriae and the oil prevents odor. Nothing except toilet paper should be thrown into the chemical closet.

When the tank becomes full, the contents are discharged into a sump hole.

Such type of closet is suitable for isolated houses, boats, air crafts, motor caravans, etc.

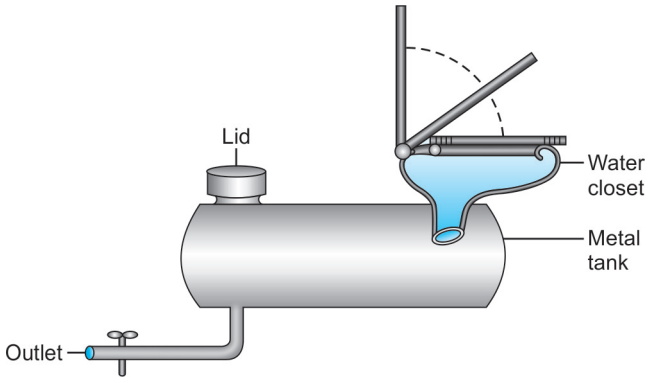


Fig. 12.9 Chemical closet

Sanitary Temporary Latrines for Fair, Mela, Camp, etc.

i. *Shallow trench latrine*: This is constructed by digging long trenches of 30 cm wide and about 1.5 meters (150 cm) deep, with a row of seats across it. About 3 meters length is required for about 100 people. Heaps of earth is provided on either side. The nightsoil, urine and ablution water fall directly into the trench. After using the latrine, the excreta should be covered with the excavated earth. The aerobic bacteriae which are enormous in the upper layers of the soil convert the organic matter into simple harmless substances, while the liquid leaches. When the trench is filled to 30 cm below the ground level, it must be covered with earth, heaped above the ground level and compacted. A new trench is constructed. Separate trenches should be provided for men and women.

   Such shallow latrines are satisfactory as temporary arrangements during fairs or camps for a short period of about 10 days.

ii. *Deep trench latrines:* These are recommended for army camps and semipermanent camps, lasting for longer duration. Here, the trench is made of 2.5 meters deep and 90 cm wide and length suitable for about 10 seats. A superstructure is built for privacy and protection.

   When the level of excreta comes to about 1 meter below the ground level, the trench is covered up with earth and discarded from use to allow for anaerobic digestion. After 5 to 6 months, the contents can be dug out and the trench is used again.

   Such latrines are used more or less continuously and semipermanent, lasting for few months.

Biogas Plant

These are also popularly known as gobar-gas plant. In this method, not only the human night soil is disposed off but also animal dung and left over animal feeds are also disposed.

A suitable place in the courtyard near the cattle-shed is selected. A well of about 3 meters is dug with variable diameter depending upon the size of the live-stock. A small chamber called 'mixing chamber' is constructed at one end of the cattle-shed near the well, where animal dung after collection from the shed is mixed with water. Urine of the cattle is also allowed in this chamber. The human night soil, urine and wash-water of the sanitary latrine is also drained into the same digester. An inverted dome shaped metallic gas holder is put in the well, which holds gasses produced in the digester, chiefly the methane. As the gas collects, dome rises. The gas is utilized for lighting and cooking purposes **(Fig. 12.10)**.

The scum and sludge are periodically removed and disposed in trenches, which later becomes an excellent organic manure.

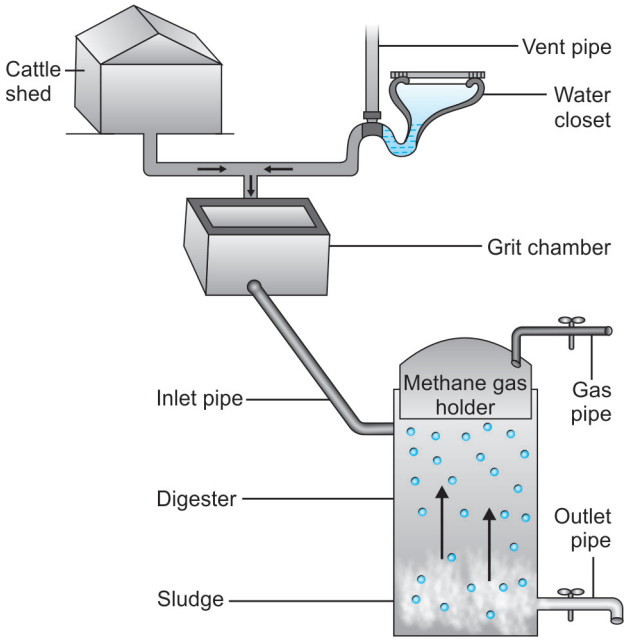


Fig. 12.10 Biogas plant

Merits of biogas plant

- Human and animal excreta can be disposed simultaneously.
- It is an excellent source of energy at a low cost.
- Refuse can also be disposed.
- Provides an organic manure of high biological value.
- It is eco friendly.
- It involves active community participation.
- It can be installed at the individual family level or community level.

Composting

Already explained.

WATER CARRIAGE SYSTEM (SEWERAGE SYSTEM)

This system is adopted to transport the human night soil and other liquid waste of the community. The term 'sewage' means liquid waste of the community containing human night soil, street washing and industrial liquid waste. The term 'Sullage' is the waste water of the houses, excluding human excreta, i.e. waste water coming from kitchens and bathrooms. In this system, the liquid waste is carried away through a system of drains and underground pipes (sewers) from the houses, industries and commercial areas, through the agency of water to the place of ultimate disposal. Therefore it requires an abundant water supply. Eventhough the initial investment is heavy, it is cheaper in the long run and is the cleanest, quickest and most sanitary method of removing night soil. For successful operations, the following conditions are essential:

- An abundant supply of water.
- Good drains and sewers with proper ventilation.
- Sufficient slope to give the required velocity, to the sewage.
- Proper means for disposal and utilization of the sewage.

Because of these reasons, it is recommended for towns and cities and not rural areas.

There are two types of water carriage system—the combined and separate sewer system. In the combined system, the sewers carry both the sewage and the surface water. In the separate system, the surface water is not admitted into sewers. The separate system is the system of choice.

The water carriage system consists of the following elements:

a. House drainage
b. Public sewer
c. Sewer appurtenances.

House Drainage

This system consists of the following structures:

i. Water closet
ii. Soil pipes
iii. House drain.

Water Closet

A water closet is a sanitary installation for the reception of human excreta and having connection with the sewer through soil pipe and house drain, removes the excreta through the agency of water immediately, thus preventing the nuisance by sight, smell and flies.

A water closet consists of two parts—closet proper and the flushing apparatus.

- *Closet proper:* This is of two types—Indian and Western types.

The Indian type consists of a squatting plate below which is a pan (or basin) with a trap, opening into the connecting pipe. The squatting plate has got foot-rest on either side of the pan proper. All these apparatus are placed flush with the floor of the closet apartment.

The Western type consists of a bowl with a flushing rim near the surface and a trap below. It is called commode **(Fig. 12.11)**.

- *Flushing apparatus:* This consists of a small cistern or tank, placed about 1 meter above the basin, holding about 15 liters of water and works by siphonic action either by pulling a chain or pedal action or a hand button and delivers the water by pipe to flush out the excreta into the connecting pipe, keeping the closet or pan clean **(Fig. 12.12)**.

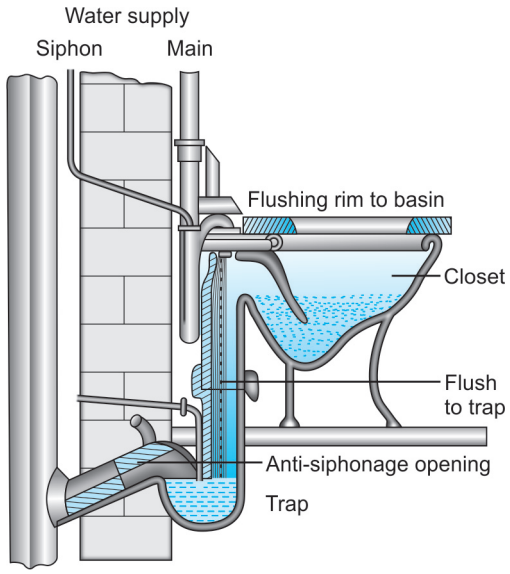


Fig. 12.11 Siphonic closet
Source: Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co Kolkata 15th edn, 1969.

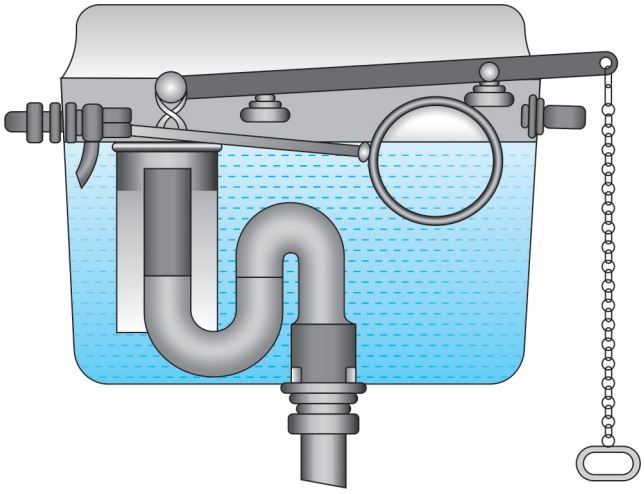


Fig. 12.12 Siphon flushing cistern
Source: Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co Kolkata 15th edn, 1969.

Soil Pipes

These are the pipes laid vertically outside the wall, meant to carry the excreta from the closet to the house drain on one side and for the escape of foul gas on the otherside **(Fig. 12.13)** covered with wire-gauze dome.

When several closets on different floors discharge into a common soil pipe, the transmission of excreta from the upper closets down the soil pipe may cause unsealing of the traps of the lower closets by siphon action. To prevent this, anti siphonic action is ensured by means of an another pipe, fixed on the crown of the trap and carried through the walls and laid on the side of the soil pipe.

The soil pipes open directly into the house drain without any intervention of a trap.

House Drain

This is an underground pipe for draining the discharges from the soil pipe and also the waste water from the house or compound to the sewer. It is laid on a bed of concrete with a sufficient gradient towards the sewer to facilitate easy transit.

If a bend is necessary, special curved pipes are used and fixed at an acute angle and at such a place it is desirable to have an inspection chamber. Smaller the drain, better is the flushing.

Requirements of a house drain:

- Sufficient inclination for good velocity to the flow
- Pipes should be both air and water tight
- Flushing arrangements should be proper
- All branches from the main drain should have Y-joints to obtain an acute angle
- It should be laid on a bed of concrete.

Gully trap: This trap is placed in courtyards, especially where rain water and waste water pipes open. It is placed about 30 cms away from the wall and the surface opening is protected by a grating. Since there is a possibility of sweeping of the mud, debris and other particles into the gully, a provision is made for such particles to settle at the bottom of the gully trap, which can be removed periodically **(Fig. 12.5)**.

Public Sewer

These are big underground pipes, laid in concrete bed, meant for draining the sewage (liquid waste) from several houses and also other liquid waste of the community. It should have sufficient gradient to ensure 'self-cleansing' velocity. It is carried to the ultimate place of disposal.

Sewer Appurtenances

These consist of inspection chambers and intercepting trap.

i. *Inspection chamber:* These are also called 'Manholes'. These are masonry underground chamber, lined with cement as to make water tight and covered with air tight iron lid **(Fig. 12.14)**. These are placed or constructed at the following sites:
   - Where the direction of the sewer is changed
   - Where two or more sewers meet
   - At distance of 100 meters in long straight runs.

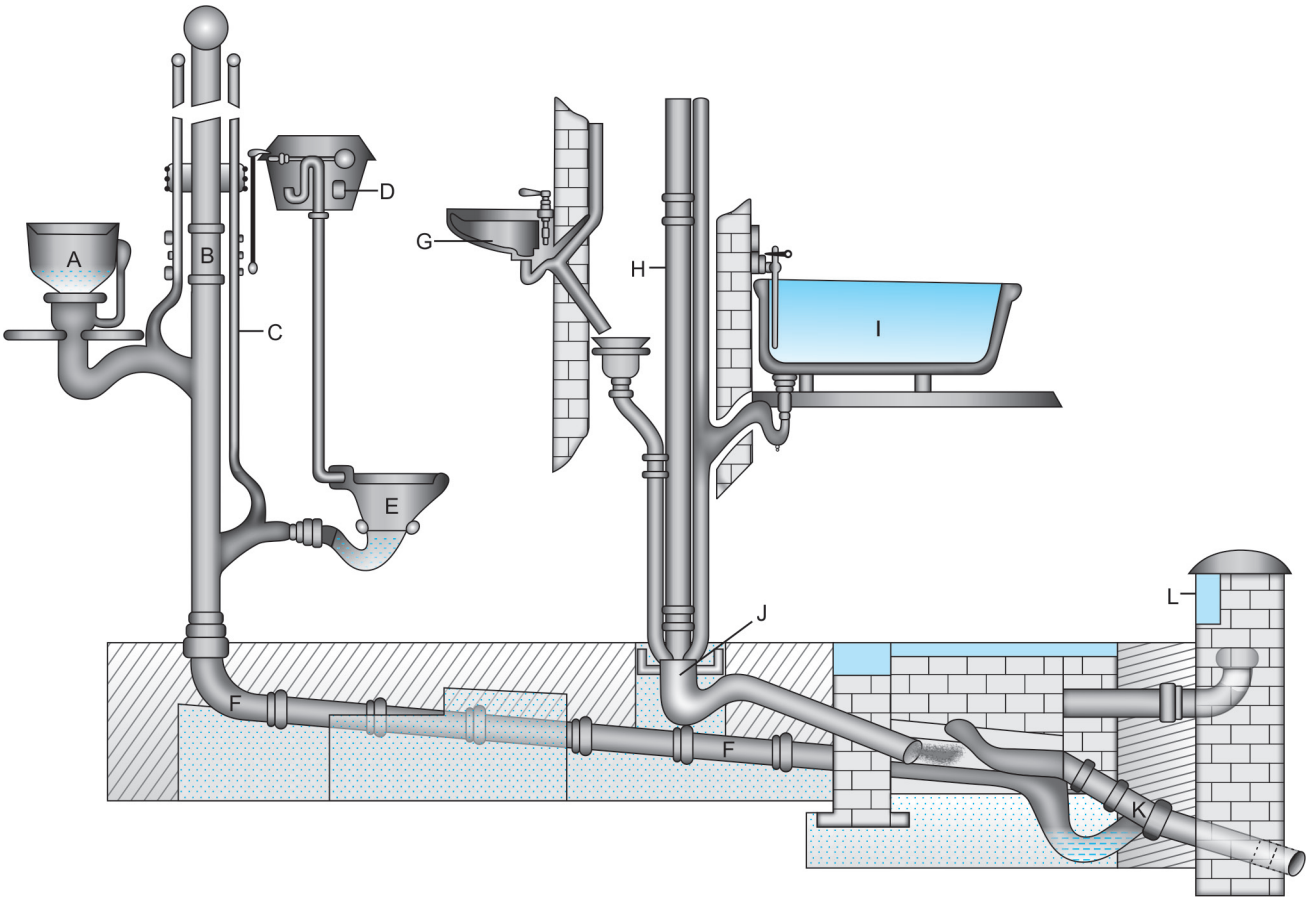


Fig. 12.13 A complete system of house drainage. A and E are two closets which open into the soil pipe; B; C, anti-siphonage pipe; D, flushing cistern opening into the closet; E; F, house drain laid on a bed of concrete; H, rain water pipe; G, wash basin; I, bath tub. These empty into the gully trap; J; K, intercepting trap placed in the manhole chamber intercepting the house drain from the sewer; L, inlet opening for ventilation. The soil pipe and the ventilating pipes are carried above the roof and are protected by wire gauze; they act as outlets
Source: Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co Kolkata 15th edn, 1969.

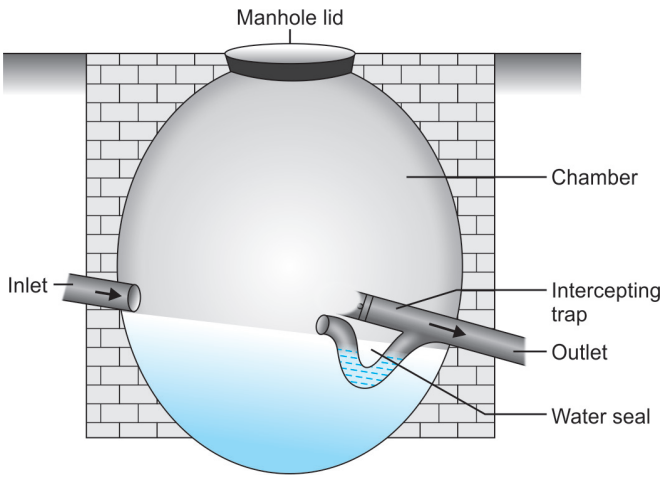


Fig. 12.14 Manhole chamber

The chamber permits a person to enter inside to carry out inspection, repairs and cleaning activities. Since they are at risk of gas poisoning and asphyxiation, due precautions are taken for their safety.

ii. *Intercepting trap:* This is interposed between the house drain and the sewer. It is also called 'Disconnecting trap' **(Fig. 12.5)**. These are designed to remove sand, grit and grease from sewage.

DISPOSAL OF SULLAGE

Sullage is the waste water coming from kitchen and bathroom. It is disposed by the following methods:

- Pervious pits such as soakage pit
- Impervious pits or nonsoakage pits such as septic tank

- Surface irrigation such as kitchen garden
- Underground drainage or sewerage system.

Soakage Pit

It is also called soak pit or seepage pit. It is the simplest and cheapest method of disposal of sullage water in villages, on a small scale.

For individual houses a pit of about 1½ cubic meter of rectangular shape is dugged, filled from bottom to top with large stones, brick bats and gravel, lined with bricks, keeping open the joints for absorption. The topmost layer is of gravel or sand. It is covered with a gunny cloth, tarred on both sides to prevent the loose soil slipping into the trench and block it **(Fig. 12.15)**. Bottom of the pit should be sloping away from the house. The pit is dug at a strategic point in courtyard of the house where in sullage can be admitted.

Since the sullage contains grease, oil, detergents and solid waste, these are removed by allowing the sullage to pass through an earthen pot (or matka or kerosin tin) with perforated bottom, filled with straw and grass. If not removed these will interfere with proper functioning of soakage pit. The perforated pot with grass is also therefore known as 'grease trap'. Grass has to be changed periodically, once in 10 to 15 days, depending upon the waste water. Use of grease trap is not essential in hot climates because fats do not solidify. It would be still better if a small grit chamber is constructed between the outlet of the house and the soakage pit. This small chamber functions like that of gully trap to remove solid waste from the sullage. T-shaped pipe connection is made between the outlet of the house and the matka.

The sullage from the house is drained to the grease trap and then to the soakage pit through submerged pipes.

As the sullage passes through the grease trap, the grease, oil, garbage, food waste, grit or dust, etc. are all mechanically trapped. The sullage passes through the bottom of the trap into the soakage pit, where it gets large area for biological degradation by the aerobic bacteriae in the pit, ultimately converting it into harmless inorganic substance. The water percolates into the ground.

After sometime, the pit become sullage sick, because pores become clogged. So, another pit must be constructed by the side and two pits are made to work alternatively. When one becomes sullage sick, it is dugged up and exposed to air and sun and filled again with fresh stones and gravel.

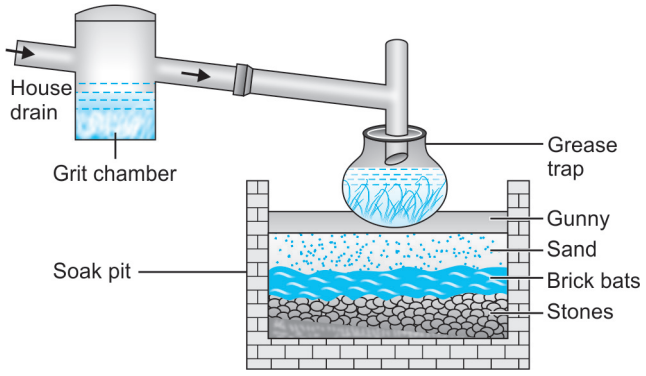


Fig. 12.15 Soakage pit

DISPOSAL OF SEWAGE (SEWAGE TREATMENT)

Sewage is a mixture of human excreta, urine, wash water, liquid waste coming from bathrooms and kitchen, surface water and industrial liquid waste. It is a dirty water with unpleasant sight and smell, which if not drained and disposed off, can contaminate sources of water and also food and vegetables resulting in diseases and deaths.

Objectives of Sewage Treatment

- Protection of water sources from contamination
- Protection of soil against pollution
- Protection of fish and acquatic lives
- Protection of human food, which are eaten raw
- Prevention of hazards to live-stocks
- Prevention of nuisance by sight and smell.

Therefore, from hygienic and aesthetic considerations, sewage treatment is essential. The economic aspect of sewage treatment is also far and wide. Valuable recoveries are possible from a completely treated sewage such as nitrates, phosphates, vitamin B_{12}, methane gas for lighting and cooking purposes, grease, etc.

The aim of the sewage treatment is to stabilize the organic matter by bacterial action, to utilize the innocuous products without risk to human health and to produce an effluent which can be disposed off into land, river or sea without causing danger. Stabilization means breaking the organic matter into simpler substances, which cannot be decomposed further.

The quality or strength of the sewage is expressed in terms of biochemical oxygen demand, Chemical oxygen demand and suspended solids. These indicators are required to know the amount of water needed to dilute the sewage during its final disposal.

Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen required by the living organisms in the sewage, during 5 days incubation at 20°C for aerobic oxidation of the organic matter. It is expressed as mgms per liter of sewage (i.e. ppm). If BOD is 100 ppm the sewage is said to be 'Weak' and if it

is 300 ppm, the sewage is said to be 'Strong'. After complete treatment of sewage, the BOD is reduced to nearly 90 percent.

Chemical Oxygen Demand

Chemical oxygen demand (COD) is the amount of organic matter in the sewage that is susceptible to oxidation by a strong chemical oxidizer.

Suspended Solids

If the amount of suspended solids is 100 ppm, the sewage is said to be 'weak' and if more than 500 ppm, the sewage is said to be 'strong'.

After treatment of the sewage, it should become weak with reference of BOD and suspended solids.

TREATMENT OF SEWAGE

This is done in two stages—namely primary and secondary treatment **(Fig. 12.16)**.

Primary Treatment

In this stage (Preliminary treatment), the suspended matters like the floating objects, settleable organic matter and inorganic particles are all removed by employing simple physical methods—such as screening, grit chamber and primary sedimentation (i.e. anaerobic digestion).

a. *Screening:* The sewage is allowed to pass through metal screens to hold back the floating objects. Screens may be coarse or fine. Coarse screens consist of metallic bars placed vertically or inclined, set 5 cm apart. The fine screens have meshes. Screening removes leaves, pieces of wood, rags, vegetable garbage, waste paper, polythene bags, dead animals and various other floating objects. The screenings are removed periodically and disposed off by burning or by burial. If not removed, they clog the treatment plant.

b. *Grit removal:* Grit consists sand, gravel, ash, clay etc. These are removed by allowing the sewage to pass through a 15 to 20 m long, narrow chamber, called Grit chamber or Detritus chamber (after passing through the screens) where the sewage passes at a velocity of 0.3 m per second, which is just sufficient to permit the grit to settle down and the organic matter to pass over. The grit is removed periodically and disposed off by dumping or trenching.

c. *Primary sedimentation:* After clearing the sewage from the floating objects and gritty matter, it is subjected to sedimentation in a tank for the removal of settleable suspended matter. The rectangular sedimentation tanks provide horizontal flow and circular tanks radial flow, where the sewage is detained for about 6 hours. All the suspended organic matter settle as sludge. The sludge of the primary sedimentation tank is highly organic and offensive. It is removed periodically to control nuisance and to prevent interference in the sedimentation process (i.e. desludging). Such a sludge should not be disposed off directly but transferred to sludge digestion tank for appropriate treatment.

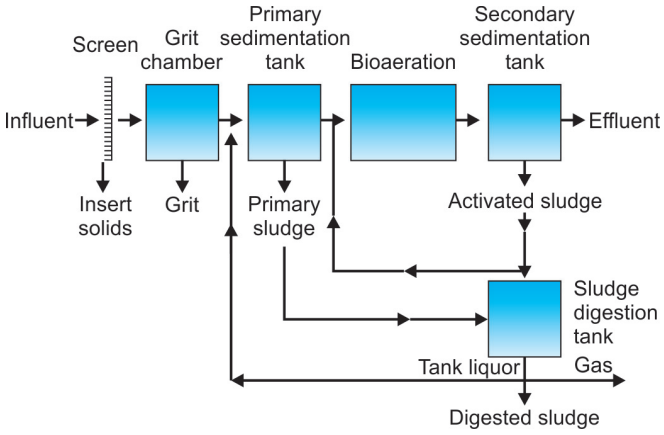


Fig. 12.16 Flow diagram of modern sewage treatment

Secondary Treatment

In this stage, the effluent is subjected to bacterial action for stabilization (i.e. aerobic oxidation).

The sewage after primary treatment is subjected for the complete or final treatment by biological action/treatment followed by secondary sedimentation and sludge digestion.

The biological treatment is of two types—biofiltration and bioaeration. Biological action (aerobic oxidation) is necessary for stabilization of unsettleable organic matter.

Biofiltration

In biofiltration, the sewage, (after primary treatment) or the effluent from the septic tank is allowed to 'filter' through a medium supporting the aerobic bacteriae that carry out the biological treatment. Biofiltration can be done by either of the three methods. Trickling filters, Intermittent contact beds and intermittent sand filters.

i. *Trickling filters:* These are also called 'Percolating filters' or 'Sprinkling filters' or 'Streaming filters.' The filter consists of water-tight, concrete, enclosure tank, circular in shape, of about 25 meters diameter and 2.5 meters depth, filled with a filter medium consisting of pieces of 2 to 10 cm of coarse materials like stones, coke, clinker (hard brick) or cinder (burned coal) etc. arranged loosely to provide oxygen to the aerobic bacteriae resting on them. Such a tank is provided with

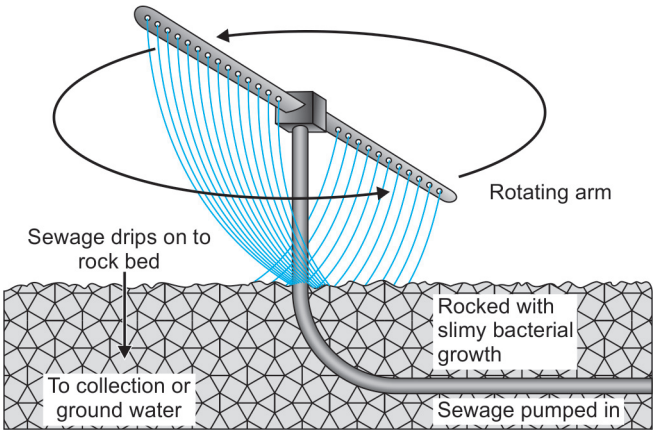


Fig. 12.17 Trickling filter

a sewage sprinkling system, which consists of a pipe carried above the tank and fitted with rotatory arms, usually four in number, each arm having a series of spray nozzles, wherefrom the sewage trickles down on the filter medium **(Fig. 12.17)**. This ensures uniform distribution with alternate dosing and resting periods. The sprinkling system is operated by a motor.

As the sewage/effluent passes through the filter, a sling Jelly like film called 'zoogleal layer' is formed over the filtering medium, which will absorb the organic matter and oxidize it with the help of aerobic bacteriae. This jelly like layer consists of living flora including algae, fungi, protozoa, planktons, diatoms, aerobic bacteriae etc. As the organic matters are oxidized, nitrification takes place. The intermittent application of sewage permits good circulation of air through the bed during the rest period, thus encouraging the growth of aerobic organisms. The oxidized sewage which leaves the trickling filter is passed on to secondary sedimentation tank for further treatment.

These filters practically require no attention. It is cheaper, more efficient and requires less space and attention than a contact bed.

ii. *Intermittent contact beds:* These are also watertight, rectangular shaped, masonry tanks, filled with granular materials like gravel, crushed stones, bricks, etc upto a depth of about 2 meters. Drainage pipe is placed at the bottom of the bed, drains the effluent. The sewage after preliminary treatment or effluent from the septic tank is distributed over the bed and allowed to remain for a fixed period of about 6 hours. During this time the aerobic bacteriae convert the nitrogenous matter into nitrates. A working period of 6 hours is interrupted by a rest period of another 6 hours. Thus, the filter bed is loaded twice daily with sewage. During the rest period, the bed is emptied, air comes in and the bed is reaerated. This should be done within half an hour.

A series of contact beds is needed to allow intermittent use of beds without causing interruption in the process of sewage treatment. The effluent from these beds is not as good as that from the trickling filters because it contains considerable suspended solids. Another disadvantage of contact bed is that it needs the services of an operator and needs number of such persons. Such contact beds are used nowadays.

iii. *Intermittent sand filter:* A bed of sand, supported by earth embankments and an under drainage system is also used for the purpose. The sewage is intermittently spread on the surface of the sandbed by distribution pipes lying inside the earth embankment. Two loadings of sewage, of about 10 cm thickness, are permitted in a 24 hour cycle with intervening rest period, during which the sewage is fed to other beds. As it passes through the sand-bed, there will be nitrification of the sewage by the aerobic bacteriae. The effluent is reasonably fit to be discharged into a natural water course. The beds become clogged after several months of use. It is the time to scrape off the accumulated deposit over the sand bed and the sand is loosened by racking. The beds become fit for use again.

Bioaeration

This is also called 'Activated sludge process'. This is the most modern method and satisfactory method of purifying the sewage, better than trickling filter method.

The bioaeration plant consists of two chambers, a mixing chamber, in which the sewage coming after preliminary treatment is mixed with 'activated sludge' (or return sludge) obtained from the secondary sedimentation, tank, in the ratio of 70:30 (%) and then let into the next chamber, i.e. aeration chamber, where it is subjected to compressed air aeration for a period of about 6 hours, from the bottom of the tank. Aeration is continued till all the ammonia of the sewage is oxidized into nitrates. Aeration is then stopped and allowed to settle. The settled sludge is called 'Activated sludge' or 'Aerated sludge'. It differs from the sludge of primary sedimentation tank in that it is inoffensive and is an aerobic 'bacterial culture', which is not only employed in activated sludge process but also has a high manurial value.

The purification of sewage occurs in two stages. During the first stage, organic matters are broken down and carbon is converted into CO_2. The liquid becomes more or less stable. During the second stage, nitrates are formed.

Advantages of activated sludge process

- The effluent is fully oxidized; it is clear and free from colloids.
- Purification is rapid and perfect.
- The system is free from smell and flies.
- The sludge is inoffensive and has high manurial value.
- Only a small area of land and a skilled attendant is enough to manage the work.

Secondary Sedimentation

The effluent coming from the trickling filter or aeration chamber is directed to secondary sedimentation tank, where it is detained for about three hours. The sludge that collects at the bottom of the secondary sedimentation tank is fully aerated and practically inoffensive, rich in bacteriae, nitrogen and phosphates, thus differing from the sludge of primary sedimentation tank which is highly organic and offensive.

Desludging of the tank is done periodically to avoid interference in the process of sedimentation. The sludge of the secondary sedimentation tank if dehydrated, becomes manure. Part of it is pumped back into aeration tank for activated sludge process and the rest is pumped into sludge digestion tanks for further treatment and disposal (i.e. for anaerobic decomposition).

The effluent leaving the secondary sedimentation tank is inoffensive and fully stabilized. It is almost free from suspended impurities and does not show putrefactive changes even on long storage. Its BOD is reduced to minimum. But still it is better to chlorinate it and let into water course.

Since the river water is used for drinking purposes, the BOD of the effluent should be lesser than 30 ppm and 5 day BOD should be less than 20 ppm, according to Royal Commission of England.

Sludge Digestion

The sludge obtained from primary and secondary sedimentation tanks consists of 95 percent water. It is a thick, black mass with a revolting odor and is a potential source of nuisance. It is therefore further rendered innocuous by appropriate treatment with the help of anaerobic bacteriae.

The sludge digestion is carried out in a cylindrically shaped concrete tank with a hopper bottom and a leak-proof cover. The tank is provided with heating arrangement in the form of hot water circulating coils, a mixing arrangement in the form of propeller pump, a gas collecting arrangement in the form of floating cover with a central gas dome and a disposal arrangement in the form of liquor and sludge outlets.

In this tank, the sludge is incubated at favorable conditions of temperature and pH. The sludge undergoes anaerobic autodigestion (i.e. liquefaction) and water is removed. Solid, liquid and gaseous end products are formed.

The solid product is called digested sludge. It settles at the bottom. It is an innocuous granular mass, i.e. it is inoffensive, sticky, tarry mud which is removed and on drying becomes an excellent manure and is used as fertilizer.

The liquid product is called tank liquor, which is removed at various levels of the tank via liquor outlets. It is returned to the sludge treatment plant ahead of the primary sedimentation tank.

The gaseous product is composed of 65 percent methane, which is used for heating and lighting purposes, 30 percent CO_2 and other gasses constituting together another 5 percent.

If suitable land is available, the effluent can be used for irrigation purposes (e.g. Okhla Sewage Treatment Plant in Delhi).

Other Methods of Sewage Disposal

- Sewage dilution
- Sewage lagoon
- Sewage farming.

Sewage Dilution

This consists of discharging the sewage directly into a large body of water such as river (river outfall) or sea (sea outfall). This is an age old practice still prevalent in many cities which are located on the banks of rivers and on sea-shores. Natural purification takes place in the water to some extent.

River outfall is hygienically not safe. Especially discharging the industrial waste may even lead to dangerous consequences. However, discharging the sewage beyond the habitation area, in a downstream, will reduce the public health hazard.

Sea outfall is also good, because of large body of water available for dilution and solids get oxidized. But the drawback is that the offensive solid matter may be washed back to the shore and create nuisance. It may affect the acquatic life. So to overcome this, the sea outfall is designed to discharge the sewage into deep water at many points.

Sewage Lagoon

This is also called 'Oxidation pond'. It is so called because in this lagoon (pond) the sewage organic matters are oxidized into inorganic substances including CO_2, Ammonia and water and thus the sewage is purified.

The oxidation pond is a shallow pool of about 20 acres area, constructed in open areas, about 1.5 meter deep, having an inlet in the middle of the pond to allow the wind and wave action for the uniform mixing and distribution of the sewage and an outlet for the effluent. Better if the sewage is subjected for screening and grit removal and then let into the lagoon.

The sewage lagoons stabilize the sewage by a complex interdependent mechanism involving algae, aerobic bacteriae, oxygen and sunlight **(Fig. 12.18)**.

The aerobic bacteriae, which feed on decaying organic matter, oxidize the organic matter and convert it into CO_2, ammonia and water. Hence the name 'Oxidation pond'.

The algae, with the help of sunlight, carry out photosynthesis, by utilizing CO_2, water and inorganic materials and liberate oxygen. Thus, oxygen required by the aerobic bacteriae for oxidation, is obtained mainly from the algae and partly from the atmosphere.

Sunlight provides the necessary energy to algae to thrive by carrying out photosynthesis. Algae cannot thrive in the absence of sunlight. Consequently, sunlight is an important

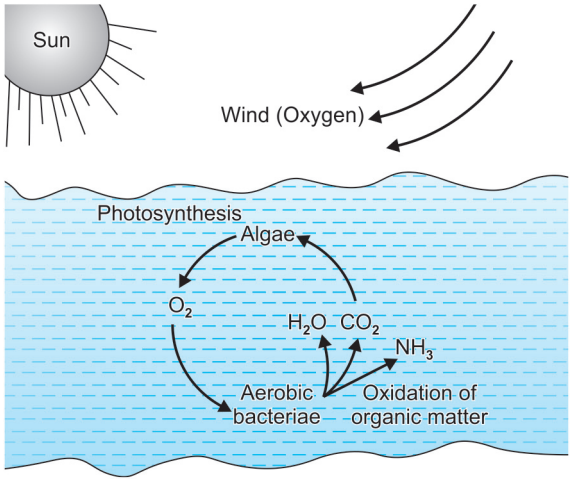


Fig. 12.18 Sewage lagoon (Oxidation pond)

factor for proper functioning of the oxidation pond. Cloudy weather definitely lowers the efficiency of the process.

The other synonyms are 'Waste stabilization pond', and 'Redox pond'.

The effluent may then be let into the land for irrigation purpose or into a water course after treatment.

The lagoons require periodic servicing for optimum functioning. The luxurious growth of marginal vegetation and other weeds over a period of time, should be eliminated periodically to discourage breeding of the mosquitoes.

Such ponds are the established method of disposal of sewage for small communities.

Sewage Farming

It is also called 'Broad irrigation'. It is also an age old method of sewage treatment. It suits in those areas where porous land is available in the vicinity of the habitation. An acre of land would be required to dispose the sewage of about 300 persons. Before admitting the sewage in the farm, it is subjected for screening and grit removal.

The land (farming area) is first laid in the form of ridges and furrows. Sewage is allowed in the furrows and crops are grown on the ridges. Only such crops are grown which do not come in the direct contact with sewage or not likely to be eaten raw. Fodder grass and potatoes seem to be the most paying crops. But tomato, cucumber, sugar cane, coriander and such others are not recommended to be grown.

Sewage farming can remove 90 percent of the suspended organic matter by the activity of the aerobic soil bacteriae. Continuous feeding of sewage farms without any interruption leads to stinking and soddenness of the soil, a condition called 'Sewage sickness', due to lack of sufficient aeration of the land. Such badly managed farms can be hazardous. Therefore, maintenance of sewage farms deserves special attention. However, during the rainy season, it may not be possible to operate the sewage farms. Alternate methods may have to be provided then.

BIBLIOGRAPHY

1. Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn, 2006.
2. Ghosh BN. A treatise on hygiene and public health. Scientific Publishing Co Kolkata 15th edn, 1969.
3. Gupta MC, Mahajan BK. Textbook of Preventive and Social Medicine. Jaypee Brothers Medical Publishers, 3rd edn, 2003.
4. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.

CHAPTER 13

Management of Hospital Waste

INTRODUCTION

Any waste generated out of hospitals can be said to be 'Hospital waste'. Any waste generated consequent to health care activity including those at home is 'Health care waste'. According to Biomedical Waste (Management and Handling) Rules 1998, of India, 'Biomedical Waste' (BMW) is defined as a waste generated during diagnosis, treatment, immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals. Thus Biomedical Waste encompasses a wider category of waste and includes waste from veterinary institutions and slaughter houses also. However, radioactive waste is not included under BMW.

Hospitals generate large volumes of wastes as a by-product of a variety of health services and procedures carried out such as surgery, dressing of the wounds, dialysis, deliveries, laboratory and dental procedures, postmortem procedures, etc. Such a waste may be infectious or non-infectious. If such a waste is not collected, transported and disposed off, it not only results in causation of 'Hospital Acquired Infections' (Nosocomial infections) but also poses a major public health hazard by causing pollution of air, water and soil. Persons who are constantly exposed to these wastes especially waste-sharps, are hospital workers (nurses), rag pickers, cleaners, laundry staff, etc. who are always at a risk of getting fatal diseases like Hepatitis B and C and HIV through injuries by contaminated needles and sharps as an occupational hazard. Indiscriminate dumping of the hospital wastes into the backyards or into open municipal pits, become breeding places for disease spreading mosquitoes, flies, rodents and microbes. Epidemics can result from the contamination of drinking water and food sources with these infectious wastes, which are washed by rains. Indiscriminate open burning of infectious waste, especially plastics will result in emission of noxious gasses, which may produce cancer. Further, there is scope for (improper) re-use of syringes, needles, polythene bags, catheters and other rubber tubes, bottles, etc.

Not all the waste from a health care setting is infectious or hazardous. There is a mixture of different types of waste. The twin problems of Health Care Waste are its characteristics and quantity.

CHARACTERISTICS OF HEALTH CARE WASTE

It is estimated that about 10 to 15 percent of health care waste is 'Infected Waste'. Noncontaminated or non-infectious waste becomes infected when it gets mixed with infected waste. Hence one should not allow mixing of infected waste with household (non-contaminated) waste. This is possible only if the waste is segregated or sorted into 'Infected' and 'Household' waste at the source or point of generation.

QUANTITY OF HEALTH CARE WASTE

This depends upon the type of health care setting and the services offered.

A survey of wastes generated in different health care settings (waste survey) is a basic pre-requisite for planning and implementing a waste management endeavor. This is known as 'Waste audit'.

With an estimated 0.5 to 1.0 kg of wastes per bed per day, state hospital like Community Health Centers, Taluka Hospitals and Sub-District Hospitals with bed strength of 30 to 100 can produce 15 to 50 kg of wastes per day, whereas District and Teaching Hospitals including private hospitals in urban cities may need to handle 200 to 1000 kg of hospital wastes daily. With improved services and more health seeking population in years to come, this load is likely to get doubled or even tripled. Extensive use of disposables has added another dimension to the problem. Health institutions are being shunned away not so much because of inadequate patient care or drugs but more because of the dirty wards, toilets and the labor rooms. Management of hospital waste has thus become a growing concern.

OBJECTIVES OF THE WASTE MANAGEMENT SYSTEM

- To reduce the infectious/hazardous nature of the waste
- To reduce the volume of the waste
- To prevent misuse or abuse of the waste
- To ensure occupational safety and health
- To consider esthetically
- To reuse the items that can be of repeat utility
- To recycle the waste so that it can serve as another utility item.

(Recycling is a process by which the waste materials are transformed into new products in such a manner that the original products loose their identity).

SAFE WASTE MANAGEMENT PRACTICES HELPS

- To maintain order and cleanliness in the hospital
- To maintain a healthy environment for patients, staff and public
- To prevent spread of infectious diseases
- To project good impression of the management
- To attract more clientele
- To generate revenue for the institution.

LEGISLATIVE FRAMEWORK

Government of India, passed the 'Biomedical Waste (Management and Handling) Rules' on 28th July 1998 and it was amended in 2000 and 2003. The rules define the Administrative Medical Officers of health care facilities as biomedical waste 'generators' and fix responsibility on them for developing an effective waste disposal mechanism for the waste their facilities generate. Standards for various treatment and disposal technologies that may be employed have been stipulated. The rules have also fixed time scale for implementing a treatment and disposal technology (incinerator technology) in hospitals of different bed strengths.

The rules are passed under section 6, 8 and 25 of Environment (Protection) Act, 1986.

Summary of biomedical waste rules:

1. The rules apply to all persons who generate, collect, receive, store, transport, treat, dispose and handle biomedical waste in any form.
2. Biomedical waste is defined as any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals including categories mentioned in Schedule 1 of Biomedical Waste (Handling or Management) Rules, 1998 **(Table 13.1)**.
3. Authorized person is an 'Occupier' or 'Operator' of any health care facility who has control over the facility and has been authorized by the prescribed authority to deal with all aspects of biomedical waste in accordance with rules.
4. Biomedical waste treatment facility is one where treatment and disposal of biomedical waste is carried out.
5. Every 'Generator' or 'Occupier' of a health care facility has the duty to take steps to ensure that waste generated is handled without any adverse effect on human health and environment.
6. Every occupier shall treat and dispose off biomedical waste in accordance with Schedule 1 and Schedule 5 of these rules and for this purpose set up requisite treatment and disposal facilities, like incinerator, autoclave, etc.
7. Biomedical wastes shall not be mixed with other waste. It must be segregated from other wastes at the source, collected in color coded containers in accordance with Schedule 2 and transported for treatment and disposal within 48 hours of its generation. The containers shall be labeled as per Schedule 3.
8. Transportation of biomedical wastes outside the occupier's premises shall follow labeling procedures as per Schedule 4.
9. The Government of every State and Union Territory shall establish a prescribed authority who will authorize and implement these rules.
10. Every occupier of an institution generating and handling biomedical waste in any manner shall apply in form 1 to the prescribed authority for authorization along with the prescribed fee.
11. The prescribed authority shall on receipt of Form 1 from an applicant (occupier) with grant or renew authorization for a period of 3 years if satisfied about the occupier's capacity to handle biomedical waste.

12. Every occupier shall submit a report in Form 2 by 31st January of every year. All records related to handling of biomedical waste in the facility shall be maintained for verification.
13. The authorized person of a health care facility shall inform on Form 3 to the prescribed authority, any accident occurring during handling of biomedical waste.

Thus, an effective waste management strategy in a hospital is an important step towards enhancement in quality of care.

Categories of Waste

As per these rules, there are 10 categories of biomedical waste as shown in **Table 13.1**.

Table 13.1 Schedule I: Categories of biomedical waste

Option	Waste category
Category 1	Human anatomical waste (Human tissues, organs, body parts, placenta, aborted fetus, amputated parts, tumors, etc.)
Category 2	Animal waste (Animal tissues, organs, body parts, carcasses, waste generated in veterinary hospitals, colleges, discharge from animal house)
Category 3	Microbiology and biotechnology waste (Laboratory cultures, specimens, vaccines, human and animal cell culture, toxins, etc.)
Category 4	Waste sharps (both used and unused) (needles, syringes, scalpels, blades, glass)
Category 5	Discarded medicines and cytotoxic drugs
Category 6	Soiled waste (Waste contaminated with blood and body fluids such as cotton swabs, bedding, dressings, plaster casts, linen, etc.)
Category 7	Solid waste (Catheters, IV sets, tubings, blood bags, etc.)
Category 8	Liquid waste (Waste generated from laboratories and washing, cleaning, housekeeping)
Category 9	Incineration ash (Ash generated from incineration of biomedical waste)
Category 10	Chemical waste (Wastes of disinfectants, insecticides, etc.)

Segregation of hospital wastes: For the purposes of easy transportation and disposal, the hospital wastes are segregated in different color coded containers **(Tables 13.2A to C)**. The multiple treatment options are shown in **Table 13.3**.

STRATEGIES ADOPTED FOR HOSPITAL WASTE MANAGEMENT

1. Waste reduction strategy
2. Waste assessment strategy
3. Waste recycling strategy
4. Hospital waste disposal

Table 13.2A Color coding for waste containers

Type of waste	Contents	Color code of container	Remarks
1. General waste	**All domestic type:** Non-infectious non-hazardous, e.g. (a) recyclable: all kinds of papers, cardboard packing materials, metal or aluminum tins, magazines, newspapers, ledgers. (b) non-recyclable: Kitchen waste.	**WHITE** Container with black label "for general wastes only".	May be periodically sold at prevailing rates
2. Infectious waste:			Segregate carefully into correct type of bag
(a) Category No. 1	**Human anatomical waste:** Human tissue, organs and body parts.	**Yellow** With biohazard sign 	
(b) Category No. 3	**Waste from laboratory**		
(c) Category No. 6	**Soiled waste:** Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood.	**Red** International infectious substance symbol	
(d) Category No. 4	**Waste sharps:** Needles, syringes, scalpels, blade, glass, etc.		
(e) Category No. 7	**Solid waste:** Wastes generated from disposable items IV tubes, catheters, IV and blood bags, etc.	**Blue**	After treatment and multilation these wastes are recyclable
(f) Category No. 5	Discarded and outdated medicines	**Black**	May be infectious

Table 13.2B Categorization of wastes
(For color version see Plate 1)

Category	Waste types	Segregation	Disposal
Cat No. 1	Human anatomical wastes		Incineration/ deep burial
Cat No. 2	Animal wastes		-Do-
Cat No. 3	Microbiology and bio-technology wastes		Do/ Autoclave
Cat No. 4	Sharps		Autoclave/ destruction/shred
Cat No. 5	Discarded medicine and cytotoxic drugs		Secured landfill
Cat No. 6	Soiled wastes		Incineration/auto-clave
Cat No. 7	Solid wastes		Autoclave/ destruction/shred
Cat No. 8	Liquid wastes		Effluent treatment
Cat No. 9	Incineration ash		Secured landfill
Cat No. 10	Chemical wastes		-Do-

Source: CME on awareness of biomedical waste disposal, 2006.

Table 13.2C Norms of the color coding containers

Color coding and waste segregation		Waste disposal
Black	General waste: Office waste, dry non-infectious waste	• Dispose with regular garbage in a secure sanitary landfill or have incinerated.
Red	Infectious plastic: Syringe, cannula, catheter	• Should be shredded, cut or mutilated. This ensures that they are not recycled/reused. • Should be placed in a sturdy impervious (plastic) bag, tied securely with a twist tie and the contents identified with a label or tag. • Dispose with regular garbage in a secure sanitary landfill or have incinerated.
Yellow	Infectious waste: Pathological specimens anatomical waste	• Should be place in leak proof container and the contents identified with a label or tag. • Should either be incinerated or autoclaved before disposal in a secure sanitary landfill.
Blue/ White	Glass waste: Whole and broken glass	• Should be placed in disposable, puncture resistant containers. Bottles with a narrow neck are well suited for the purpose. • Disinfected with chemicals or autoclave or incinerated before disposal.
Gray	Sharps: Needles, blades, scalpels	

Waste Reduction and Management Strategy

The objectives of this strategy are:

- Reducing the waste quantity by a significant percentage.
- Decreasing waste disposal efforts and expenses (e.g. construction of landfills, operational cost of equipment like incinerators, etc.)
- Recycling all paper and cardboard waste.
- Increasing use of recycled products.
- Enhancing the hospital's reputation in the community.

Waste Assessment Strategy

A waste assessment indicates the type and the amount of waste generated in the hospital. A walk through the hospital, interviewing the workers and examining the records will provide information about the type and the quantity of waste generated at different parts of the hospital, collection and handling practices, etc. thereby the disposal strategy can be planned.

Waste Recycling Strategy

This is to prolong the life of the material. It helps cost saving and waste volume reduction. Examples are gowns, gloves, masks, syringes, needles, catheters, etc. However, it is important to note that these reusables are properly sterilized before they are reused in order to prevent the risk of fatal infections. Other examples for recyclable materials are different kinds of paper, steel and aluminum cans, plastics, ledgers, newspapers, magazines, plastic utensils, computer papers, corrugated cardboard, glass wares, batteries, journals, X-ray film boxes so on.

Hospital Waste Disposal

This forms the critical part of the total hospital waste management, because any failure in this aspect will have hazardous consequences. The basic principle is that the wastes are disposed in most hygienic and cost-effective manner, by methods which at all stages, minimize risk to healthy environment. Government of India has prescribed certain procedures and guidelines as follows.

- Collection of wastes
- Source segregation
- Transportation
- Storage
- Treatment.

Table 13.3 Biomedical waste (Handling and management) Rules, 1998, Ministry of Environment and Forests, Government of India Schedule I and II (Under rule 5 and 6)

Waste category	Contents	Treatment and disposal options	Color code	Type of container
1. Human anatomical waste	Human tissues, organs, body parts	Incineration[1]/Deep burial[2]	Yellow	Plastic bag
2. Animal waste	Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research, Waste generated by Veterinary hospitals college, discharge from hospitals, animals houses	Incineration/Deep burial[2]	Yellow	Plastic bag
3. Microbiology and biotechnology waste[6]	Laboratory cultures, stocks, specimens of microorganisms live or attenuated vaccines, human and animal cell culture used in research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures	Local autoclaving/micro-waving/incineration[1]	Yellow/red	Plastic bag/disinfected container
4. Waste sharps	Needles syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps	Disinfection/Chemical treatment[3]/autoclaving/ Micro-waving and mutilation and shredding[4]	Blue/White translucent	Plastic bag/Puncture proof container
5. Discarded medicines and cytotoxic drugs	Waste comprising of outdated, contaminated and discarded medicines	Incineration/destruction and disposal in secured landfills	Black	Plastic bag
6. Soiled waste	Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, linens, beddings, other material contaminated with blood	Incineration/autoclaving/ micro-waving	Yellow/Red	Disinfected container/ Plastic bag
7. Solid waste	Waste generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets, etc.	Disinfection by chemical treatment[3] autoclaving/ micro-waving and mutilation/shredding[4]	Red/Blue/White	Disinfected container/ Plastic bag
8. Liquid waste	Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities	Disinfection by chemical treatment[3] and discharge into drains.	NA[5]	Not applicable[5]
9. Incineration ash	Ash from incineration of any biomedical waste	Disposal in municipal landfill	Black	Plastic bag
10. Chemical waste[5]	Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.	Chemical treatment[3] and discharge into drains for liquids and secured landfill for solids	Black	Plastic bag

1 = There will be no chemical pre-treatment before incineration. Chlorinated plastics shall not be incinerated. 2 = Deep burial shall be an option available only in towns with population less than 5 lakhs and in rural areas. 3 = Using at-least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection. 4 = Must be such so as to prevent unauthorized reuse 5 = Liquid waste do not require containers/bags. 6 = If disinfected locally need not be put in containers/bags

Note: Color coding of waste categories with multiple treatment options to depend on treatment options chosen.

Thus, waste management is a comprehensive term, encompassing collection, segregation, transportation, storage, treatment and ultimate safe disposal of waste.

Collection of Wastes

The wastes should be collected and stored in a thick, non-corrosive, disposable plastic bags of adequate size, which may be kept in a hard plastic container of suitable size covered with a lid. A list of common wastes to be deposited in the container pasted on the container, will help correct segregation of the waste. The containers need to be cleaned with hot water frequently. The waste containers may be placed at strategic places in all the departments, corridors and public utilities of the hospital. Containers for recyclable wastes should be kept away from those for infectious wastes, to avoid mixing. Polythene bags and containers of specified coded colors that are labeled appropriately with non-washable material are used for specific type of hospital waste to enable proper treatment and disposal of these wastes.

Source Segregation

Segregation simply means separation of the wastes into different types of categories. The hospital wastes of different categories are best segregated at source by personnel who generate the waste and collected into appropriate plastic bags kept in color coded containers. For this, all hospital workers need training in understanding what waste belongs to which category or type. Mistakes done in segregation can result in serious health risks as some infectious wastes may be taken for recycling. Plastic bags should be collected preferably on a daily basis to reduce spread of infection by flies or spillage by dogs. They should be allowed to fill to a maximum of three quarters of their capacity to prevent the bag from tearing and also to facilitate the ease of transport by workers.

Transportation

Internal and external transportation is an integral part of the hospital waste management system. Within the hospital, the plastic bags containing the waste may be tied well and transported by handcart to a storage point. General non-infectious recyclable waste may be transported to suitable areas for temporary storage from where they can be sold periodically. Personnel transporting the waste should be thoroughly trained on all aspects of hygienic transport of waste. Organic waste in particular poses problem of odor and risk of spread of infection. Equipment used for transport should be frequently cleaned using disinfectants. Designated vehicles used for external transport of wastes should be road-worthy and should carry the wastes in covered containers.

Storage

Daily hospital waste from different sections of the hospital awaiting final disposal are stored in a storeroom meant for the purpose. The storeroom should be away from the service areas and should be dry and well secured to prevent rodent nuisance.

Treatment

Treatment modifies the wastes before final disposal. ***The objectives are:***

a. Decontamination of the waste to render it non-infectious by steam sterilization or autoclaving or chemical disinfection.
b. Reduction of bulk volume by incineration.
c. To give the waste an aesthetic look, e.g. for body parts, etc.
d. To destroy reusable infected materials like needles and blades.

A technique which decontaminates the wastes to destroy spores of Bacillus subtilis at concentration of 10^4, is said to have attained Level III disinfection, resulting in reduction of volume and making the waste unrecognizable with minimum handling and transportation.

AVAILABLE TREATMENT AND DISPOSAL TECHNOLOGIES

1. Incineration
2. Chemical disinfection
3. Wet and dry thermal treatment
4. Deep burial or landfilling
5. Recycling
6. Worm composting.

Newer Technologies

1. Microware irradiation
2. Plasma torch technology
3. Gamma irradiation
4. Hydroclave
5. Pyrolator
6. Bacterial cultures
7. Electron beaming.

EXISTING AVAILABLE TECHNOLOGIES

Incineration (Mass Burn Technology)

This method consists of burning the waste in a simple kiln or incinerator to a very high temperature of about 1000°C, resulting in reduction of organic and combustible solid waste to inorganic, incombustible matter, thus converting the waste into bottom ash (incombustible matter) and fly ash

(containing particulate matters and hazardous noxious gasses). Incineration offers a direct disposal technology with zero occupational hazard and a volume reduction of 85-95 percent. The process of burning is usually selected to treat waste that cannot be recycled, reused or disposed off in a landfill site.

Proper source segregation and installing multichambered electrical incinerators with pollution control technology are key points to ensure environmental safe use of this technology, as recommended by Environmental Protection Agency (EPA). Incineration as a process involves waste preparation (segregation), waste charging and combustion, treatment of emission through controls and handling of incinerator ash. The ash may be collected in thick puncture proof bags and stored for periodic dumping into community landfill. Presorting is done to eliminate bulky and non-burnable items.

There are basically three types of incinerators:

1. Double chamber pyrolytic incinerators, for burning the infectious health care waste **(Fig. 13.1)**.
2. Single chamber furnaces, which is next best.
3. Rotary kilns, operating at high temperatures capable of causing decomposition of genotoxic substances and heat resistant chemicals.

Double Chamber Pyrolitic Incinerator

This is designed to burn the infectious health care waste, at temperatures between 900 and 1200°C and has pollution control devices. Thus the technology is environment-friendly. So, the pyrolitic incineration is also called 'Controlled air incineration' **(Fig. 13.1)**.

Function

The waste is thermally decomposed through an oxygen deficient, medium temperature of 800 to 900°C combustion process, producing solid ashes and gasses. The process starts with a fuel burner.

The gasses produced in the primary chamber are then burnt in the second, post-combustion chamber at 900-1200°C, using an excess of air to minimize smoke and odors.

For effective operation, the incinerator should fulfill the following criteria:

- The temperature in the post-combustion chamber should reach at least 1000°C
- Gas residence time should be at least 2 seconds
- Air inflow with 100 percent excess oxygen and high turbulence should be ensured.

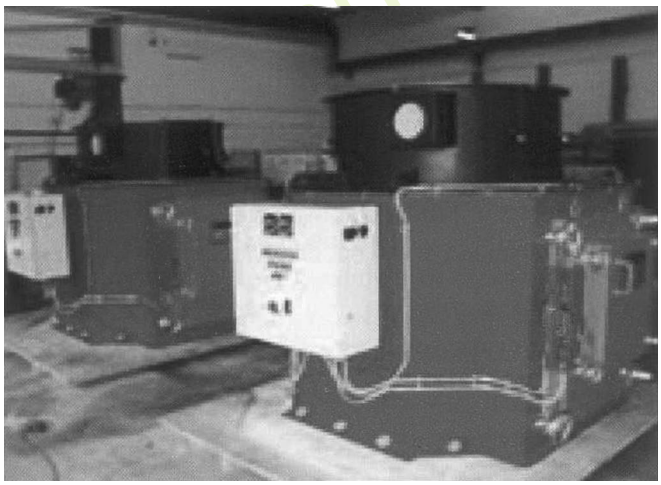


Fig. 13.1 Double chamber incinerator (Capacity: 2 × 800 kg/day)

Design

The incinerator is designed for capacity of 50 to 250 kg of waste per hour (for incineration of above 250 kg/hour, rotary kiln incinerators are preferred). The waste is fed into the incinerator in small batches. The refractory lining and insulation bricks shall be strong enough to sustain the high temperature. There are separate burners for primary and secondary chambers, with automatic switching 'Off/On' control and equipped with spark igniter. The secondary burners are positioned in such a way that the flue gas passes through the flame. There is no manual handling of the waste. On the other hand, the waste is charged through automatic feeding device. It has a computer recording devices which will automatically and continuously monitor and record dates, time of day, batch number and operating parameters such as temperature in both the chambers, and emissions of CO, CO_2 and O_2 periodically.

Standards for Incinerators

Operating Standards

- Combustion efficiency at least 99.99 percent.
- Primary chamber temperature 800 ± 50°C.
- Secondary chamber gas residence time at least one second; temperature at 1050 ± 50°C; minimum 3 percent oxygen in the stack gas.
- Temperature of the waste gas leaving the secondary chamber brought down immediately to 230°C.

Emission Standards

Parameters	Concentration (mg/Nm^3) (at 12% CO_2 correction)
• Particulate matter	150
• Nitrogen oxides	450
• HCl	50
• Minimum stack height (in mtrs)	30
• Volatile organic compounds in ash shall not be more than 0.01%.	

Note:

- All waste to be incinerated shall not be chemically treated with any chlorinated disinfectants.
- Chlorinated plastics shall not be incinerated.
- Only low sulphur fuel like LDO/LSHS/Diesel shall be used as fuel in the incinerator.

Single Chamber Incinerator

This is next best to pyrolytic incinerator. This is good to incinerate infectious waste (including sharps), pathological waste and general health care waste (similar to domestic refuse). Loading and de-ashing operations are performed manually. The combustion is initiated by addition of fuel. The temperature is 300 to 400°C.

Atmospheric emissions are volatile organic chemicals and acid gases such as sulphur dioxide, hydrogen chloride and hydrogen fluoride, black smoke, carbon monoxide, nitrogen oxide, etc. Cleaning of these gases is not practicable. So this should not be installed where air pollution is already a problem.

There are different types of single chamber incinerators. The Bailleul single chamber incinerator **(Fig. 13.2)** can be used as a guideline for design.

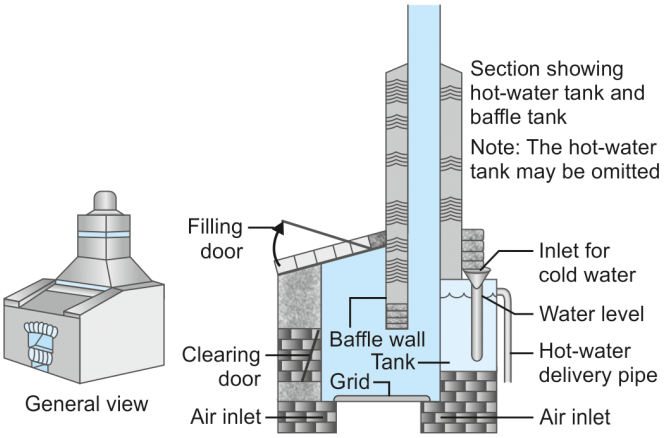


Fig. 13.2 Bailleul single chamber incinerator

Rotary Kiln Incinerator

This comprises of a rotating oven and a post-combustion chamber. It is specifically used to burn the chemical waste such as infectious waste (including sharps) and pathological waste at 1200 to 1600°C.

The kiln rotates 2 to 5 times per minute and is charged with waste at the top. The ashes are evacuated at the bottom end of kiln. The gases produced in the kiln are heated to high temperatures to burn off gaseous organic compounds in the post-combustion chamber and typically have a residence time of 2 seconds. The functional principle of the rotary kiln is shown in **Figure 13.3**. Its equipment and operation costs are high.

Chemical Disinfection

This involves destruction of most of the pathogens from the surface of the wastes, by using chemical disinfectants such as bleaching powder, glutaraldehyde, alcohols or quaternary ammonium compounds, etc. Factors like concentration,

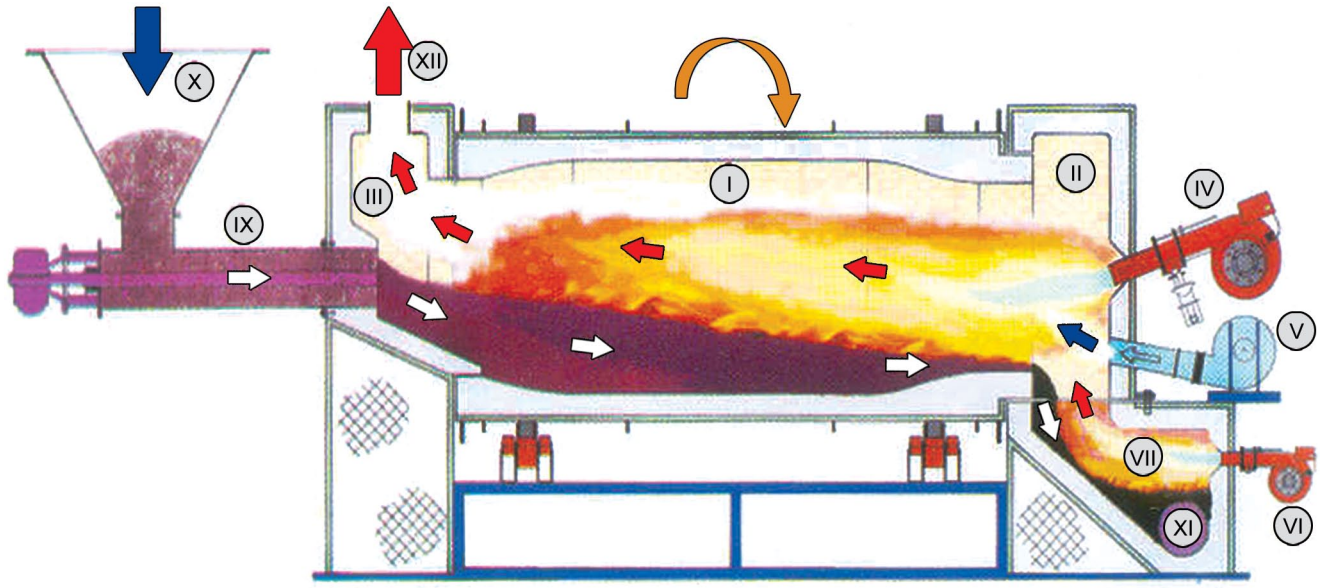


Fig. 13.3 Functional principle of the rotary kiln. I. Rotative combustion chamber, II. Front head, III. Rear head, IV. Start and supporting burner, V. Primary air fan, VI. Automatic ashes chamber burner, VII. Ashes chamber, XI. Waste feeder, X. Solid, liouid, pasty and sludgy hazardous waste, XI. Uploading ashes cochlea, XII. Gas to postcombustion chamber

stability of chemicals, surface contact time determine the effectiveness of a chemical disinfectant.

The instruments and equipment in contact with patients, infected sharps, contaminated floor, beds, etc. may be disinfected by using neutral disinfectants. Chemical disinfection is most suitable for treating liquid waste such as blood, urine, stools or hospital sewage. However solid wastes may also be disinfected chemically with certain limitations. Chemically disinfected wastes should continue to be treated hazardous, unless bacterial testing shows complete disinfection. The main disadvantage of chemical disinfectants is that there is no disinfectant which attains the desirable level III disinfection and there is no test to judge the efficacy of disinfection.

Wet and Dry Thermal Treatment

Wet Thermal Treatment (Autoclaving)

In this technology the infectious wastes are steam heated at specified temperature and pressure for specific period of time. Decontamination occurs when steam penetrates the waste. The equipment requires supply of high temperature and pressurized steam from a boiler unit. A gravity flow autoclave or a vaccum autoclave which functions within specified range of temperature (121-149°C), pressure (15-51 psi) and time (60-30 min) should be used. Vacuum autoclaves are more efficient as absence of air ensures uniform and total penetration of waste by steam and thus total disinfection **(Fig. 13.4)**. The treated waste from an autoclave remains wet with no change in volume. The emission is foul smelling and infectious. Autoclaves can decontaminate most categories of waste except biodegradable organic waste and toxic waste. Autoclaves with superior technology conforming to regulations of Central Pollution Control Board (CPCB) are efficient and offer advantages of volume reduction and odorless and non-toxic emission. But they may cause more occupational hazard and are not cost-effective.

An autoclave should completely and consistently kill the approved biological indicator, i.e. bacillus stearothermophilus spore using vials or spore strips, with at least 1×10^4 spores per milliliter. Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, regardless of temperature and pressure; a temperatures less than 121°C or a pressure less than 15 psi. A strip/paper that changes color at a particular temperature, can be used as a chemical indicator to assess that a specific temperature has been achieved.

Dry Thermal Treatment (Screw-feed Technology)

In this dry thermal, disinfection, non-burning process, the waste is heated in a rotating auger. The waste is reduced by 80 percent in volume and 20-35 percent in weight. This process is suitable for treating infectious waste and sharps, but it should not be used to process pathological, cytotoxic or radioactive waste.

Deep Burial

Wastes belonging to Category I, III and VI collected in yellow containers are disposed by deep burial **(Fig. 13.5)**.

Standards for Deep Burial

1. A pit or trench should be dug about 2 meters deep with 1.5 mtr square.
2. The site should be impermeable, away from habitation and not prone for flooding or erosion and authorized by the prescribed authority.
3. It is ensured that the site does not contaminate the surface water or the ground water. No shallow well should be close to the site.

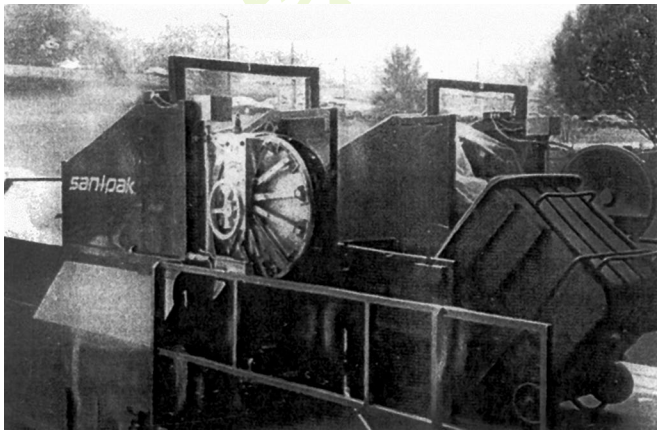


Fig. 13.4 Autoclave

Fig. 13.5 Deep burial—a pit for disposal of organic (biodegradable) waste
Source: Govt. of Karnataka. Karnataka Health Systems Development Project Management of Hospital Waste 2001.

4. The pit is half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of pit with soil.
5. On each occasion of adding waste to the pit, a layer of 10 cms of soil shall be added to cover the wastes.
6. Burial must be performed under close and dedicated supervision.
7. It must be ensured that animals do not have any access to burial sites. Covers of galvanized iron/wire meshes may be used.
8. The institution shall maintain a record of all pits for deep burial.

Landfilling

Landfilling means, disposal of residual solid wastes on land in a facility designed with protective measures against pollution of ground water, surface water, air and ground erosion. Water becomes contaminated by the leachate of the waste. Leach/leachate means the liquid that seeps through the waste and has dissolved or suspended extracts of the waste.

Sanitary landfills are specially constructed for disposal of non-biodegradable infectious hospital wastes **(Fig. 13.6)**. This method is simple and cost-effective. The area should be away from the residential area. A hospital with a bed strength of 100 may require a landfill site of about 500 to 600 cu ft.

The basic features of an engineered landfill are:

- An impermeable clay and pebble base
- Graded base create leachate collection
- Stored earth for covering at the end of each disposal operation.

The essential features of operation of sanitary landfilling are:

1. That all the waste bags are completely pushed into the landfill without getting opened up.
2. Enough earth and hay is put to cover the entire waste so that stray animals do not pick the waste.
3. Frequent spray of the insecticide is done.
4. Personnel protective measures are taken by wearing boots, gloves and aprons.

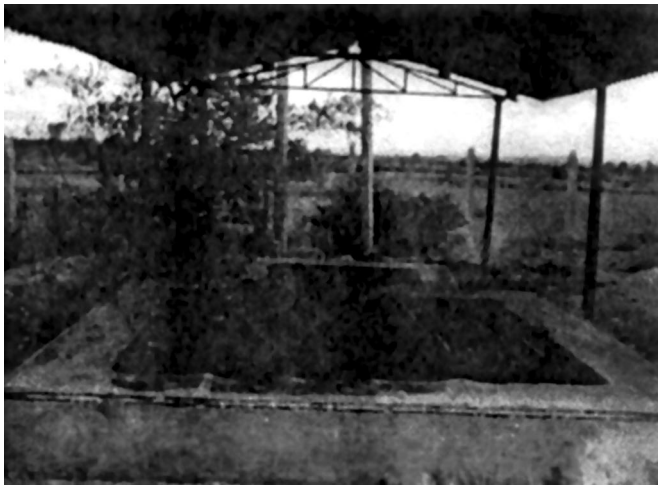


Fig. 13.6 An engineered landfill for safe final disposal of waste
Source: Govt. of Karnataka. Karnataka Health Systems Development Project Management of Hospital Waste 2001.

Landfills are still the most popular method for disposal. But the strict guidelines are that the landfill should be double lined, it should have leachate collection system and a ground water monitoring system to check for the failure of the leachate collection system.

Worm Composting

In this method not actually the hospital waste but the biodegradable general waste from areas of the hospital like kitchen, dining places, cafeteria, which mostly contain organic food wastes, peelings of vegetables, etc. collected in white containers with black-stripes, are disposed off. A rectangular pit of about 1 meter deep bound by brick wall will serve the purpose. A few hundred earthworms are introduced to the earth bed on which the waste can be dumped and some water sprinkled daily. The worms will facilitate microbial decomposition of waste which will form the agriculturally useful compost in 2-3 months. Periodically the compost may be collected either for the hospital kitchen garden or for marketing. A wire mesh may cover the area to prevent birds and animals from picking up the waste.

Microwave Irradiation

In this technique, heat is generated inside the equipment during bombardment of electromagnetic waves into the rotating molecules of the waste. The waste should have some water content to enhance molecular mobility, because the water contained within the waste is rapidly heated by the microwaves and the pathogens are destroyed. However, this technique is not suitable for the wastes of the category I and II. Any microwave equipment must comply with efficacy tests stipulated under the biomedical rules. At the maximum design capacity, microwave unit should show total destruction of Bacillus subtilis spores (used as biological indicator) at a concentration of 10^4 spores per minute. A modern microwave machine is shown in **Figure 13.7**.

The main advantages of this technology are high efficiency, 30 to 40 percent volume reduction, minimal environment pollution and occupational risk, compact nature of equipment and cost-effectiveness.

Plasma Torch Technology

Plasma torch technology (PTT) consists of using a flame at about 6000°C, hotter than the surface of the Sun to turn everything that it touches into fourth state of matter, i.e. plasma which is an ionized gas. It takes in various types of garbage

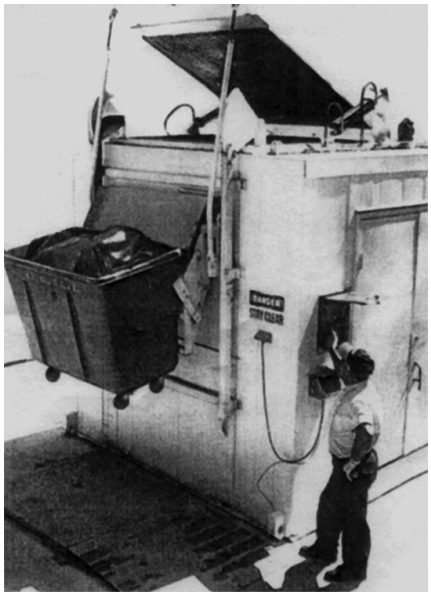


Fig. 13.7 Microwave technology

and vapourizes most of it. What is produced is a gas that can be burnt for energy and a solid black rock like material, used in construction. The glossy rock is not leachable and nontoxic. This technique was developed by NASA in 1960s.

Pros and Cons at Plasma Torch Technology

Pros	Cons
PTT reduces trash that otherwise would fill up landfills. It can dispose off biohazardous waste safely. It produces useful materials that energy of otherwise useless objects.	PTT is extremely costly. It is a complex set up that requires two separate factories to be productive.

Locations of Current Facilities of PTT

- St Lucie country, Florida
- Utashinai, Japan
- Yoshii, Japan

Plasma torch waste disposal is an interesting and useful application of plasma technology. However, until it can be made cheaper and easier to comprehend, it is unlikely that it will become popular among the general public.

Inertization

In this process, the waste is mixed with other substances like cement, lime and water, in the ratio of 65, 15, and 5 percent respectively, before disposal so that the risk of toxic substances migrating into the surface water or ground water is minimized. A homogeneous mass is formed and then transported to suitable sites.

Hydroclave

It is an advanced autoclave method for treating infectious waste, utilizing steam, but with much faster and much more even heat penetration. It is a double walled cylindrical vessel, mounted horizontally. The vessel is fitted with a mixing arm that rotates slowly inside the vessel **(Fig. 13.8A)**.

Hydroclave works in the following stages:

- *Stage 1: Loading*: Hydroclave is loaded. It can process the bagged waste (in ordinary bags), sharp containers, liquid containers, cardboard containers, metal objects and pathological waste **(Fig. 13.8B)**.
- *Stage 2: Sterilizing*: The powerful rotators mix the waste and breaks it into small pieces. Steam is filled in the double wall jacket of the vessel, which heats the interior of the vessel. The liquid in the waste turns to steam. After 20 minutes all the waste and liquids become sterile.
- *Stage 3: Dehydration*: The vent is opened. The vessel is depressurized via a condenser and the sterile liquid is drained into sanitary sewer. Steam heat and mixing a continued until all the liquids are evaporated and the waste becomes dry.
- *Stage 4: Unloading*: The unloading door is opened. The mixer is now rotated in the opposite direction, so that all the waste is pushed out. The dry sterile waste is further

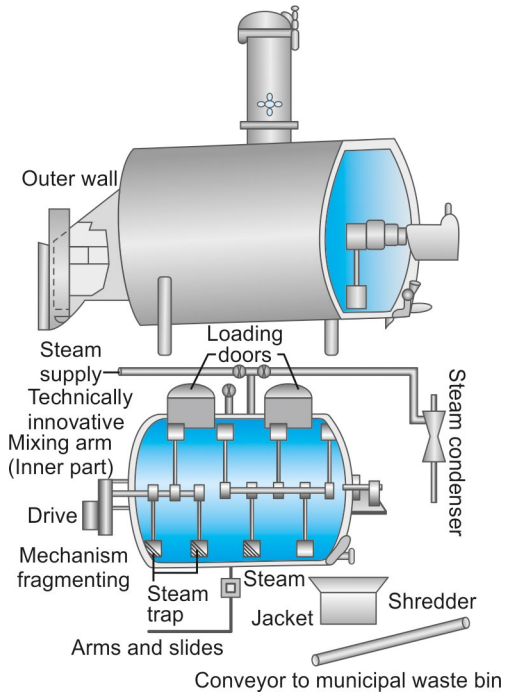


Fig. 13.8A Hydroclave (Infectious waste treatment system)

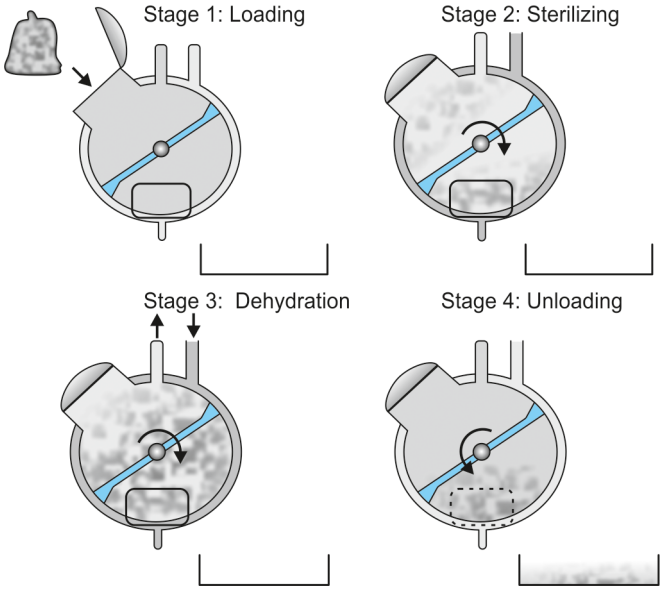


Fig. 13.8B Hydroclave (treatment process)

fine shredded or dropped in a waste disposal bin. The waste is now ready for safe disposal.

Note: The Tata Memorial Hospital, Mumbai, has installed, an advanced hydroclave, for treating its non-pathological waste.

Advantages of Hydroclave

- Totally sterilizes the waste (for treating non pathological waste).
- Treats all infectious waste (except anatomical and cytotoxic waste), even bulk liquid and pathological.
- Complete dehydration of the waste, reducing the volume by 70 percent.
- No harmful emissions.
- Very low operating cost.
- Steam is not lost. It is returned back to the boiler in the form of clean, hot water, ready for reuse.

In most of the newer technologies, disadvantages outweigh the advantages **(Table 13.4)**. There is no ideal waste disposal strategy. Therefore a method which satisfies most conditions and cost effective is the one likely to be sustainable.

The working group of WHO in this report on management of waste from hospitals and health care establishments (1985) have made the following recommendations.

1. A systematic approach in handling, transporting, treating and disposing wastes in a safe way.
2. Training all health personnel in waste management so that they are aware of potential risk of mishandling waste.
3. Emphasis on strategies for source segregation of 'risk' waste from other waste.
4. Basic approach for waste reduction and waste recycling schemes.

Table 13.4 Advantages and disadvantages of different treatment and disposal technologies

Treatment method	Advantages	Disadvantages
1. Incineration		
• Pyrolytic incineration	Highly efficacious for all infectious wastes.	Incomplete destruction of cytotoxics. Investing and operation cost is very high.
• Single chamber incineration	Disinfection efficiency is reasonably good. Drastic reduction of waste in volume and weight. Residue may be disposed off in landfills. Does not require highly skilled persons. Investment and operation cost is low.	Significant emission of atmospheric pollutants. Slag and soot to be removed periodically. Thermal resistant chemicals and cytotoxic drugs are not efficiently destroyed.
• Rotary kiln	Effective for all infectious wastes.	Investment and operation is very costly.
• Drum or brick incineration	Drastic reduction of the waste by weight and volume. Investment is cheap. Destroys 99% of pathogens.	Chemicals and pharmaceutical wastes are not destroyed. There is massive emission of black smoke, fly ash, toxic flue gas and odors.
2. Chemical disinfection	Highly efficient method. Disinfectants are cheap.	Requires the services of highly skilled persons. Requires safety measures.
3. Autoclaving method	No environmental pollution; cost-effective.	Requires the services of qualified persons. Frequent breakdown can occur. Not suitable for cat 1, 5 and 10.
4. Deep burial	Low cost, relatively safe and simple process.	Site should be accessible; certain precautions to be taken.
5. Microwave irradiation	Highly efficient, 30-40% volume reduction, minimal environmental pollution and occupational risk, and compact nature of the equipment.	Investment and operating cost is relatively high.
6. Inertization	Inexpensive.	Not applicable to infectious waste.

5. Pathological and infectious wastes are preferably disposed by incineration adhering to pollution control standards.
6. As radioactive wastes in health care facilities have very low level radioactivity and short half-life, they should be stored till they are no more radioactive.
7. Comprehensive waste disposal plan for all health care institutions.

Comparison between Hydroclave, Autoclave and Microwave

S. No.	Feature	Hydroclave	Autoclave	Microwave
1.	Cost	Low cost (Steam recycled)	High cost (Steam not recycled)	High cost (Electricity)
2.	Sterility	Consistently high	Spotty sterility	Only disinfection
3.	Bags	No special bags required	High temperature bags required	Pre-shedding required
4.	Wet waste	Treated	No	No
5.	Weight and volume reduction	Yes	No	No

DO'S AND DON'TS OF HEALTH CARE WASTE

Do's

- Segregate all waste at the point where they are generated itself.
- Have at least four types of containers in each area of waste generation.
  - One to collect kitchen garbage
  - Second to collect infected waste
  - Third to collect all types of waste sharp
  - Fourth to collect waste paper, wrappers and packing materials.
- Do designate a separate place to keep the mop, wiping cloth, broom and such other materials.
- Do ensure 5 to 6 latrines for every 50 to 60 patients in in-patients settings and a minimum of 1 latrine in out patient settings.
- Do ensure adequate availability of water for sanitary and clean maintenance of latrines.
- Do provide soap and water for washing of hands.
- Do ensure a systematic cleaning schedule.
- Participate to establish common co-operatives incinerate facility.
- Do consider sending the kitchen waste to piggeries or compost them.
- Do take care of universal precautions, while handling infectious waste.

Don'ts

- Do not consider any type of health care waste in a casual manner.
- Do not throw any type of health care waste into the street bins.
- Do not encourage reuse of the disposables.
- Do not attempt to recycle and/or dispose without ensuring adequate decontamination.
- Do not incinerate all kind of waste. Only infected like contaminated dressings, cotton, body-parts, tissue sections, etc. need to be incinerated.
- Do not be ignorant of the legislative provisions regarding waste management especially health care waste.

Waste Sharps Management

- Waste sharps are needles, syringes, scalpels, blades, broken glass, etc. capable of causing injuries or introducing infection.
- Their segregation (separate collection) reduces the chances of injury.
- Their decontamination/disinfection reduces the chances of infection (explained below).
- Their destruction/deformation prevents misuse of needles and syringes. (It is done not by hand but by cutting-plier or by mechanical or electrical needle cutter).
- They should be collected in a puncture proof (heavy duty) plastic container, with a narrow mouth, so that it facilitates collection, minimizes unnecessary handling.
- The container should be BLUE or WHITE and labeled properly as, 'waste sharps container.'
- Use heavy duty gloves while handling waste sharps, especially while transporting.
- Transportation is done using trolley and not manually.
- Finally disposal is done by mutilation or shredding, which prevents reuse. Then either it is sent to recycler or bury in a concrete pit.

Decontamination Procedure

Chemical Treatment

One percent hypochlorite or 2 percent bleach or 10 g of fresh bleaching powder in one liter of water with a contact period of 60 minutes.

Autoclaving

A temperature of 121°C; pressure of 15 psi for a minimum of 60 minutes.

Before removing the needle from the syringe it is flushed with a disinfectant liquid. The needle is then discarded into waste sharps container. The plunger is removed from the syringe-barrel before immersing it in the disinfectant.

Plastic Waste Management

Plastics are polymers of hydrocarbons typically derived from petroleum or natural gas. Plastics being non-biodegradable remain in the soil for more than one thousand years, contaminating the soil and the surrounding water bodies. Plastics constitute a major chunk of health care waste, more so with the increase in use of disposable items like syringes, IV bags, blood bags, catheters, etc. Plastics in health care waste constitutes four times more than that in municipal waste.

Collection and reuse or resale of the disposable plastic products without adequate treatment will result in possible spread of infections to waste handlers like rag pickers and pourakarmikas. Improper burning or sub-standard incineration of these plastics release toxic gases like dioxides and furans which are potent carcinogens and other harmful gases like sulphur dioxide, oxides of nitrogen, hydrochlorides, etc. Improper landfilling or dumping results in leaching and contamination of soil and surrounding water bodies.

- Use of plastics should be minimized, especially outside patient care, by using bottles, glasses and earthen or metal wares.
- Plastics should be properly disinfected.
- It is deformed or shred before it is sold.
- Separation of the plastics from other types of waste before deforming gets more money.
- Plastics are better managed by non-burn technologies. Microwaves, autoclaves, hydroclaves, chemical disinfection are most suited to treat plastic waste.

Note: The BMW rules (1998) prohibits incineration of chlorinated plastics.

Shredding

Shredding will cause a reduction in the volume of waste and also it will prevent its re-use and facilitates plastic recycling. It is required for waste category 4 and 7 of the schedule-1 of the Biomedical Waste Management (Management and Handling) Rules, 1988. It should be ensured that waste is disinfected by chemicals/micro-waving/autoclaving before shredding.

Plastic Shredder

It has an entry chamber known as hopper and an array of rotating shredding knives. The plastics are destroyed into uniform and consistent sized particles, resulting in the reduction of volume **(Figs 13.9A and B)**.

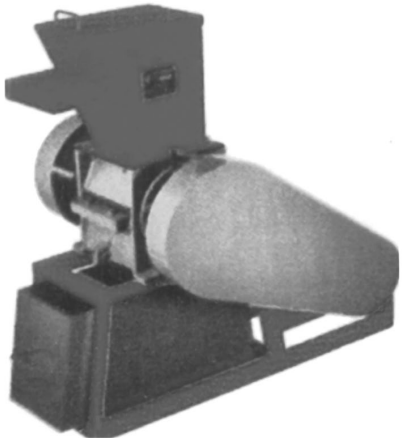


Fig. 13.9A Shredders: Plastic shredder

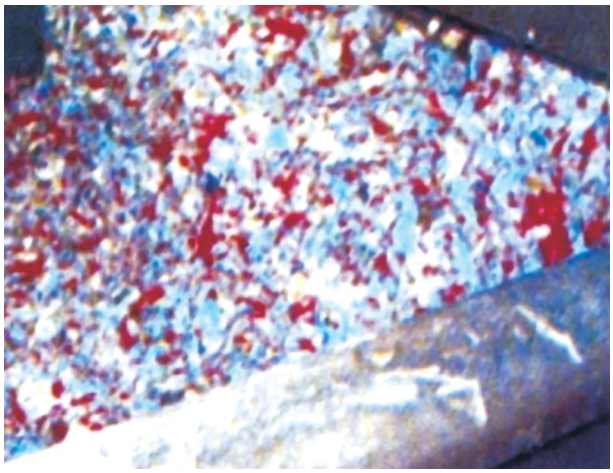


Fig. 13.9B Shredders: Shredded plastic

SUMMARY

- Hospital waste is infectious.
- Use personal protective devices while handling the waste.
- Segregate the waste.
- Ensure proper disinfection of waste before disposal.
- Many toxic pollutants are produced by waste management technologies.
- Best solution for waste management is green approach—3 "Rs" viz Reduce, Reuse, Recycle.
- Medical waste offers a fertile field for reduction and recycling.
- Innovate and explore your own methods of waste disposal based on the location, types of health care facilities provided and financial implications.

  Save the environment at least in the present state if not improve—*We all hold the earth in trust for future generation.*

BIBLIOGRAPHY

1. Adachi K, Amakawa T, Inaba T and Yasui S. Fundamental Research on Thermal Plasma Technology for treatment of Low Level Radioactive Solid Waste. Electrical Engineering, Japan. 1995;115(5):1-9.
2. Govt. of Karnataka. Karnataka Health Systems Development Project Management of Hospital Waste 2001.
3. Health Care Waste Management Cell. Health Care Waste Management. Booklet on selected issues of final treatment options. MS Ramaiah Medical College, Bengaluru 2009.
4. Health Care Waste Management Cell. Safe Management of Health Care Waste. Information and Learning Units. Working Manual for Hospital Waste Disposal. MS Ramaiah Medical College, Bengaluru 2005.
5. Ministry of Environment and Forests. Notification. New Delhi. Sept. 2003.

CHAPTER 14

Electronic Waste Management

Electronic waste, e-waste, e-scrap or waste electrical and electronic equipment (WEEE) describes loosely discarded, surplus, obsolete (disused) or broken electrical or electronic equipments **(Fig. 14.1)**. This definition includes used electronics which are destined for reuse, resale, salvage, recycling or disposal.

The electronic industry, like information technology and telecommunication, is the world's largest and fastest growing manufacturing industry. As a consequence of this growth, combined with rapid product obsolescence, discarded electronics or e-waste is now the fastest growing waste stream in the industrialized world. Although the fast development in information technology has radically changed peoples' lifestyle and helped human race, the mismanagement of e-waste has led to new problems of contamination and pollution, thus posing a threat to environment and health.

The hazardous nature of e-waste is one of the rapidly growing environmental problems of the world.

- The ever increasing amount of e-waste associated with lack of awareness and appropriate skill is deepening the problem.
- A large number of these workers are involved in crude dismantling of these electronic items for their livelihood and their health is at risk.
- A legal framework, a collection system, logistics are lacking.
- So, there is an urgent need to plan a preventive strategy in relation to health hazards due to e-waste handling among those workers in India.

Solid waste management, which is already a mammoth task in India, is becoming more complicated by the invasion of e-waste, particularly computer waste.

E-waste has become a problem of crisis proportion because of two primary characteristics:

i. The toxic ingredients of e-waste posing a threat to the occupational health of rag pickers as well as the environment.
ii. Generation of e-waste at an alarming rate.

E-WASTE BURDEN GLOBALLY

- It is estimated that about 50 million tons of e-waste is produced each year and it is escalating rapidly at a rate of 3 to 5 percent every year, which is three times faster than the municipal waste.
- E-waste, comprises of more than 5 percent of all municipal solid waste.
- 23,000 tonnes of e-waste is shipped to developing nations.
- US discards 30 million computers annually.
- Europe discards 100 million phones each year.
- It is estimated that about 15 to 20 percent is recycled and rest goes to landfill and incineration.

BURDEN IN INDIA

- 1,46,000 tonnes of e-waste was generated during 2005 and 3,80,000 tonnes during 2007.
- 8,00,000 tonnes estimated by the year 2012.
- India and other developing countries are the dumping grounds for the developed countries.

Fig. 14.1 Electronic equipment

SOURCES OF E-WASTE

E-waste is generated from three major sectors
1. Individuals and small businesses
2. Large businesses, institutions and governments.
3. Original equipment manufacturers (OEMs).

Individuals and Small Businesses

Electronic equipments, particularly computers are often discarded by households and small businesses not because they are broken but because of upgradation of new technologies. So, the customers are forced to buy new ones. Thus, the life span of computers has shrunk from five years to almost two to three years. The old ones are just dumped.

Large Businesses, Institutions and Establishments

From the large establishments, the e-waste goes to the lease companies, who take back the old ones and send it for reuse/recycling/export markets.

Original Equipment Manufacturers

In original equipment manufacturers (OEMs), when the production line does not meet quality standards, it is disposed off either by recycling or by export to developing countries in the name of free trade.

IMPACTS/HAZARDS OF E-WASTE

Effects on Environment

- Computer wastes that are land filled produces contaminated leachates which eventually pollute the ground water. For example, the cadmium from one mobile phone battery is enough to pollute 600 m^3 of water. Similarly mercury from circuit breakers, polychlorinated biphenyls (PCBs) from condensers, lead from cone glass of cathode ray tube (CRTs) etc also leach and pollute ground water.
- Incineration of e-waste can emit toxic fumes and gasses, polluting air.
- The plastic casings, cables and polyvinyl chloride cable insulation when burnt to recover copper from the wires, release toxic dioxins and furans (toxic fumes), polluting air.

Table 14.1 The toxic constituents, their source and health effects

Source	Constituent	Health effect
Solder in printed circuit boards, glass panels and gasket in monitor	Lead (Pb)	• Damage to nervous system, vascular system and kidney Affects brain development in children
Chip, resistor sand semiconductors	Cadmium (Cd)	• Accumulation in liver and kidney • Neural damage • Teratogenic
Relays and switches, printed circuit boards	Mercury (Hg)	• Chronic damage to brain • Respiratory and skin disorders
Data tapes, floppy disc	Hexavalent chromium	• Asthmatic bronchitis • DNA damage
Cabling and computer housing	Plastics including PVC	• Reproductive and developmental problems • Immune system damage • Interference with regulatory hormones
Front panel of cathode ray tubes	Barium	• Muscle weakness • Damage to heart, liver and spleen
Plastic housing of electronic equipment and circuit boards	Brominated flame retardants (BFR)	• Disrupts endocrine functions
Mother board	Beryllium (Be)	• Lung cancer • Beryllicosis • Skin diseases like warts

- Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil and if disposed in the rivers results in water contamination and acute water shortage.
- Thus, ultimately there will be disturbance of ecosystem.
- Thus, the hazardous effects on environment are contamination of ground water, pollution of air, acidification of soil, disturbance of aquatic ecosystem.

Effects on Health

The different toxic constituents of e-waste, their source and health effects are shown in **Table 14.1**.

In view of the ill effects of e-waste on environment and health, several countries exhorted the need for a global agreement to address the problems and challenges posed by hazardous waste. In 1980s, tightening the environmental regulations in industrialized countries, led to a dramatic rise in the cost of disposal of hazardous waste. Searching for cheaper ways to get rid of the wastes, "toxic traders" began shipping these wastes to developing countries, including India, where they are either disposed off or recycled with little or no regard for environmental or workers' health and safety, because of cheap labor and lack of environmental and occupational standards. However groups like 'Toxic Links', India are working for controlling this hazardous trade.

The international outrage following these irresponsible activities led to the drafting and adoption of strategic plans and regulations at the Basel Convention. The convention Secretariat, in Geneva, Switzerland, facilitates the implementation of the convention and related agreements. It also provides assistance and guidelines on legal and technical issues, gathers statistical data and conducts training on the proper management of hazardous waste.

BASEL CONVENTION

The fundamental aims of the Basel Convention are the control and reduction of transboundary movements of hazardous wastes including the prevention and minimization of their generation, the environmentally sound management of such wastes and the active promotion of the transfer and use of technologies.

The Basel Convention brought about a respite to the transboundary movement of hazardous waste. India and other countries have ratified the convention. Developed countries such as US, should enforce strict ligislations in their own country for the prevention of this horrifying act. The European Parliament recently passed ligslation that will require manufacturers to take back their electronic products when consumers discard them. This is called 'Extended producer responsibility'. It also mandates a time-table for phasing out most toxic substances in electronic products.

The valuable materials in e-waste and their uses are as follows **(Table 14.2)**:

Table 14.2 The valuable materials in e-waste and their uses

Source	Constituent	Uses
Cable and housing	Plastics	Insulation
Funnel glass in CRT, PWB	Lead, gold	Metal joining, connectivity
Housing, CRT, PWB	Mercury and zinc	Batteries and switches
Housing, CRT, PWB, connectors	Aluminum, silver, copper and iron	Conductivity and magnetivity

WASTE MINIMIZATION TECHNIQUES

It is estimated that 75 percent of electronic items are stored in the houses, offices, warehouses etc due to uncertainly of how to manage it. They are often mixed with household waste, which are finally disposed off at landfills, which in turn is harmful to environment and health. This necessitates the minimization of e-waste at the point of generation in the industries itself. This involves the adoption of the following measures:

- Inventory management
- Production process modification
- Volume reduction
- Recovery and reuse.

- *Inventory management:* This consists of proper control over the materials used in the manufacturing process, to reduce waste generation. This can be done not only by the purchases of only the required materials but also by strict inventory tracking system.
  a. Improved operating and maintenance procedures, i.e. instituting standards operation procedures to optimize the use of raw materials in the production process. A strict maintenance of the equipment also reduces the waste generation caused by equipment failure. Good training of the employee is the key element of waste reduction program.
  b. Replacement of hazardous materials by non-hazardous or less hazardous materials also helps in reduction of waste.
  c. Instillation of more efficient or updated equipment in place of old equipment can also significantly reduces waste.
- *Volume reduction:* The volume of the waste can be reduced by removing or segregation of hazardous portion from nonhazardous portion and also by concentration methods such as vaccum filtration, ultra filtration, reverse osmosis, freeze vapourization, etc.
- *Recovery and reuse:* A number of physical and chemical techniques are available to reclaim waste material such as electrolysis, condensation, centrifugation, filtration, reverse osmosis etc.

MANAGEMENT OF OPTIONS

The following options/responsibilities are suggested for the Government, the Industries and the Public.

1. Responsibilities of the government
   - Government should set up regulatory agencies in each district.
   - Ligislation should be strictly enforced.
   - Research in the e-waste management should be encouraged.
2. Responsibilities of the industries
   - Industries should identify the hazardous waste and should provide management options.
   - E-waste handlers should be properly qualified and trained.
   - They should adopt waste minimization techniques.
   - There must be "reverse production system". That means there must be infrastructure to recover and reuse the materials present in e-waste such as lead, copper, aluminium, gold, plastics, glass, wire, etc.
   - The manufacturers, distributors and retailers should undertake the responsibility of recycling/disposal of their own products.
3. Responsibilities of the citizens
   - Reusing the donated, working electronics, keeps them out of waste management system.
   - E-wastes should never be disposed with garbage and other household wastes.
   - NGOs should adopt a participatory approach in the management of e-wastes.

E-WASTE DISPOSAL

E-waste disposal as the following methods:

- Recycling
- Landfilling
- Incineration
- Reuse.

E-waste Recycling

Recycling is defined as assembling, developing, promoting or buying of new products, which are prepared from waste products.

Steps in Recycling

First, the e-wastes are dismantled. Then hazardous materials such as PCB (polychlorinated biphenyls), mercury and plastics are removed. Then the valuable metals such as lead, gold,

Fig. 14.2 Landfill

copper etc., are removed, retrieved and new equipment are developed. Thus, the environmental pollution is avoided.

Landfilling

This consists of dumping and/or burial of the e-waste. The disadvantages are that the materials like mercury, cadmium, lead, etc. leaches into the soil, polluting the ground water. So, it is not a safe method **(Fig. 14.2)**.

Incineration

In this method, the e-waste is burnt in a specially designed incinerators at a high temperature of about 1000°C. It is a complete combustion process. This method not only helps in the reduction of the volume of the waste, but also the hazardous substances are converted into less hazardous substances **(Fig. 14.3)**.

Reusing

This consists of direct use of the equipment or using it after slight modification, e.g. computers, cell phones etc. This

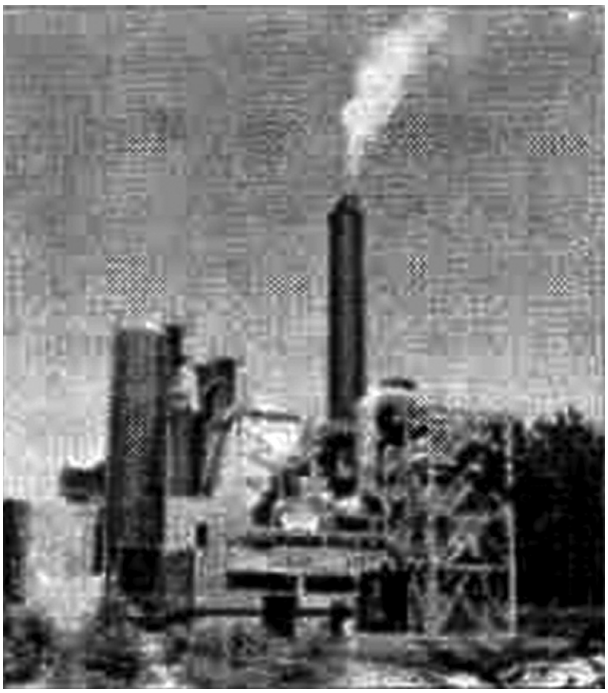


Fig. 14.3 Incinerator

method reduces the volume of generation of e-waste and there is no wastage of time and money.

BIBLIOGRAPHY

1. Kurian Joseph. E-Waste Management in India: Issues and Strategies. Proceedings. Sardina 2007. Eleventh International Waste Management and Landfill Symposium. Cagliari, Italy. 2007.
2. Monika and Jugal Kishore. E-Waste Management: As a Challenge to Public Health in India. IJCM. 2010;35(3):382-4.
3. Ramachandra TV and Saira Varghese K. Environmentally Sound Options for E-Waste Management. Envis Journal of Human Settlements. March 2004.

CHAPTER 15

Medical Entomology

It is that branch of community medicine, which deals with the study of arthropods of medical importance. The term 'arthropoda' is derived from two Greek words: *arthron* means jointed and *poda* means foot. Accordingly arthropods are creatures having jointed legs. Their other features are absence of vertebrae, bilateral symmetrical body consisting of segments, chitinous exoskeleton and power of ecdysis (i.e. moulting). Internally the body is filled with colorless fluid called Hemocele, in which the internal organs are bathed, the heart dorsally, the central nervous system ventrally and the alimentary canal in between. Respiratory system consists of air tubes, which open by a series of pores called spiracles. Sexes are separate.

The medical importance is that they transmit the diseases directly or indirectly. Directly they can act as parasites and indirectly they can spread the diseases from other persons or animals, by acting as 'vectors' or carriers of disease. Their bites and stings may result in urticaria, scratch injuries and even secondary infection.

CLASSIFICATION OF ARTHROPODS

The phyllum arthropoda consists of three important classes—Class Insecta, Arachnida and Crustacea. Their distinctive features are as given in **Table 15.1**.

Table 15.1 Phyllum arthropoda and their distinctive features

	Insecta	Arachnida	Crustacea
• Body shape	Cylindrical	Circular or oval	Pear shaped
• Body division	Head, thorax and abdomen	Cephalothorax and abdomen	Cephalothorax and abdomen
• Antennae in head	1—pair	Absent	2—pairs
• Wings	Some are winged, some are wingless	Absent	Absent
• Legs	3—pairs	4—pairs	5—pairs
• Living	On land	On land	In water
• Examples	Winged • Mosquitoes • Flies Wingless • Fleas • Lice • Bugs	• Ticks • Mites • Spiders* • Scorpions*	• Cyclops • Crabs* • Lobsters* • Prawns*

** These do not transmit any disease.*

Vector: It is an arthropod capable of transmitting or spreading the disease. There are two types of vectors, depending upon the mode of transmission of disease—namely mechanical vector and biological vector.

A. **Mechanical vector:** It is an arthropod, which passively, directly transmits the pathogens without biting.
   For example: Housefly mechanically lifts up the pathogens from the filthy substances and deposits over the eatables and contaminates the food.
B. **Biological vector:** It is an arthropod, which transmits the pathogens indirectly by biting the reservoir and sucking the blood containing pathogens. Subsequently the pathogens undergo biological development inside the body of the vector for a specified period, only after which the vector can spread the disease. For example: mosquito, rat flea, cyclops, etc.
   The biological transmission are of three types:
   i. **Propagative:** In this type, the pathogens undergo multiplication inside the body of the vector, e.g. Plague bacilli in rat flea, yellow fever virus in aedes mosquito.
   ii. **Cyclopropagative:** In this type, the pathogens undergo not only multiplication but also cyclic development inside the body of the vector, e.g. malarial parasites in female anopheline mosquito.
   iii. **Cyclodevelopmental:** In this type, the pathogens undergo only developmental changes and no multiplication inside the body of the vector, e.g. *Wuchereria bancrofti* microfilariae inside female culex mosquito; Guineaworm embryo in cyclops.

Other than mechanical and biological means, arthropods also transmit the disease by invading the tissues (skin) of the man (e.g. itch-mite invading the skin and resulting in scabies) or by inoculating poisonous substance (e.g. like scorpion when it stings or the spider when it bites).

ARTHROPOD BORNE DISEASES

The vector borne diseases take a heavy toll of human life in developing countries of the world. In India, the annual morbidity of malaria is about 2 million cases. During 2003 about 1.65 million cases were reported with 943 deaths due to malaria. About 500 million people are living in filarial endemic areas. Dengue, Hemorrhagic fever, Japanese encephalitis and Kyasanur Forest Disease are also important arthropod borne viral diseases, often occurring in epidemics. Classical diseases like plague and Kala-azar, which have not been really eradicated from this country, are a potential threat to human life. Trachoma constitutes an important cause of blindness. Scabies is rural problem. A wide spectrum of disease agents—viral, rickettsial, bacterial, protozoal and nematodal—are transmitted by arthropod vectors.

The notable arthropod borne diseases are grouped as given in **Table 15.2**.

Table 15.2 The notable arthropod borne diseases

Causative agent	Disease	Vector
Virus	Yellow fever, Dengue fever, Dengue Hemorrhagic fever, Chickungunya, West–Nile fever, Japanese encephalitis Phlebotomus fever Kyasanur forest disease	Mosquito Mosquito Mosquito Mosquito Sandfly Hard tick
Rickettsiae	Epidemic typhus, trench fever, endemic (murine) typhus tick typhus, Q-fever Rocky mountain spotted fever Rickettsial pox, scrub typhus	Louse Rat flea Tick Tick Mite
Bacteriae	Typhoid, cholera, shigellosis, plague	Housefly Rat flea
Spirocheta	Relapsing fever	Louse
Protozoa	Malaria Leishmaniasis African trypanosomiasis Chaga's disease	Mosquito Sandfly Tsetse fly Reduviid bug
Nematoda	Filariasis Dracunculiasis Onchocerciasis	Mosquito Cyclops Black fly

Common Terms Used in Entomology

Extrinsic Incubation Period

It is the period of time required for the disease agent to undergo multiplication or a phase of cyclic development or both, inside the body of the arthropod, e.g. extrinsic incubation period in malaria, filariasis, yellow fever are 10 to 14 days.

Infective Mosquito

A mosquito capable of transmitting the disease agent. It becomes so after the extrinsic incubation period.

Infected Mosquito

A mosquito is said to be infected when it has the disease agent inside the body but has not yet become infective.

Definitive Host

It is one in which the sexual phase of the development or life cycle of the parasite takes place. In otherwords, a definitive host is one in which the adult parasite develops, e.g. female anopheline mosquito in malaria, man in filariasis.

Intermediate Host

It is one in which asexual phase of the development or life cycle of the parasite takes place.

(In other words, an intermediate host is one in which the larva parasite develops), e.g. cyclops in dracontiasis; Female culex mosquito in filariasis, man in malaria.

Infestation

It means the lodgement, growth, development and reproduction of the arthropod parasite on the surface of the body, e.g. louse infestation.

Metamorphosis

Changes that take place in size, shape and structure during the different stages of the life cycle of the arthropod, from the stage of egg to adult stage is known as 'Metamorphosis.' There are two types of metamorphosis, namely incomplete and complete.

Incomplete metamorphosis (Hemimetabola): In this type, the young one coming out of the egg, resembles the adult in its shape but smaller in size. The stages in the life cycle are egg, nymph and adult, e.g. louse, ticks.

Complete metamorphosis (Holometabola): In this type, there is complete change in the appearance, in all the stages of the lifecycle. Before the adult stage, there is a pupal stage, e.g. life cycle of mosquito, fly, flea, etc. consists of four stages—egg, larva, pupa and adult.

PRINCIPLES OF ARTHROPOD CONTROL

Control of arthropods can be conceived under three measures—offensive, defensive and corrective.

Offensive measures comprise attacking the arthropods and killing them, e.g. use of insecticides.

Defensive measures comprise personal protective measures from the attack of insects, e.g. use of repellants, curtains, etc.

These do not contribute to the control of arthropods, however, it helps in control of the disease. Corrective measures comprise modification of the environment such that it becomes unfavorable for the arthropods to lay the eggs, thereby the arthropod population is controlled. This also includes health education of the community to participate in the control of arthropods.

Since no single method is effective in controlling the arthropods, the recent trend is to adopt two or more methods to control the vectors. This is called 'Integrated approach.' This approach helps to obtain maximum results with minimum efforts.

The newer methods of control of vectors are:

- Genetic control measures such as sterile male technique, cytoplasmic incompatibility and chromosomal translocations.
- Insect growth regulators
- Chemosterilants
- Sex attractants
- Pheromones.

Pheromones means the substance secreted by the arthropod, received by another arthropod, resulting in the change of behavior or the development process. They are also called ectohormones.

Arthropods of Public Health Importance

The phylum arthropoda consists of five classes, of which three are of public health importance. These are the Class— insecta, arachnida and crustacea. The class insecta includes mosquitoes, flies, fleas, lice and bugs. The class arachnida includes ticks and mites and the class crustacea includes cyclops.

CLASS INSECTA

MOSQUITOES

Mosquitoes are the small biting insects, found all over the world in millions and trillions. The important groups (or genera) of mosquitoes in India that spread diseases are four. They are Anopheles, Culex, Aedes and Mansonia.

Morphology

A mosquito has a cylindrical body, divisable into three parts namely head, thorax and abdomen. Head and thorax are connected by a small fleshy neck, while thorax and abdomen are continuous **(Fig. 15.1)**.

Head

Head is spherical and bears the following structures:

- A pair of large, prominent, compound eyes.
- A long needle like structure in the center, anteriorly, called 'Proboscis' with which it bites and sucks.
- A pair of maxillary palpi, one on either side of proboscis. It is long in male and short in female, except in anopheline female mosquito, which also possesses long palpi.
- A pair of antennae, each one lateral to palpi, with which it feels. The hairs over antennae are long and bushy in male mosquitoes and short and less bushy in female mosquitoes **(Fig. 15.2)**.

Thorax

The thorax is large and round. The dorsal surface is formed by a large plate, the mesonotum. The posterior end of the

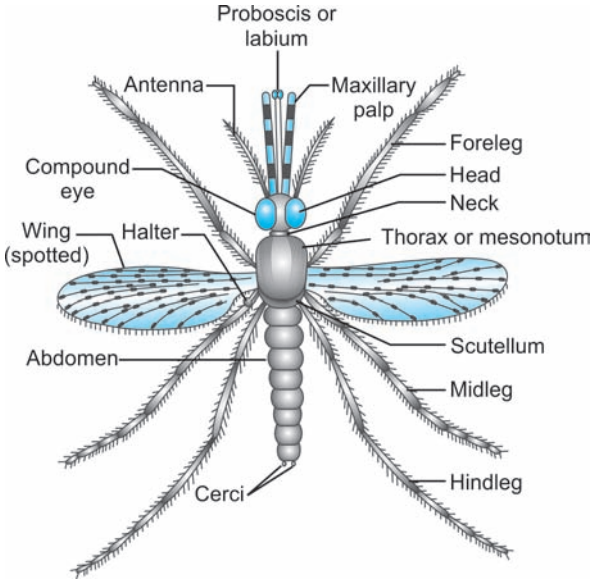


Fig. 15.1 Female anopheles mosquito (wings spread out and maxillary palpi slightly separated)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

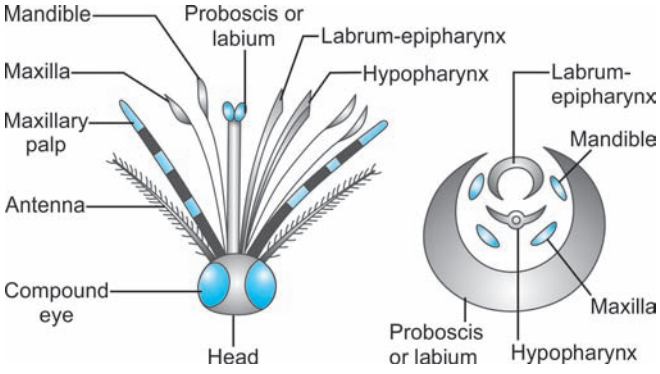


Fig. 15.2 Mouth parts of mosquito (♀ anopheles) and X′ section through proboscis
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

thorax bears a projection like structure called scutellum, to which hairs are attached, the arrangement of which helps in identification of the mosquitoes **(Fig. 15.3)**. Thorax bears the following structures:

Wings: A pair in number attached dorsally, help for flying **(Figs 15.4 and 15.5)**. The buzzing noise of the mosquitoes is due to beating of the wings and not due to singing.

Halters: A pair of rudimentary wings are located below the wings, which helps the mosquito to maintain the balance while flying. So they are also called balancers.

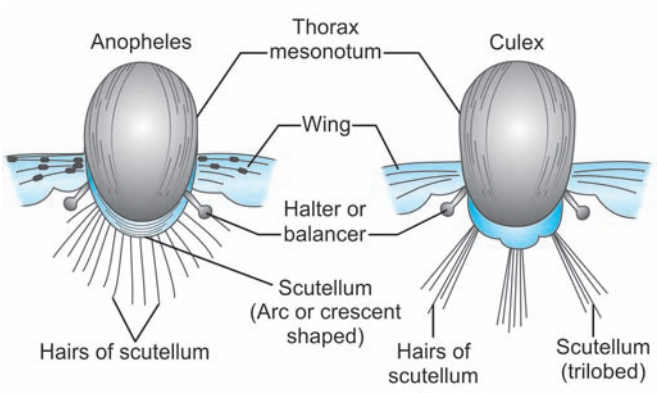


Fig. 15.3 Thorax of anopheles and culex showing scutellum and halter (Dorsal view)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

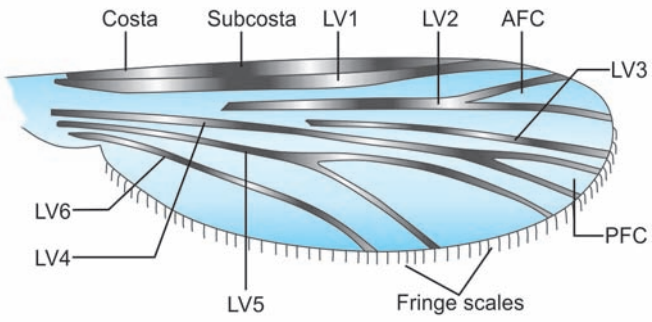


Fig. 15.4 Spotted wing of anopheles (LV1 to LV6-longitudinal veins; AFC and PFC–anterior and posterior forked cells)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

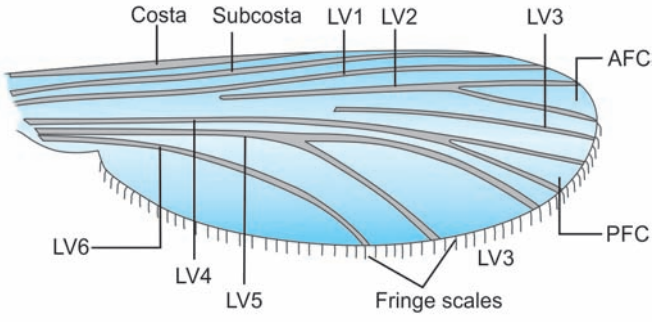


Fig. 15.5 Unspotted wing of culex (LV1 to LV6-longitudinal veins; AFC and PFC–anterior and posterior forked cells)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Legs: Three pairs of legs are attached ventrally. They are multi jointed. The tip of the last segment ends in a pair of claws **(Fig. 15.6)**.

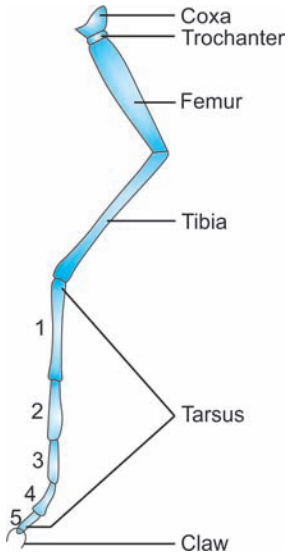


Fig. 15.6 Leg of mosquito
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

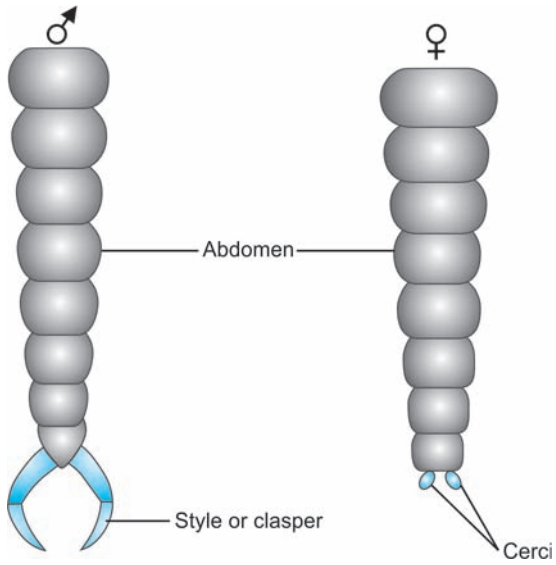


Fig. 15.7 Genitalia or terminalia of ♂ and ♀ Imosquito
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Abdomen: Abdomen is long and narrow, composed of 10 segments, but only 8 segments are visible and the last two are modified into genitalia, represented by a pair of claspers in the male and a pair of cerci in the female mosquitoes. The claspers are long and curved; the cerci are small and rounded. The genitalia (terminalia) helps in identification of the sex **(Fig. 15.7)**.

Life Cycle and Life Habits

There are four stages in the life history of mosquitoes, namely egg, larva, pupa and adult. Each stage differs in its size, shape and structure from the other stage. So metamorphosis is complete (Holometabolous type). The first three stages are acquatic and the last stage is terrestrial. Eventhough the general features of the stages of development in the life cycle is the same in all the four genera of mosquitoes, there are certain differences in the morphology in each of the stages (Described below).

Egg Stage

Eggs are always laid on the surface of the water, either in singles or in clusters. They are white and soft when freshly laid and become dark and hard thereafter. The eggs are barely visible to the naked eye. Inside the egg is the embryo. This stage lasts for two days, after which it hatches and a tiny larva comes out.

Blood meal is a must for a female mosquito to lay the eggs. The period between the blood meal and the deposition of eggs is called 'gonotrophic cycle'. It is about 48 hours in tropical areas. Egg is passive, i.e. it does not take food, does not move but only floats.

Larva Stage

The larva comes out by breaking the shell of the egg. It is a free, swimming creature, cylindrically shaped, about 1.0 mm long. The body is divisible into head, thorax and abdomen. It is a very active stage, swims freely and eats voraciously. It feeds on micro-organisms, algae, diatoms, etc. found in water.

Normally the larvae float near the surface of the water. This facilitates breathing. On slight disturbance, the larvae drive to the bottom with lightening speed, only to rise up again in search of air. The swift movement is due to the action of feeding brushes and twisting of the bodies. The larvae undergo four moultings before transforming into the next stage, pupa. This stage lasts for about 5 to 7 days.

Head: Head bears 2 pairs of eyes. One pair is small and it is called larval eyes. It is temporary and disappears soon after this stage. The other pair is large and is permanent. It is called imaginal eyes. Mouth is located anteriorly, which has feeding brushes on either side of the mouth. The feeding brushes not only help in catching the food but also for active movement. Head also bears a pair of maxillary palpi and a pair of antennae **(Fig. 15.8)**.

Thorax: This appears as a single large segment. The wings and legs are absent.

Abdomen: This is composed of 10 segments. The first seven segments are almost similar in structure. Eighth and ninth segments are fused to form 'respiratory apparatus' **(Fig. 15.9)**.

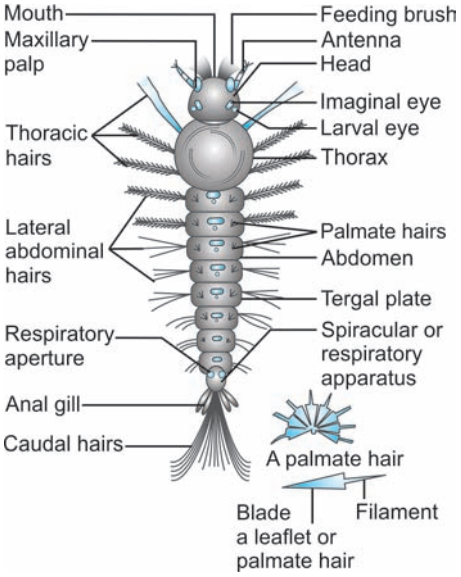


Fig. 15.8 Dorsal view of anopheles larva
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

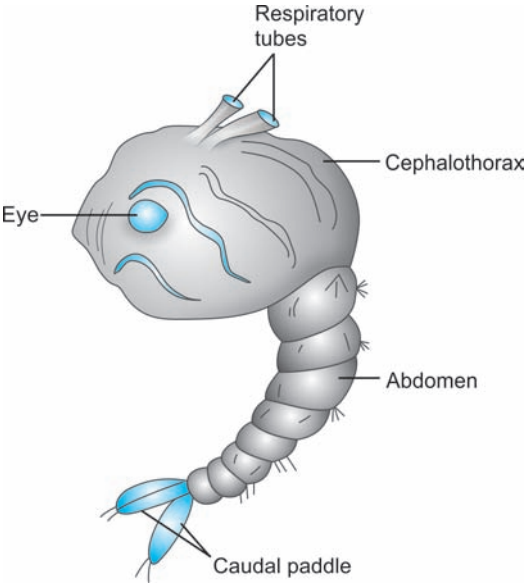


Fig. 15.10 Pupa of mosquito
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

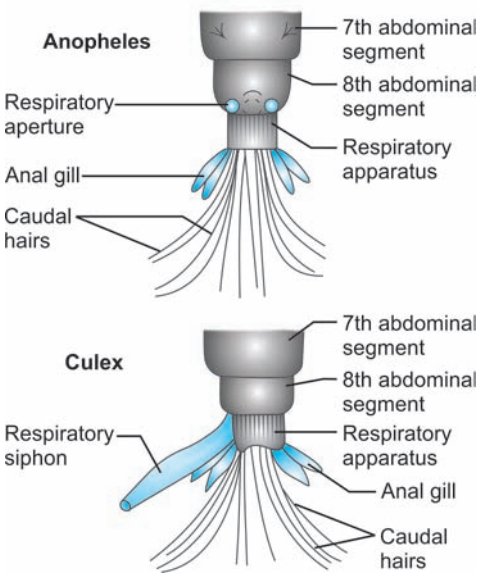


Fig. 15.9 Terminal segments of abdomen of anopheles and culex larvae showing the respiratory apparatus
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

The tenth segment possesses anal opening and anal gills. The tip also bears long caudal hairs. Some larvae possess a pair of special hairs called 'palmate hairs' on the dorsolateral portion of each abdominal segment. These do not serve any purpose but help in identification. These palmate hairs look like palm leaf and help in floating.

Pupa Stage

In this stage, the head and thorax is fused to form cephalothorax and the cylindrical abdomen is curved looks like tail. Thus this stage looks like 'comma' shaped structure. Cephalothorax bears a pair of eyes. Mouth is absent. So does not feed. The respiratory apparatus (or two siphon tubes) disappear from the last abdominal segment of the larva and is developed on the cephalothorax of the pupa. The siphon tubes open on the surface of the water for breathing. The tip of the abdomen has caudal paddles and caudal hairs **(Fig. 15.10)**.

Pupa is the resting or quiescent stage and it does not take any food. It prefers to remain in a suspended state close to the surface of water but if disturbed, it drives quickly to the bottom by caudal paddles and hairs, in a peculiar tumbling fashion. It returns to the surface very soon for breathing purpose. During this stage adult is developing inside the pupa.

Pupal stage lasts for about two days.

Adult Stage

This is also called 'imago stage.' The young adult mosquito breaks open the pupa and emerges out. It rests on the empty case till the wet body dries up and wings expand, after which it flies away in search of food.

Thus, it takes about 10 to 12 days for completing the life-cycle. Metamorphosis is complete **(Fig. 15.11)**.

The adult male mosquito lives for about 2 weeks; the females live little longer. The male mosquito never feeds on blood but feeds only on vegetable sap or fruit juice. The female requires a blood meal every 2 to 3 days for oviposition. The

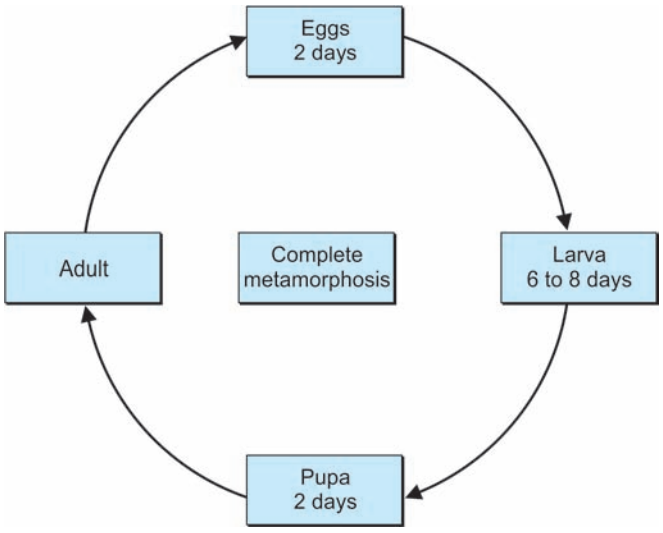
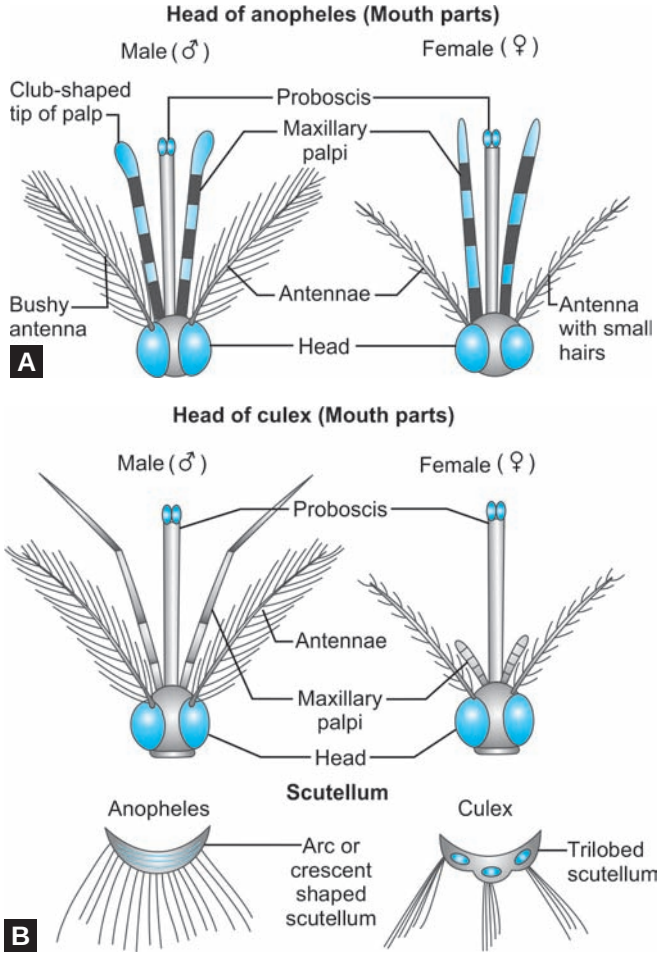


Fig. 15.11 Life-history of mosquito



Figs 15.12A and B Heads of anopheles and culex
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

blood may be obtained from animals (Zoophilic) or humans (anthrophilic). Male mosquitoes are smaller and slender whereas females are larger and aggressive.

Normally, mosquitoes remain concealed in the dark corners of the room and emerge out in the evening or night time in search of food. Outside the dwellings, the mosquitoes rest in shrubs, trees, tree-holes and dark and damp places. They also lurk in cattle sheds, wells, cracks and crevices of walls, roofs etc. Before copulation the males collect in swarms and engage in a 'nupitial dance'; mating generally occurs high up in the air during evening timings. Fertilization usually takes place 12 to 24 hours after the emergence of the young adult, whereupon the female lays eggs which marks the repetition of the life cycle.

Classification of Mosquitoes

Depending upon the morphological and developmental characteristics **(Figs 15.12A and B)**, the mosquitoes are broadly classified into 2 groups, namely Anopheline group and Culicine group. The first group comprises anopheline mosquito and the second group comprises culex, aedes and mansonia mosquitoes. The morphological features of mansonioides and aedes are described in **Figures 15.13** and **15.14** respectively.

The comparative features of these mosquitoes in different stages of life cycle **(Fig. 15.15) (Table 15.3)** are as follows:

Control of Mosquitoes

The various measures of control of mosquitoes can be classified under the following heads:

1. Antilarval measures.
2. Antiadult measures.
3. Personal prophylaxis.

Antilarval Measures

These are grouped into three groups—physical, chemical and biological.

1. Physical measures:

This consists of mainly environmental control measures or modifications in the environment in a manner that discourages the breeding of the mosquitoes or destroys their habitat. This is known as 'Source reduction' (i.e. reduction of the population of mosquitoes at the source itself), which consists of filling and leveling the ditches, drainage of stagnant waters. In situations where stagnant water cannot be disposed of by surface drainage, underground pipes may be used to drain away the water.

Table 15.3 Comparative features of the mosquitoes in their life cycle

Anopheles	Culex	*Aedes*	Mansonia (or monsonioides)
Egg stage			
• Breads in clean, fresh water. Eggs are laid in singles. • Each egg is boat (spindle) shaped. • Egg floats with lateral floats containing air.	• Breeds in dirty, organically contaminated water collections like pits, pools, drains, sewage farms, etc. • Eggs are laid in clusters of 150–200, which are cemented together, in the form of boat shaped mass called 'Egg raft'. Raft helps in floating. • Each egg is cigar shaped. • Eggs have no lateral floats • *Exception:* Culex vishnui group of mosquitoes breed in water containing acquatic plants.	• Breeds in peridomestic artificial collections of water such as broken pots, bottles, tyres, tins, flower pots, flower jars, air-coolers, coconut shells, tree-holes, etc. • Eggs are laid in singles. • Eggs are black in color and do not possess lateral floats. But they possess small air bubble like cavities on the surface, with which they float.	• Breeds in water bodies containing certain acquatic plants like pistia plant and water hyacinth. Eggs are laid in 'star' shaped clusters, attached to under-surface of leaves of water plants. Presence of acquatic plants and organic pollution of water are the two important conditions for breeding of this mosquito. • Each egg is black in color, flask shaped and has pointed ends.
Larva stage			
• Larva floats horizontally parallel to the water surface, with the help of palmate hairs. • Respiratory apparatus (Siphon tube is absent) consists of two openings, in direct contact with the surface of water. • Feeds on the things present on the surface of the water. • Hence it is called 'surface feeder.'	• Larva floats with the head downwards, obliquely from the surface of the water (So it feeds on the things present inside the water. Hence it is called 'bottom-feeder'). • Palmate hairs are scanty. • Siphon tube is long and narrow. • It opens at the surface of the water for respiration.	• Larva remains suspended in the water obliquely with the head downwards like culex larva (So bottom feeder). • Palmate hairs are scanty. • Larva is black in color. • Siphon tube is short and barrel shaped, opens at the surface for respiration.	• Larva floats with the head downwards, like culex larva but it is attached to the roots and rootlets of the acquatic plant with the help of spines of the siphon tube (It utilizes the stored air in the roots and rootlets of acquatic plant). • It goes to the bottom of water for feeding purpose and then again gets attached to the roots. • Palmate hairs are scanty.
Pupa stage			
• 'Comma' shaped structure. • Pupa are suspended in water. • Siphon tubes are short and broad, a pair in number, found on cephalothorax. • Caudal paddles and hairs are seen on the tip of last abdominal segment.	• 'Comma' shaped structure. • Suspended in water. • Siphon tubes, a pair in number, long and narrow, open on the surface of the water.	• 'Comma' shaped structure. • Similar to culex pupa. • Black in color	• 'Comma' shaped structure. • Similar to culex pupa, but attached to the roots and rootlets of the acquatic plants, with the help of spines of the siphon tubes. • Pupa gets detached from the acquatic plants and comes to the water surface only at the time of emergence of the imago, (i.e. young adult).
Adult stage			
• In the resting position, the body (head, thorax and abdomen) is in a line and is inclined at an angle to the resting surface (except *Anopheles culicifacies*). It is called 'Tail in the air' posture.	• In the resting position, the head and thorax are held in an inclined plane pointing downwards and the body is held in horizontal plane parallel to the resting surface, giving a 'Hunch back' appearance.	• In the resting position, aedes mosquito also gives 'hunch back' appearance like culex mosquito. • It appears like culex mosquito in all respects except that it is black in color with alternate white bands.	• In resting position, the mansonia mosquito also exhibits 'hunch-back' appearance. • There are some white dots on the head and dorsum of thorax and white bands on the abdomen and legs.

Contd...

Contd…

Anopheles	Culex	*Aedes*	Mansonia (or monsonioides)
• Wings are spotted (i.e. the veins in the wings posses alternate band of white and dark fringe scales over them). • Scutellum on the thorax is crescent shaped with long hairs at regular intervals. • Maxillary palpi are long in both the sexes, but the tip is club shaped in males and not club shaped in females. • Antennae are bushy and more hairy in males and less hairy in females. • Mosquito makes no noise while flying. • Scales on the abdomen are arranged in a scattered manner.	• Wings are strong and unspotted (i.e. no fringe scales over the veins). • Scutellum is trilobed, each lobe with a group of hairs. • Maxillary palpi are long in males (longer than proboscis) and bent outwards (i.e. acuminate type), the tip being pointed. Palpi are short in females. • Antennae are bushy and more hairy in males and less hairy in females. • Mosquito makes humming noise while flying. • Bites are painful and often causes irritation. • Scales on the abdomen are arranged close together overlapping each other.	Hence it is called 'Tiger mosquito' (Silver spotted mosquito). Legs are also banded. • Wings are unspotted. • Scutellum is trilobed, each lobe with a tuft of hairs. • Dorsum of thorax reveals two 'Lyre' like pattern, white marked, i.e. two outer curved lines (bracket shaped) and two median parallel lines. • Maxillary palpi are long in males and short in females. • Antennae are bushy in males and less hairy in females. • Antennae are also black with white bands (stripes). • Mosquito does not make any noise while flying and the bites are also not painful. Female mosquito bites during day time mainly.	• Wings are unspotted. But veins have dark fringe scales scattered in an indiscriminate fashion, like pepper powder thrown on white background. • Scutellum is trilobed, each lobe with a tuft of hairs. • Maxillary palpi are long in males and short in females. • Antennae are more hairy in males and less hairy in females. • Makes no noise while flying and bites are also not painful.
Important species			
• *Anopheline culicifacies* • *Ano. fluviatilis.* • *Ano. sundaicus.* • *Ano. stephensi.* • *Ano. minimus.* • *Ano. philippinensis*	• *Culex quinquefasciatus* • *Cu. vishnui* • *Cu. pseudo vishnui* • *Cu. gelidus* • *Cu. tritaenyrhincus*	• *Aedes aegypti* • *Aedes albopictus* • *Aedes vittatus.*	• *Mansonioides annulifera* • *M. uniformis* • *M. Indiana* • *M. longipalpis*
Diseases transmitted (by infective female mosquito)			
• Malaria	• Filariasis caused by *Wuchereria bancrofti* and transmitted by *Cu. quinquefasciatus* • Japanese encephalitis by *Cu. vishnui* and tritaeniorhynchus	• Yellow fever • Dengue fever • Chickungunya fever	• Filariasis, caused by *Brugia malayi*
Control measures (antilarval measures)			
• Filling and drainage of breeding places. • Overhead tanks are kept clean and dry for one day in a week. • Malarial oil was used to destroy the larvae and pupae. • Paris green is used to destroy the larvae of anopheline mosquito because they are surface feeders.	• Proper drainage and disposal of sewage and waste water. • Oiling of breeding places once in a week by using diesel oil. • Paris green can be used to kill bottom feeders, when used in the form of pellets or granules	• Artificial containers are turned upside down to drain away the water. Waste containers are collected and disposed off in a far off place. • Oiling is not useful. • Paris green not necessary.	• Physical removal of acquatic plants or use of herbicides. • Oiling is not useful. • Paris green can be used in the form of pellets or granules.

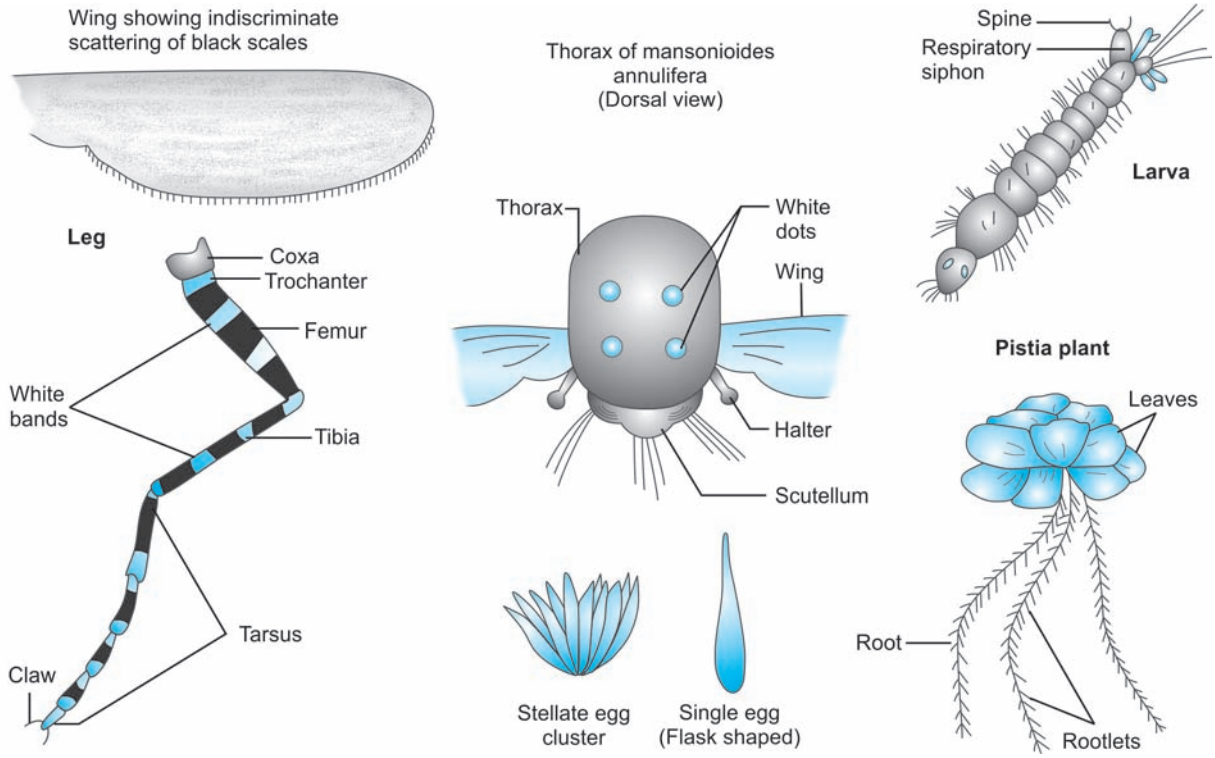


Fig. 15.13 Mansonioides

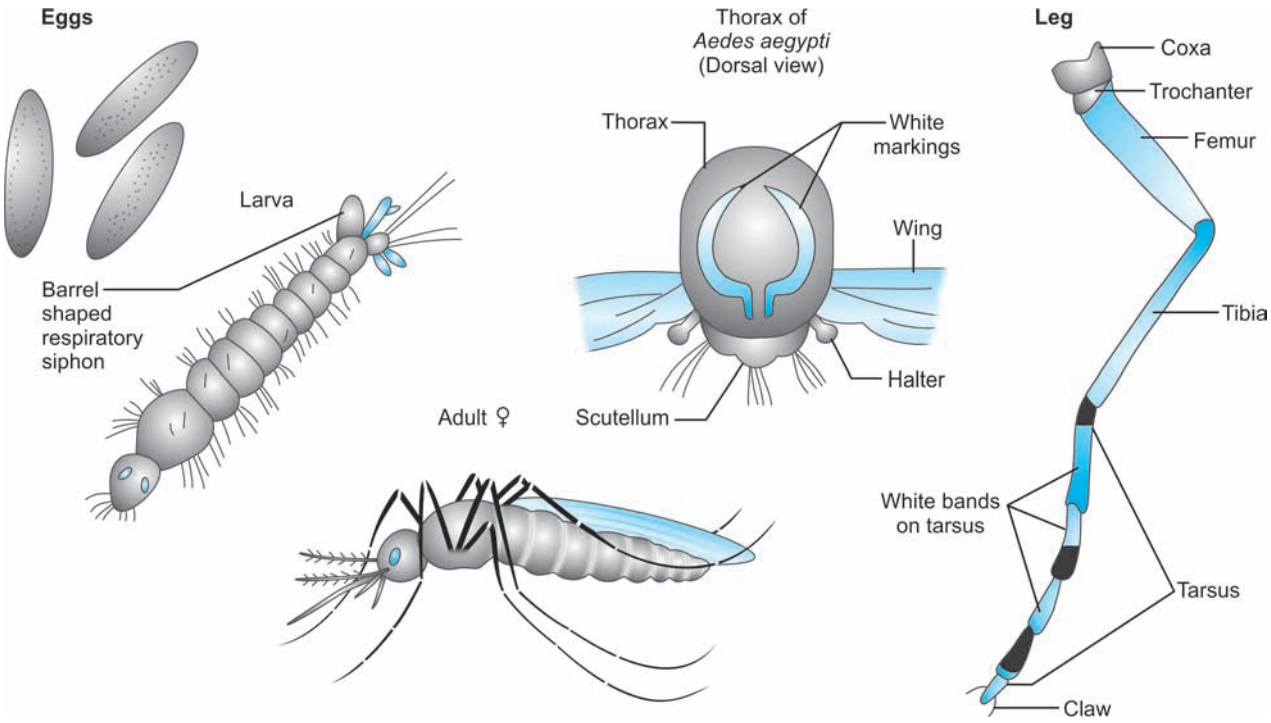


Fig. 15.14 *Aedes* (Stegomyia)

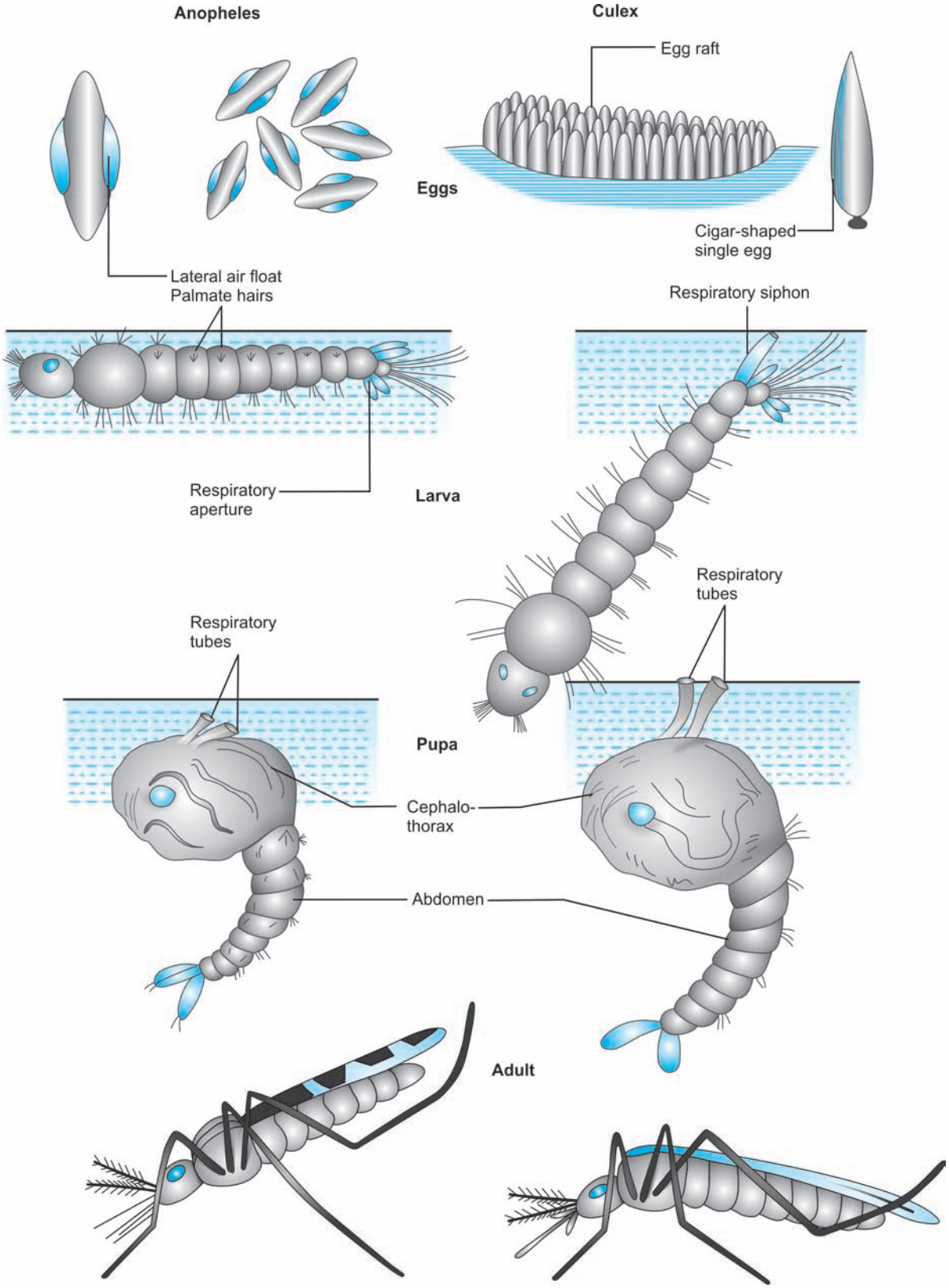


Fig. 15.15 Differences in the various stages of anopheles and culex
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Source reduction method differs depending upon the type of the mosquitoes to be controlled as follows:

- If anopheles are the problem, filling and drainage of stagnant water has to be done. In urban areas, the overhead tanks should be kept clean and dry for at least one day in a week.
- If culex are the problem arrangements should be made for disposal of sewage and waste water.
- If aedes mosquitoes are the problem, the water holding containers which are all in and around the houses such as broken pots, bottles, coconut shells, tins, etc. are all removed and the environment around the house is kept clean.
- If mansonioides mosquitoes are the problem, the aquatic plants have to be removed or destroyed by using herbicides.

Usually these physical measures provide permanent results.

2. Chemical measures:

The commonly used methods are oiling, paris-green and larvicides.

i. Oiling: The application of mineral oil to the water is a good old and accepted method of control of mosquito larvae. The commonly used oils are kerosene oil, fuel oil, diesel oil, malariol (malarial oil) aromex oil, etc.

These oils when sprayed on water surface, reduces the surface tension of water and forms a film over the water and cuts off air supply to not only larvae but also pupae of all types of mosquitoes, which come to the surface for breathing. Actually the oil penetrates into the respiratory (siphon) tube of larvae and pupae, clogs them resulting in choking or suffocation and killing them. Oiling is repeated once in a week.

Oiling has no effect on larvae and pupae of mansonia mosquitoes because they are attached to the roots and rootlets of aquatic plants for respiration and do not come to the surface.

Kerosene oil is preferred because of its remarkable spreading property over water. Malarial oil is a special oil introduced in India by Burma oil company.

However it is to be remembered that while oiling kills fish also, it renders the water unfit for drinking purposes and its effects get compromised by blowing winds, which break the oil film.

Use of oil to control larvae and pupae of the mosquitoes was first put into practice by Howard in USA in 1892.

ii. Paris green: It is copper aceto-arsenite, bright, emerald green colored powder, insoluble in water but soluble in dilute acids. It is harmless for man, fish or domestic animals in the proportion applied as larvicide.

Paris green as such is not used but mixed with inert materials like soap powder, slaked lime, ash, talc powder, charcoal powder, etc. in the proportion of one part of paris green with 99 parts of any inert powder which will give 1% Paris green mixture. The mixing is done preferably in a rotary mixture. The mixture is dusted on water surface with the help of hand blowers or rotary blowers (sprinklers). This is called 'dusting' method.

The inert powder sinks to the bottom of water leaving the Paris green powder particles to float on the surface. Anopheline larvae being surface feeder, they ingest paris green, which is a stomach poison and die due to the effect of arsenic poison. Paris green has no action on the larvae of culicine group of mosquitoes (such as culex, aedes and mansonia) which are all bottom-feeders and also no action on pupae which are in the resting stage.

Since the larval stage lasts for one week, weekly application of Paris green regularly will help in control of anopheles mosquitoes.

However, in the form of fine pellets or granules, paris green can also be employed to destroy the larvae of culicine group of mosquitoes but not preferred.

iii. Larvicides: Most effective larvicides are abate, fenthion, and chlorpyrifos. They are organophosphorus compounds. Organochlorine compounds are least effective.

- **Abate or temephos:** It is a potent larvicide but a poor adulticide. Being low in toxicity it is used as larvicide in artificial water reservoirs and domestic water containers for controlling breeding of aedes mosquitoes in a concentration of 1 ppm and also to control larvae of *Ano. stephensi* in wells.
- **Fenthion:** It is a colorless oily liquid, insoluble in water but soluble in organic solvents. It is a contact and stomach poison with good penetration power and residual action. Fenthion is a broad spectrum insecticide which is effective as a larvicide, particularly against the larvae of culex mosquitoes.

3. Biological measures:

This consists of using larvivorous (or larvicidal) fish, which feed on the larvae of the mosquitoes. There are two types of fish—the surface feeders and bottom feeders. Only the surface feeder fish are helpful in controlling the mosquito population.

Gambusia affinis, Haplochilus panchax and *Lebister reticulatus* (often called *Barbados millions*) are very useful, specially *G. affinis*. It is used to control anopheline mosquitoes in the wells. It has prolific breeding potential. It can survive even in adverse environmental conditions and thrive even in polluted waters. However it is to be considered that oiling of the water can cause suffocation of the fish and the aquatic vegetation can restrict the movement of fish. Therefore it is important that breeding places should be deweeded before the introduction of the fish and no oiling should be done in the presence of fish.

Before the introduction of Gambusia fish, the predatory fishes should be removed after killing them by superchlorination. After the superchlorination effect wanes off, both male and female Gambusia fish should be introduced in the ratio of

1:3 respectively. A dozen fish is enough for an ordinary well. *Gambusia affinis* is an American introduced fish. It is thriving well in all parts of India. So it is the fish of choice.

The indigenous larvivorous fish are *Haplochilus panchax* and *Lebister reticulatus*. These do not get acclamatized in all types of water and mortality is great.

Antiadult Measures

These are of two methods—use of insecticides and genetic control methods.

1. **Insecticide method:** This consists of using insecticides to kill the mosquitoes by spraying in their resting places like dwelling houses, cattle sheds, pigsties, etc. Frequency of spraying depends upon the insecticide used.

The insecticides are grouped into four groups—organochlorine, organophosphorus, carbamate and botanical insecticides.

a. **Organochlorine compounds:** DDT, BHC, dieldrin, chlordane, methoxychlor, etc.
   - **DDT (Dichloro-Diphenyl-Trichloroethane):** The insecticidal property was first discovered by a Swiss scientist, Paul Müller in 1939. It is a white or nearly white, amorphous powder, having a faint aromatic odor, insoluble in water but soluble in organic solvents like toluene, xylene and even kerosene. The active principle responsible for insecticidal property of DDT is 'Para—para isomer.' It is present to the extent of 70-80 percent in DDT.

     When DDT is completely soluble, as in oils like kerosene or petrol, it becomes a solution.

     When it is partially soluble, as in aromex oil, it becomes an emulsion.

     When it is not soluble at all (insoluble) as in water, it becomes a suspension.

     DDT 5 percent suspension is employed to control mos-quitoes and in 10% strength, it is used to control other insects like lice, fleas, bugs and ticks.

     DDT is a contact poison. When the mosquito rests on the DDT sprayed surface, DDT is absorbed through the cuticle of the legs, acts on the nervous system, resulting in convulsions, paralysis and death. It does not result in rapid knock down effect but takes several hours to kill. DDT is a residual insecticide. The residual action lasts for about 6 months.

     In the middle of the 20th century, DDT was extensively used for the control of mosquitoes. But continued use of DDT *resulted in cumulative* toxic effects in man, on one hand and the development of resistance of the various arthropod vectors, on the other. This reduced the scope of DDT as an insecticide and gave impetus to the development of alternative insecticides like organophosphorus compounds to overcome the resistance.
   - **Benzene hexa chloride (BHC):** The insecticidal property of this substance was discovered much before than that of DDT in 1933. It is a white or chocolate (light brown) colored powder with a musty smell, irritating to the eyes, nose and throat. It has several isomers of which the 'gamma-isomer' is the most active principle. The technical hexachloro-cyclohexane (HCH) contains 13 to 16 percent of the gamma isomer. Pure HCH containing 99 percent of gamma isomer is called 'Lindane' or 'Gammexane' or 'Gamma HCH.'

     Basically it is also a contact poison, a residual insecticide, the residual action lasts for about 3 months only, because it is volatile. Since it is slightly volatile, it acts as a fumigant also. It is more toxic to insects than DDT and it acts more rapidly than DDT.
   - **Dieldrin:** It is a crystalline solid, light brown in color with a characteristic odor, insoluble in water but soluble in organic solvents. It is more stable than DDT. Its effect lasts upto one year or even more. It is more toxic also.

b. **Organophosphorus compounds:** Malathion, parathion, fenthion, dichlorvos, chlorpyrifos, abate, diazinon, etc.
   - **Malathion:** It is an yellow or brown colored liquid with an unpleasant smell. It is also available as powder. It is a contact poison. It is least toxic to any other organophosphorus compound but more effective than DDT. It is used against those insects resistant to organochlorine compounds. It is used both as an indoor and as an outdoor insecticide. It is used as an 'Ultra Low Volume' (ULV) spray specially in the control of diseases like Dengue fever and Japanese encephalitis. It is also used for disinfestations of animals infested with lice, fleas, ticks and mites.
   - **Parathion:** It is extremely toxic insecticide and highly effective in the control of wide range of arthropods. It is a contact and stomach poison. It has some fumigant action also. It is insoluble in mineral oils but slightly soluble in water and completely soluble in xylene and benzene. Because of its toxic effects, it may be used in outdoor situations to kill resistant mosquitoes.
   - **Diazinon:** It is a colorless, liquid, having a peculiar faint odor. It is moderately toxic, in between that of malathion and parathion. It is a contact poison. Since it is volatile, it acts as a fumigant also. It is quite effective against mosquitoes, houseflies, bed-bugs and ectoparasites of domestic animals.
   - **Dichlorvos:** It is a pleasant smelling, colorless liquid soluble in water and organic solvents. Being highly volatile, it acts mainly as a fumigant. A special advantage is that it can be combined with solid substances such as wax and can be formulated as tablets and successfully used for disinfection of air crafts.
   - **Abate and Fenthion:** Explained under larvicides.

c. **Carbamates:** Propoxur, carbaryl.
   - **Propoxur:** This is a broad spectrum insecticide. It is insoluble in water but soluble in organic solvents. It is successfully used to control a wide range of arthropods such as mosquitoes, flies, fleas, bugs, cockroaches, etc. on a large scale. It is used in hostels, hotels, bakeries, store rooms, ware houses, barracks, ships, air-crafts, etc.
   - **Carbaryl:** This is a non-specific insecticide, effective against a wide spectrum of arthropods and is specifically used for disinfecting animals. Carbaryl is quite effective against ticks, fleas, bugs and cockroaches.

d. **Botanical insecticides:** These are pyrethrum, pyrethroids, rotenone and rotenoids.
   - **Pyrethrum and pyrethroids:** Pyrethrum is an insecticide. It is an extract of flowers of *chrysan-themum cinerariafolium*. The insecticidal activity of these flowers is due to the presence of 5 active principles, namely Pyrethrin I and II, Cinerin I and II and Jasmoline. These active principles are extracted by soaking the dried powdered flowers in kerosene oil for 3 days. The ready to spray solution is formulated as dusts, aerosols, emulsions, solutions, mosquito coils and fumigant mats. Pyrethrum preparations are powerful poisons. They have rapid: 'knock-down' effect, resulting in death, by suffocating the mosquitoes.

     Therefore, they are used as 'Space-spray'. Spraying is done once a week. As a space-spray, fine atomization of the spray solution is necessary and the doors and windows should be kept closed for ½ hour after spraying. Pyrethroids are synthetic compounds having almost 10 times as powerful as natural pyrethrum. Important pyrethroids are tetramethrin, allethrin, resethrin, furethrin, deltamethrin, cypermethrin, permethrin and cyclethrin. Both pyrethrum and pyrethroids lack residual insecticidal effect.
   - **Rotenone and rotenoids:** Rotenone is obtained from the roots of leguminous plants of Derris and Lonchocarpus genus. The important species are *Derris elliptica* and *D. malaccensis, Lonchocarpus utilis* and *L. urucu*. The roots are dried and powdered. It is used for the control of ectoparasites of animals (ticks, mites, lice and fleas). These insects develop paralysis and die.

2. **Genetic control methods:** This consists of reduction (or loss) of the reproductive capacity of the mosquitoes. Several approaches which are under research phase are sterile male technique, hybrid male technique, (Chromosomal aberrations or translocations technique) sex distortion and gene replacement. Out of these, the first two appear to hold promise.

In sterile male technique, the male mosquitoes are partially or completely sterilized by exposing them to radiations or feeding them on chemosterilizing agents. The sterilized mosquitoes, when released on large numbers, monopolize the mating process by competing with normal males and thereby interrupt the fertilization of female mosquitoes by normal fertile males. This in due course reduces the mosquito population.

Similarly, in hybrid male technique, chromosomal aberrations are affected in the male mosquitoes, when released in large numbers, they compete with normal males in the mating process with similar results.

These are advantageous over chemical methods in that they are cheaper and more efficient and above all not subject to vector resistance.

Personal Protection

Measures of personal protection have no role in the control of mosquitoes or any arthropods. They simply disallow the access of mosquitoes to man thereby prevent the transmission of mosquito borne diseases. These are all defensive measures. These include use of mosquito nets, screening of buildings and use of repellants.

a. **Use of mosquito nets:** Sleeping inside the mosquito nets provides protection against mosquito bites and other biting insects during night times. The net cloth should be preferably white, so that the mosquitoes will be visible. Net should be tucked under mattress all around for adequate protection. There should not be a single hole or rent in the net. The net should have at least 150 perforations per sq. inch.

Insecticide treatment procedure of bed-nets:

1. Surface area of net in $m^2 = 2 (a + b) + c$,
   where a = length × height,
   b = height × width
   c = length × width.
2. Quantity of insecticide for target dose of 25 mg/m^2, of synthetic pyrethroid Deltamethrin (2.5%) in grams.
   Quantity in grams = Surface area of net in $m^2 \times 0.025$
3. Volume of formulation (mL) required =

$$\frac{\text{Weight (Quantity in grams)}}{\text{\% formulation of insecticide}} \times 100$$

Example, find the volume of formulation required to treat a mosquito net of 10 m^2 using 2.5 percent formulation of Deltamethrin.

$$\text{Vol} = \frac{(10 \times 0.025) \times 100}{25} = 10 \text{ mL}$$

with similar results

Note: Instead of 2.5 percent Deltamethrin, 5 percent Cyfluthrin can also be used.

4. The quantity of the insecticide is then mixed with cold water wearing gloves, to prepare a solution.
5. The absorbing capacity of the net is determined by subtracting the left over water from the total quantity of the solution.

6. The net is then dried in the shade and never in sunlight.
7. The left over water is discharged into sewage drain or latrine but never in the water body or drinking water source.
   b. **Screening of buildings:** Screening of doors, windows and ventilators of the buildings preferably of galvanized iron or aluminium mesh, protects the inmates by warding off the flies and mosquitoes and prevent their entry inside the houses. Screens should have apertures measuring 0.04 to 0.05 sq. inch in diameter. Eventhough it is a costly measure, it gives excellent results.
   c. **Repellents:** These repellents when applied over the exposed parts of the body, drive away the mosquitoes on coming near the person for biting. Since the repellents are volatile, they are short acting for 2 to 3 hours. So application must be repeated. The repellants do not produce blister or any reaction. So can be applied liberally.

The common repellents are oil of citronella, effective for about two hours, vanishing cream of Dimethyl pthalate, Diethyl toluamide (DEET) Dimethyl carbate, Ethyl hexanediol, Indalone, etc. are effective for about four hours. They are applied before going to sleep.

Use of mosquito coils or pyrethrum coils which when burnt will effectively keep away the mosquitoes.

Use of fan at full speed will also repell the mosquitoes.

Remote Sensing in Vector Control

It means sensing the vector (or any object) from a distance. The principle of Remote Sensing rests on the fact that every object absorbs some part of radiation received from sunlight, depending upon its physical and chemical properties, and reflects the remaining part in a specific wavelength of the electromagnetic spectrum. This reflected energy is channelized through a telescope to the sensors present on board of the satellites.

The sensors convert the light energy into electrical voltages producing two dimensional discrete pictures, thus making it possible to monitor changes in land use features like water bodies, vegetation, mosquito density, etc.

Remote sensing has application in urban development, road network, forests, soil mapping, geology, crop estimation, detection of fire in forests, mines, oil sleek in sea, etc. Such data is generated in National Remote Sensing Agency, Hyderabad in India.

Remote sensing is likely to become a rapid epidemiological tool for surveillance of vector borne diseases and malaria in particular. Coupled with Geographical Information System (GIS), statistical analysis, knowledge on ecology of mosquito vector populations, improved remote sensing will play a key role in the macrostratification of vast malarious area for prioritizing the control measures in a cost effective way.

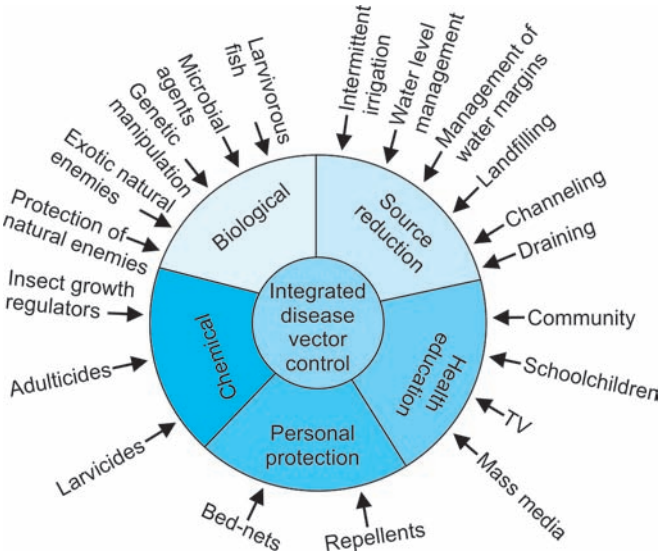


Fig. 15.16 Integration of various potential methods for control of disease vectors

Integrated Vector Control

This approach of controlling the vectors consists of combining two or more vector control methods, whether these are directed only on the larvae or adults or both in order to obtain maximum results with the minimum effort and to avoid the excessive use of any one method **(Fig. 15.16)**.

Integrated vector control is defined as 'the utilization of all appropriate technological and management techniques to bring about an effective degree of vector suppression in a cost-effective manner'.

This strategy has come out because of the following problems encountered with the prolonged use of insecticide chemicals:

- Technical problems such as development of resistance, to older insecticides
- Financial problems such as cost of newer insecticides
- Environmental problems such as environmental pollution by insecticides
- Operational problems such as lack of public cooperation for the spraying of insecticides in their houses, etc.

FLIES

Next to mosquitoes, flies are also winged insects. The flies of medical importance are Housefly, Sandfly, Tsetse fly and Blackfly.

Housefly (Musca Domestica)

This is another common insect living very close to human beings, because of two important reasons—the human excreta

and animal dung is an excellent breeding place for that and the human food is also used as food by the housefly. They are very active during day time and during summer season, when the humidity is low. Since the life cycle is completed within 5 to 6 days, minimum five generations are produced in one month resulting in enormous population and transmission of diseases. Usually house flies are non biting insects. The average life span of the housefly is 2 to 3 months but during summer it is reduced to 2 to 3 weeks.

The housefly has the habit of defecating constantly wherever it rests and also vomits alongwith the saliva on the food substance, make a solution and sucks the liquid food. Lizards and spiders are the natural enemies of the housefly.

Presence of houseflies is a sign of insanitation and their number as an index of intensity of insanitation. It is a filthy insect, acts as a mechanical vector and transmits the diseases by contaminating food and water. The important species are Musca domestica and Musca vicinia.

Housefly is a typical winged, insect, bigger and stouter than mosquito, mouse-gray in color, measuring about 7 mm in body length and wings of about 14 mm, having a well demarcated head, thorax and abdomen **(Fig. 15.17A)**.

Head

It is broader than its length, possessing a pair of large compound eyes, (which in the males are closely set and widely set apart in females) a pair of antennae and a median retractile proboscis. The proboscis has an oral disc at the tip, which is adopted for sucking liquid foods.

The antennae are made up of 3 segments, the last terminal segment bears a projection called Arista bearing stiff hairs called spinules. The arista is sensory in function **(Figs 15.17 B to D)**.

Thorax

The thorax has 4 stripes longitudinally on the dorsal surface, which is characteristic of the genus Musca. Thorax bears a pair of wings dorsally, a pair of halters at the base of wings and three pairs of jointed legs ventrally. Each leg is five segmented, the last segment terminates in a pair of claws and food-pads (pulvilli), which enable the fly to walk even on highly polished surface. The legs and the body are covered with small brush like hairs and the hairs on the pulvilli are called 'tenent' hairs, which are covered with an oily secretion and the pathogens get attached to them easily **(Figs 15.17E and F)**.

Abdomen

The abdomen is segmented. It shows light and dark markings, the pattern helps in differentiating the species. Though there are 8 segments in male and 9 segments in female housefly, yet only 4 segments are visible in either sex. The posterior part of the abdomen in female, bears an organ called 'ovipositor', which helps in depositing the eggs.

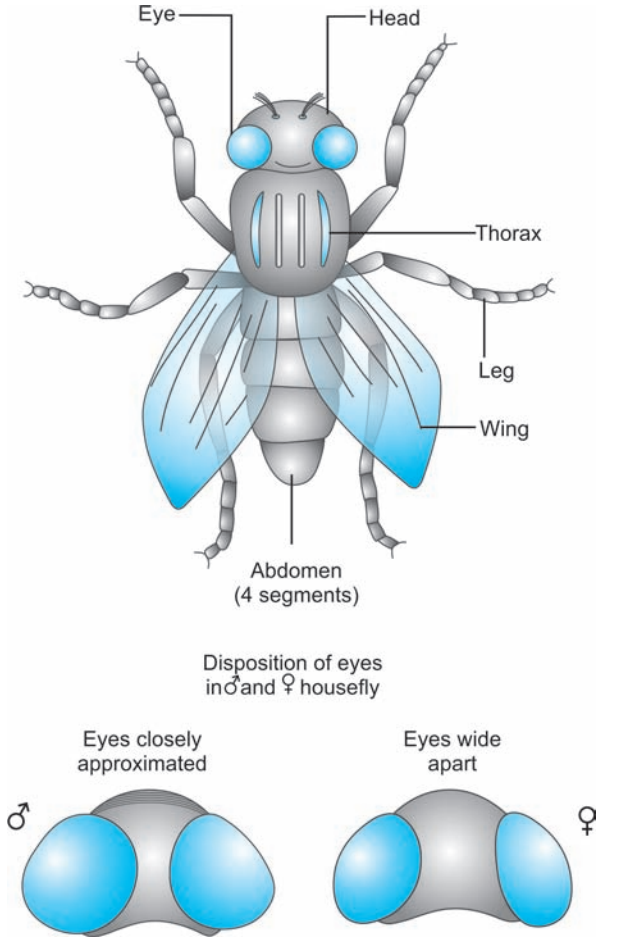


Fig. 15.17A Housefly (Musca)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

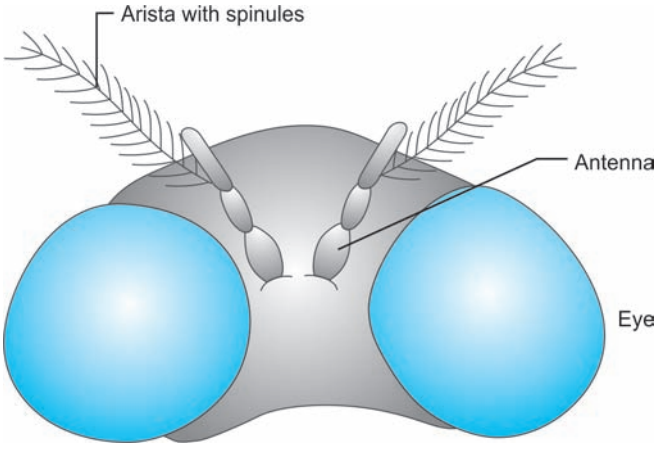


Fig. 15.17B Head of housefly enlarged to show antenna
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

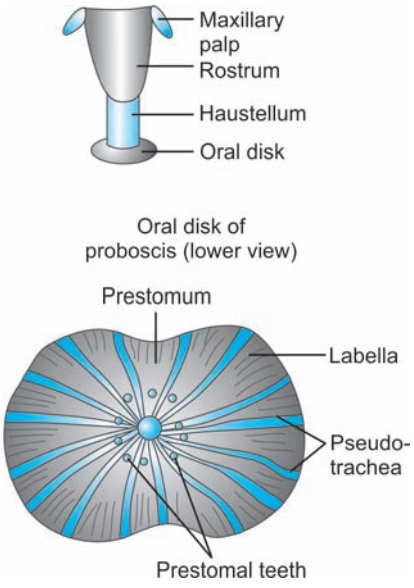


Fig. 15.17C Proboscis of housefly
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

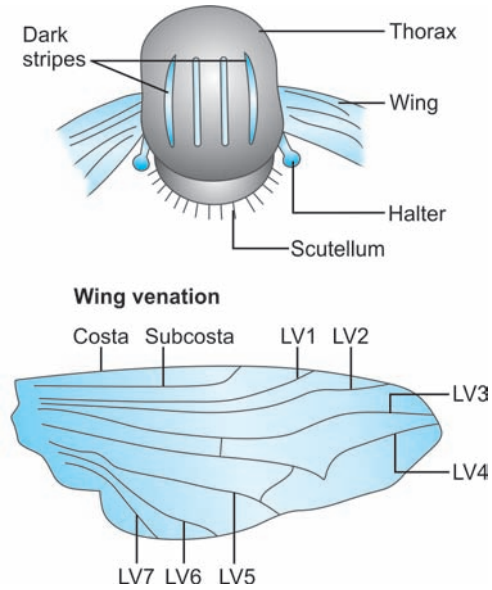


Fig. 15.17E Thorax of housefly (Dorsal view); LV—longitudinal vein 1 to 7
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

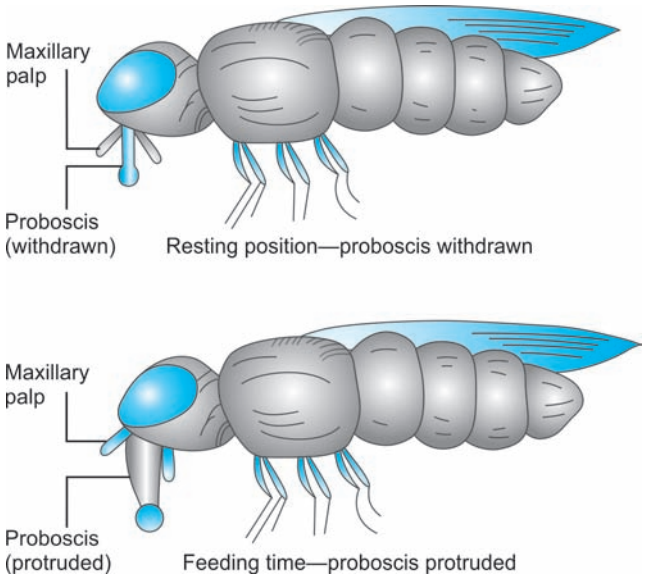


Fig. 15.17D Housefly
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

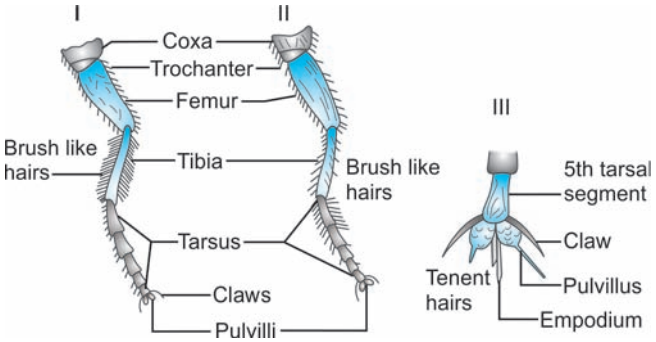


Fig. 15.17F Foreleg of housefly, hindleg of housefly, fifth tarsal segment of leg to show tenent hairs
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Life Cycle

The commonest breeding places are heaps of cowdung and dung of other animals like horse, buffalo, sheep, etc. The other places are collections of manure, refuse, human night soil, sludge removed from cesspools, etc. Maximum breeding takes place in animal dung, because it retains moisture for a number of days, which is an important factor. If moisture is present in refuse due to addition of kitchen waste, it also becomes an excellent breeding place. Any fermenting and excrementous organic matter is a breeding place for the houseflies.

Life cycle shows complete metamorphosis, having four stages, namely egg, larva, pupa and adult **(Fig. 15.18)**.

Egg: The gravid female housefly lays eggs in 5 to 6 batches, each batch consisting of about 150 eggs. The eggs are laid in moist decaying organic matter. Totally about 900 eggs are laid in its life time. The eggs are creamy white in color, oval or cylindrically shaped, about 1 mm in length, resembling rice

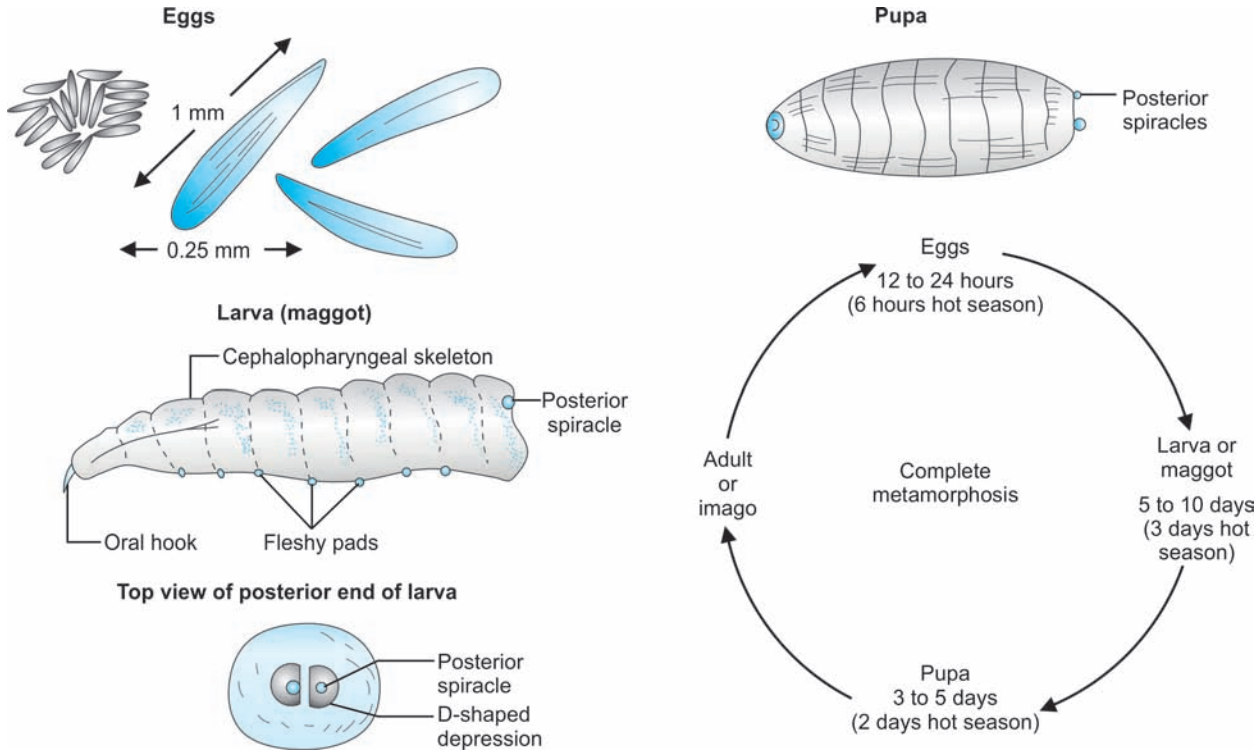


Fig. 15.18 Life-history of housefly
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

grains. Normally the egg-stage lasts for about 12 to 24 hours, but during summer season it is reduced to about 6 hours.

Larva: These are also called 'maggots'. Larva comes out of the egg. The maggot is footless, hairless, moves actively with fleshy pads, present on the ventral surface. They are narrow anteriorly and broad posteriorly. They eat voraciously. They feed on fluids. Each larva measures about 1 cm. They resent light and so remain concealed during day time and active during night times. They moult twice.

Since the center of the manure heap is very hot, the larvae are generally found just below the surface of the heap. This stage lasts for about 8 to 10 days but during hot season it is reduced to 3 days. The fully grown larvae migrate towards compact, dry soil for pupation.

Pupa: In this stage, larvae empty their alimentary canal, stop feeding and assume an inactive existence and transform into brown colored barrel shaped pupa measuring about quarter of an inch. They move vertically up to the surface of the soil just before the emergence of the adult. This stage lasts for about one week and two days in hot season.

Adult: At the end of the pupal stage, a slit appears in the pupa and the young adult fly emerges out and flies away. Thus the life cycle is completed within about a week in hot season and about two weeks in cold season.

Bionomics

House flies are restless insects, keep on oscillating between food and filth, thus are cosmopolitan in their food habits. The housefly consumes both solid and liquid food. While the liquid foods are directly sucked in, the solid foods are first liquified by scrapping the solid food with prestomal teeth and then depositing (vomiting) saliva, thus converting into liquid food then consumes the food by lapping and sponging. Housefly spits and defecates simultaneously contaminating the food with a variety of disease agents including bacteriae, viruses, protozoa, ova and cysts.

Quite oddly, house flies are conscious of their 'cleanliness', whenever at rest, they are seen cleaning their proboscis by forelegs and their abdomen by hind legs. In the process they succeed in smearing their bodies with infective material.

By their filthy habits and close association with man and his food, house flies act as mechanical vectors of immense public health importance.

Mechanism of Transmission of Diseases

The diseases are transmitted by external and internal carriage system.

External Carriage System

In this system the pathogens are carried by the fly on its body mechanically. The factors favoring mechanical transmission are wet and sticky oral disc, brush like hairs on its legs, tenent hairs of the pulvilli covered with oily secretion.

Internal Carriage System

As the housefly swallows the foods, it swallows the pathogens also, which are retained in the alimentary canal. These pathogens will come out through vomit-drop and excreta (i.e. fly specks). Vomit drops contain more pathogens than fly-specks. Therefore vomit drops are more important from the point of transmission of diseases.

As a mechanical vector, the diseases transmitted by the housefly are, typhoid, para-typhoid, cholera, diarrheas, dysentery, poliomyelitis, viral hepatitis A, which are all excremental diseases. The non-excremental diseases transmitted are trachoma, yaws, acute conjunctivitis and anthrax.

Myiasis is a condition of parasitization of human tissues with dipterous larvae (maggots), which feed on dead or living tissues. The maggots attach three main parts of the body-skin (bedsores), body cavities (nose, eyes and ears) and gut and urogenital system.

Control Measures

A. **Improvement of environmental sanitation:**
(Corrective measures)
This consists of the following measures to eliminate their breeding places:
- Disposal of human faeces by underground drainage system.
- Proper and speedy disposal of refuse and garbage by incineration, composting or sanitary landfill.
- Provision of sanitary latrines.
- Discouraging open air defecation.
- Sanitary disposal of animal excreta.
- Quick removal and burial of remains of slaughter houses.

A clean house with a clean surrounding is the best answer to the fly problem.

B. **Control of houseflies:** This is done by the following offensive measures:
a. *Antiadult measures*:
- **Insecticidal use:** Use of organophosphorus compound or pyrethrum extract mixed with kerosene, when used as spray will destroy the house flies. Special care is taken to cover food and water containers.
- **Use of baits:** Baits in the form of powder poisoned with organophosphorus compounds are very effective in killing the house flies.
- **Tangle foot poison bait:** The cotton wool soaked in a mixture of milk and formalin (one pint of milk with 3 spoons of 40% formalin) is placed on a flat container. Milk attracts the house flies and formalin kills them.
- **Trapping:** A mixture of resin, groundnut oil and vaseline is smeared over both sides of a paper or ribbon and hung like festoons from ceilings. Since the fly-paper is sticky and resin attracts the house flies, they get stucked up and ultimately die.
- **Use of fly swatter:** It has a handle to hold and a mesh of 5' × 6', used to kill the houseflies physically in the houses, hospitals, etc.

b. *Antilarval measures*:
- Spraying organophosphorus insecticides like diazinon, dichlorvos, dimethoate over the breeding places can be done. But it is only a supplementary process and not a substitute for the sanitation.
- Escaping larvae from the breeding places like manure heaps, can be trapped and destroyed by open water channel or drain.
- Proper composting of rubbish and refuse also controls larvae.

c. *Defensive measures*:
- Screening of doors and windows of the houses with wire mesh.
- Food hygienic measures by covering meat, milk, sweets, etc.
- Air conditioning of the houses by those who can afford it.
- Use of housefly repellent like Flit, Listerine, etc.

Sandfly

It is a light, brown colored, very hairy insect, smaller than mosquito. About 30 species are found in India but important ones are *Phlebotomus argentipes*, *Ph. sergenti* and *Ph. papatasi*.

Eventhough they are winged insects, they do not fly but only hop from place to place with the help of their large, slender and disproportionately longer legs. They inhabit the domestic and peridomestic areas taking shelter during day time in cracks and crevices of the walls in dark rooms and appear during night times. Only female sandflies bite, as they require blood meal for laying the eggs. The bite is irritating and painful. It can bite even through thin clothes like socks and night clothing. They prefer to bite wrists and ankles. Since they are smaller than mosquitoes, they can easily pass through the routine mosquito nets used.

Public Health Importance

The different species and the diseases transmitted are as follows:

Species	*Diseases transmitted*
• *Phlebotomus argentipes*	– Kala-azar (caused by *Leishmania donovani*)
• *Ph. papatasi*	– Sandfly fever, (viral fever) oriental sore
• *Ph. sergenti*	– Oriental sore (or Tropical sore) (Caused by *Leishmania tropica*)
• *Ph. intermedius*	– Espundia (Mucocutaneous leishmaniasis)

Other diseases reported in S. America are Espundia (or Nasopharyngeal leishmaniasis) and Carrion's disease.

Morphology **(Figs 15.19A to C)**

The body of the sandfly consists of three parts—head, thorax and abdomen.

- **Head:** The head bears a pair of large, prominent, black eyes, a shaggy median proboscis, a pair of maxillary palpi and a pair of antennae, which are multisegmented, possessing whorl of hairs at each segment and there is no difference between male and female antennae unlike in mosquitoes.
- **Thorax:** Thorax bears a pair of wings dorsally and three pairs of legs ventrally. The wings are densely hairy, lanceolate (elliptic) in shape and are typically held up vertically in 'V' shape while at rest. Each wing has 6 longitudinal veins, the second one divides twice, the first branch takes place in the middle of the wing. This is a characteristic feature of the genus Phlebotomus. The legs are long and slender, hairy, disproportionate to the size of the body and adopted for hopping or jumping.
- **Abdomen:** Abdomen has ten segments, covered with hairs, 8 are visible and the last two are modified into genitalia.

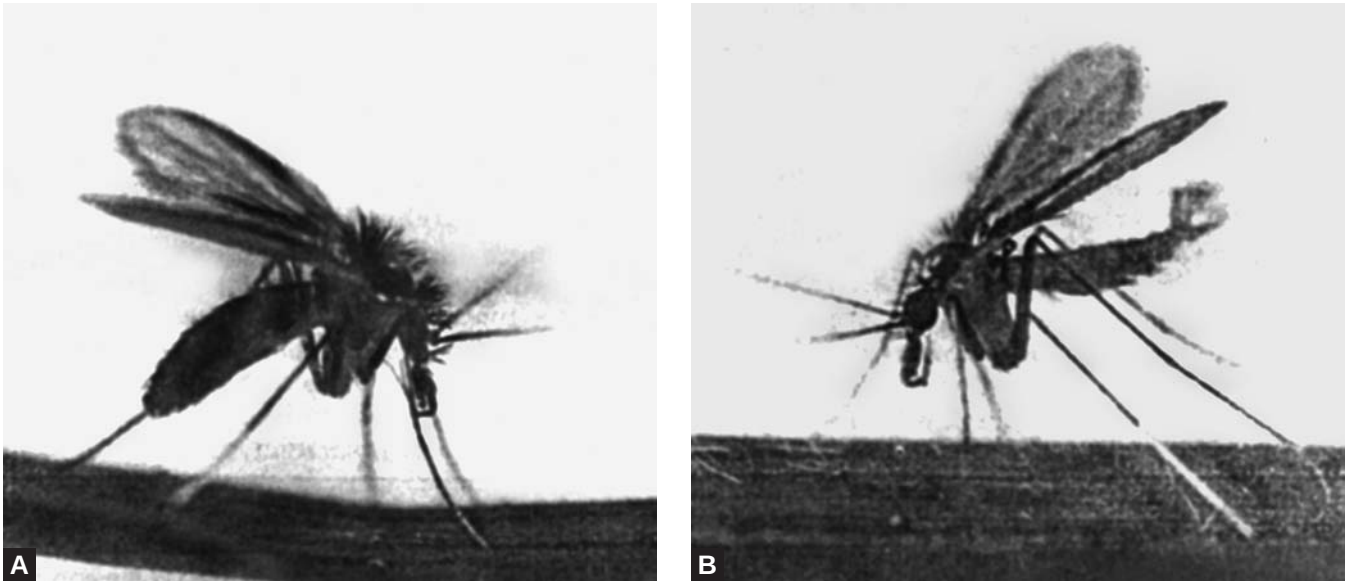
Thus sandflies differ from mosquitoes in that they are smaller, hairy, wings are lanceolate shaped, second vein branches twice, the first branch taking place in the middle of the wing, legs are abnormally longer, adopted for hopping and the sandflies do not fly by choice.

Life History

This occurs in four stages: egg, larva, pupa and adult. Thus the metamorphosis is complete.

Egg stage: Three important factors are required for the gravid female sandfly to lay eggs. These are presence of moisture, organic matter and aeration of the soil. In that way, the backyard of the houses and the ground near cattle sheds and the like constitute the peridomestic breeding place. The dust accumulations with moisture and organic matter in the cracks and crevices of the walls of the houses constitute intradomestic breeding place. Eggs are whitish in color when laid, become dark colored after few hours. They are bigger in size compared to that of mosquitoes and houseflies. They are torpedo shaped with longitudinal striations on the surface. This stage lasts for about one week after which the egg hatches and larva comes out.

Larva stage: The larva is a footless, hairy, maggot with a distinct head, thorax and abdomen. Head possesses a pair of mandibles but eyes are absent. Thorax has three segments, and legs are absent. Abdomen consists of nine segments.



Figs 15.19A and B Living female (left) and male (right) phlebotomine sandflies (Lutzomyia longipalpis), showing the hairy body and wings, the generally mosquito-like stance and appearance except for the characteristic position of the wings, held in a V over the back

Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

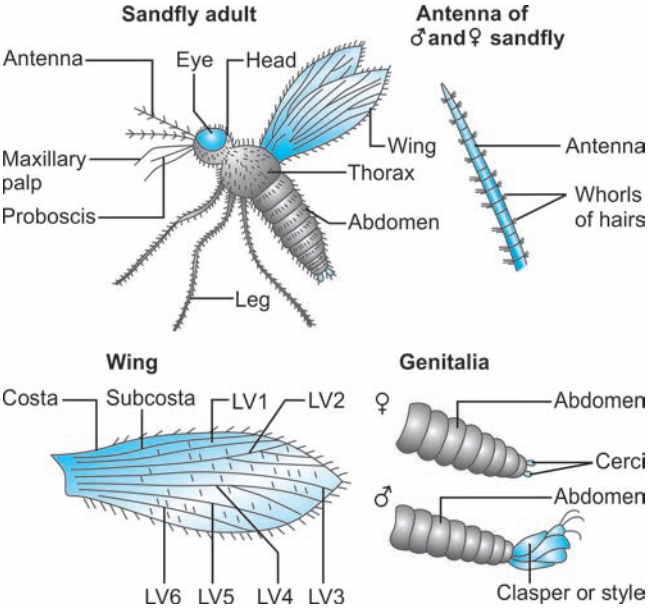


Fig. 15.19C Sandfly

Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

The last abdominal segment has a narrow and small tube like structure called 'Stigmata', which serves respiratory function and dorsally it has 2 pairs of long bristles, 'caudal bristles' which are kept erect. Larva can go to a depth of one foot into the soil. This stage lasts for about 3 to 4 weeks, during which it feeds on decaying organic matter and develops into next stage.

Pupa stage: In this stage, head and thorax are fused to form cephalo-thorax. The abdomen is characteristically curved upwards. The body is covered with small spines like hairs. Pupa comes to the surface after taking rest for about 10 days before emergence of the young adult sandfly.

Thus it takes about 30 to 45 days for the completion of the life cycle and the adult lives for about 15 days. The flight range is about 50 to 70 meters.

Control Measures

- Improvement of environmental sanitation (cleanliness) around the houses
- Filling up of the cracks and crevices of the house-walls by cement plastering
- Location of cattle sheds and poultry houses away from the human habitations
- Spraying of human dwellings, cattle sheds and such other places is done with lindane once in 3 months. DDT is also effective.

Tsetse Fly (Glossina)

This belongs to hematophagous or blood sucking group of flies. These flies are voracious blood suckers of animals and dark men. Both the sexes bite. They love to live in dense forest areas because of shade and moisture. They require loose soil and nearby water sources for laying eggs. Therefore they are commonly found in Central African forest areas. They bite almost exclusively during the day and act as intermediate host of a fatal disease called Trypanosomiasis or sleeping sickness, caused by *T. gambiense*. The disease affects men, cattle and wild life. The regions on either side of rivers, infested with tsetse flies are called 'Fly belts'.

Morphology

Tsetse fly is larger than housefly in size, brown in color, measuring about half an inch. At rest, the wings overlap each other like the blades of a scissor and cover the abdomen dorsally, completely **(Fig. 15.20)**.

Head bears a pair of large compound eyes, with a median proboscis which is rigid, non-retractile and adopted for biting and sucking the blood and a pair of maxillary palpi, one on either side of the proboscis. The palpi are as long as proboscis and they protect the proboscis. Therefore, the palpi and the proboscis together look like a single structure. A pair of three segmented antennae are also found.

The venation in the wings are the same type as in housefly except that the fourth vein is curved twice.

Abdomen reveals 6 segments.

Fig. 15.20 Tsetse fly (Glossina palpalis)

Life History

The life history of tsetse fly is little peculiar in that the gravid female does not lay eggs (not oviparous) but directly gives birth to larva, one at a time, at 10 day intervals. Therefore it is 'viviparous' or 'larviparous'. The larva is a fat maggot, having two black small spherical structures, the 'polypneustic lobes', in the lost abdominal segment. The larval stage lasts hardly for 30 to 60 minutes.

Larva goes deep into the soil and develops into pupa. Pupa is a barrel shaped structure, having polypneustic lobes at the posterior end. It takes rest for 1 to 2 months and then comes to the surface of the soil at the time of emergence of the young adult.

Thus the life history is that of complete metamorphosis.

Control Measures

- Offensive measures are destruction of wild animals on which the flies feed (this is now not practiced).
- Spraying of 20 percent Dieldrin insecticide from the air craft to cover large area in the forest.
- Defensive measure is personal protection by chemo-prophylaxis.
- Corrective measure is clearing of vegetation along the banks of rivers is now the recommended measure. This is more effective, when supplemented by insecticidal spray.
- No human habitation to be allowed within 450 meters of fly breeding zones. The intervening area must be maintained free from bushes.
- Research is going on for the genetic control of flies.

Black Fly

It is a black colored, small, robust fly, found in forest areas. Only female bites. It is a vicious blood sucker of cattle and occasionally bites man. It breeds in fast flowing waters **(Fig. 15.21)**.

Simulium indicum is the Indian species, but it does not act as vector nor does it transmit any disease in India. However black flies are responsible for the transmission of Onchocerciasis in Africa, Mexico and South America.

The eggs are laid in the submerged stones and water weeds. The larvae are also acquatic, attached to stones and weeds. Larval stage lasts for about one month, after which pupae come out and that stage also lasts for about 2-3 weeks and the young adult flies out of the water as soon as the wings dry up.

Control of black flies is difficult because the range of fly is about 100 miles. So the control measures are implemented at the larval stage by using Abate in 1 ppm concentration, at weekly intervals. Defensive measures are personal protection by using protective clothing while frequenting in forest areas. Corrective measures include health education.

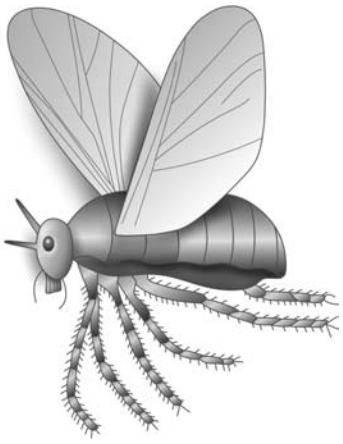


Fig. 15.21 Simulium (Black fly)
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

FLEAS

Fleas are small bilaterally compressed, hard skinned, brown colored, wingless insects, found as blood sucking ecto-parasites on the body of warm blooded hosts and birds. In the absence of elective species of the host, the fleas will readily feed on the blood of other animals.

The entire body is covered with bristles or spines, which are directed backwards. The bilaterally compressed body, backwardly directed bristles and strong legs help the fleas to move freely through the hairs and feathers of their warm blooded hosts. The fleas are popularly named after their hosts as rat-fleas, dog fleas, cat-fleas, human fleas, etc. the so called water-flea, which has somehow-earned the name of a flea, is not a true flea, as it belongs to the class Crusta-cea, rather than Insecta.

Fleas of both the sexes are hematophagous. Each kind of flea is found on a particular animal which is called the 'chief host'. In the absence or death of the chief host, they attack other hosts for their blood meal, which are known as 'Secondary hosts'. On the body surface of the hosts, the fleas move by crawling and outside the body, they move by jumping with the help of their legs. The fleas live for about 2 years and capable of resisting starvation for several months (4–6 months).

The important genera and species of fleas are as follows:

- Rat fleas (oriental) - *Xenopsylla astia*
  Xenopsylla brasiliensis
  Xenopsylla cheopis
- Rat fleas (Temperate zone) - *Nosopsylla fasciatus* (Europe)
  Nosopsylla niligiriensis (India)

- Dog fleas and cat fleas — *Ctenocephalus canis*, *Ctenocephalus felis*
- Sand fleas (Jigger or chigoe fleas) — *Tunga penetrans*
- Human fleas — Pulex irritans (Do not transmit any disease)

Rat Fleas

Among the three species, *xenopsylla cheopis* is the most efficient vector in transmission of the disease. *Xenop.astia* and cheopis are found all over India, whereas *xeno. brasiliensis* is largely confined to central and peninsular India.

The rat fleas transmit the following diseases.

Plague (Bubonic), Murine (or Endemic) typhus, Chiggerosis and *Hymenolepis diminuta* (dwarf tapeworm).

Another rat flea, *styvalius anale*, is a vector of plague in the foot hill areas of South India.

Morphology

Rat flea is a bilaterally compressed, wingless insect, having bristles over the body, directed backwards. Body is divisible into head, thorax and abdomen.

Head

Head is conical in shape, closely attached to thorax leaving no demarcation between the two (i.e. without neck). Head bears a pair of small yes, which are laterally displaced and look like dark pigmented spots. A pair of three segmented, short and stout, antennae lie in a groove behind the eyes, called 'antennal groove'. The mouth parts are adapted for piercing and sucking the blood. These project downwards **(Fig. 15.22)**.

Thorax

Thorax consists of three segments namely pro-thorax, meso-thorax and meta-thorax. The hind margin of the pro-thorax carries a row of spines called prothoracic or pronotal combs. Ventral surface of the thorax bears three pairs of legs, which are well developed and adapted for leaping or jumping. The hind pair of legs are usually longer than others. It can jump to an height of about 8 to 10 inches. Wings are totally absent.

Abdomen

This consists of ten segments. The last three segments are modified into reproductive structures. The dorsal surface of the abdomen is flat in the males and convex in the females. The posterior part of the abdomen, in the male, consists of a coiled structure called 'aedegus' or penis and in the female, a bag like structure called 'spermatheca' or 'receptaculum seminis'.

Thus, the sexes are easily identified. The shape of the spermatheca helps in the identification of the species. It is 'a' shaped in astia, 'b' shaped in brasiliensis and 'c' shaped in cheopis **(Fig. 15.23)**.

Life History

The life cycle of the rat flea occurs in four stages—egg, larva, pupa and adult, thus undergoing a process of complete metamorphosis **(Figs 15.24A and B)**.

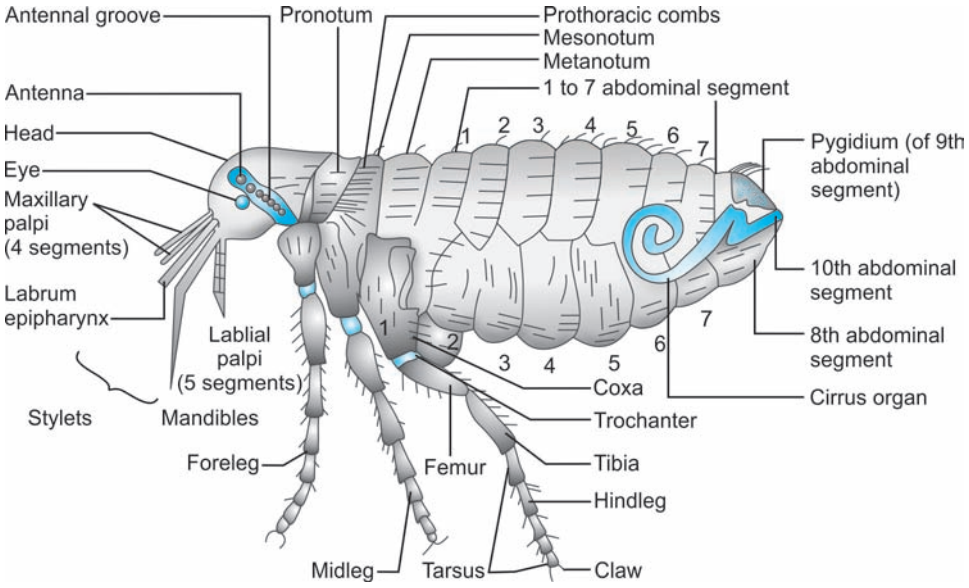


Fig. 15.22 External anatomy of a male rat flea

Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

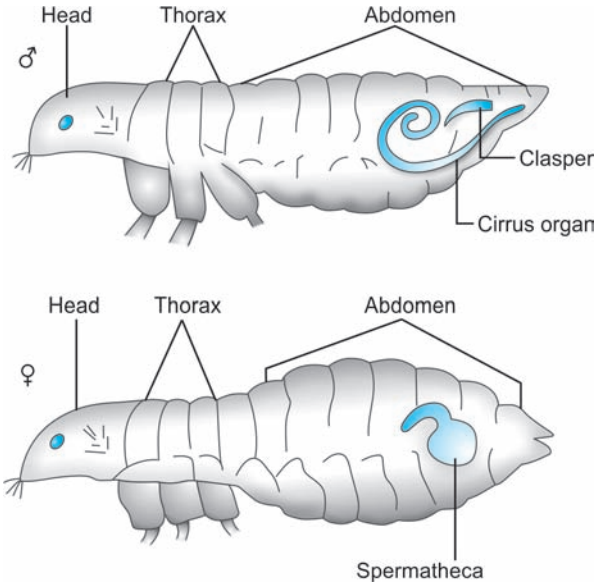


Fig. 15.23 Differences between ♂ and ♀ rat flea
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Breeding Places

Dust collections with organic matter and moisture as in burrows of the rats, cracks and crevices in the floor, godowns, store rooms, chicken houses, and in the space beneath the staircase carpets.

Egg Stage

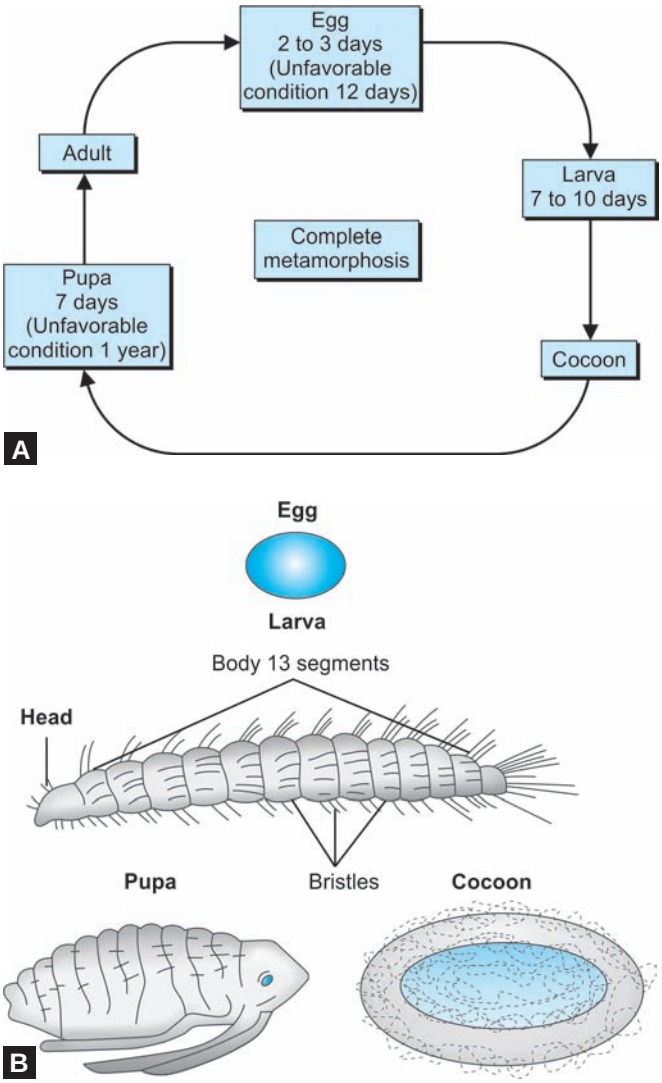
A gravid female rat-flea lays eggs in batches of 5 to 6 at a time and about 350 eggs in its life time. The eggs are small (about 0.5 mm), oval shaped, cream in color. Eggs when deposited over the animal among the hairs, fall readily on the floor and thus they are found in or near the haunts of the host (i.e. burrows of rats). This stage lasts for about 3 days.

Larval Stage

The larvae coming out of eggs, look like miniature caterpillar, whitish or yellowish in color, and are active. They are eyeless, legless, hairy maggots. They feed on the organic matter of the breeding places. Each larva measures about 4 mm long. The larva undergoes two moults in three stages. The larval stage lasts for about 8 to 10 days.

Pupal Stage

The larva in its last stage, spins a cocoon or a protective covering with the help of its saliva. Inside the cocoon, pupa develops. The cocoon is silky and sticky. So dirt and debris adhered to it. Pupa is the resting stage of transformation. The pupal stage lasts for 1 to 2 weeks.



Figs 15.24A and B Life-history of flea
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Adult Stage

At the end of pupal stage, the young adult flea emerges out. Soon after leaving the cocoon, the adult flea goes in search of its host for leading an ectoparasitic life. Both male and female fleas live exclusively on blood, yet they are not continuous suckers. They leave the host frequently and survive for several weeks. Breeding takes place all round the year. The cycle repeats itself after the eggs are laid.

Modes of Transmission of Disease

Fleas transmit the diseases by the following modes: biologically, mechanically and by defecation.

Biologically

The disease is transmitted biologically by biting and this is the chief mode of transmission of the disease plague. The rat-fleas biting and sucking the blood of the infected rats, ingest plague-bacilli, which multiply in the 'proventriculus' (a small chamber between the esophagus and the stomach) and block it. Depending upon whether the proventriculus is blocked completely or partially, the flea is called 'Blocked flea' and 'Partially blocked flea' respectively **(Figs 15.25A and B)**.

The total blockage of the food passage makes the flea unable to obtain its food and makes it starving. Because of hunger, it wants to release the block by making frantic efforts while biting. In such an attempt it bites ferociously and inoculates the plague bacilli into the wound causing infection. This is the commonest mode of transmission.

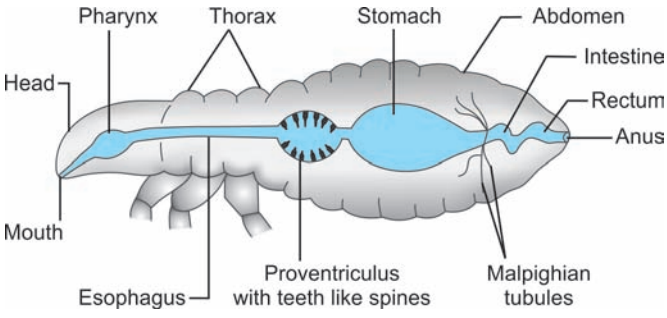


Fig. 15.25A Alimentary canal of flea

Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

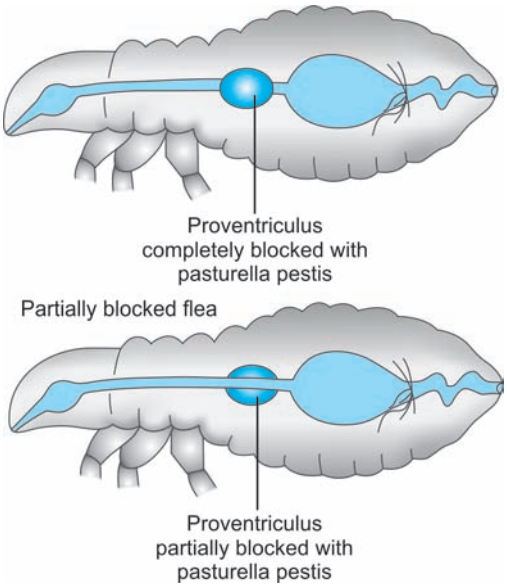


Fig. 15.25B Blocked and partially blocked flea

Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

When the proventriculus is not completely blocked and has a small canal-like space, such a flea is called 'Partially blocked flea.' A partially blocked flea is more dangerous because the blood is regurgitated with greater force and larger number of plague bacilli (Pasteurella-pestis) will be inoculated and also it lives longer than blocked flea.

Since the pathogen undergoes multiplication inside the body of the vector, it is called 'Propagative' type of biological transmission.

Mechanically

The transmission takes place from the proboscis of the flea, which had recently fed on an infected rodent.

By Defecation

The pathogens are found in the feces of the infected flea. When the host scratches over the flea bitten area, man gets the infection through the contamination of abrasions or wounds. This is how murine typhus caused by *Rickettsia mooseri* is transmitted.

Flea Indices

These are the indicators which help to know the density of fleas in general and the density of the particular species of fleas which indicates the possible outbreak of plague and also they help to evaluate the control measures of fleas and rodents carried out, in the endemic areas of plague.

Before finding out the flea-index, the fleas have to be collected from rats. For this rats are trapped in a cage type of metal wire traps kept in rat-runs. Next morning the traps with the rats are put in a cloth bag and killed *in situ* by cyanogas fumigation. Next, the trap is opened, each rat is placed on white paper, fleas are removed by combing the rats, all the fleas are picked up, counted, identified for species and sex and noted.

The following indices (indicators) are used in flea surveys:

- **General flea index:** It is the average number of fleas of all species, found per rodent.

$$\text{GFI} = \frac{\text{Total no. of fleas of all species collected}}{\text{Total no. of rodents collected}}$$

The normal general flea index is 3 to 5.

- **Specific flea index (Ex. X-cheopis index; X-astia index; X-brasiliensis index):** It is the average number of fleas of each species found per rodent.

$$\text{SFI} = \frac{\text{Total no. of fleas of each species collected}}{\text{Total no. of rodents collected}}$$

Any X-cheopis index more than 1.0 is indicative of possible outbreak of plague and warrants suitable anti-plague measures to be instituted.

- **Percentage incidence of flea species:** It is the percentage of fleas of each species found per rodent.
- **Rodent infestation rate:** It is the percentage of rodents infested with fleas of all species.

Control Measures of Fleas

1. **Offensive measures:**
   - **Use of malathion powder:** It is dusted over rat-runs, burrows of rats, under gunny bags and other harborage areas to kill rat fleas.
   - **Cyanogas fumigation:** Cyanogas has to be used only in the enclosed areas, because it is highly poisonous. The gas is fumigated into the burrows of the rats using cyanogas pump. It not only kill rats, but also rat fleas, and the eggs and pupae of the fleas.
2. **Defensive measures:** These are by the application of the repellents such as Diethyltoluamide, Benzyl benzoate, etc.
3. **Corrective measures:** Corrective measures are those which prevent the ingress of rats such as rat-proofing houses, godowns and sanitary disposal of garbage attracting the rats.

LICE

Lice are the ectoparasites of mammals and birds.

Human lice are a small group of wingless insects, living as ectoparasites and feed exclusively on human blood. They cannot live in isolation from the host. Lice infestation is called pediculosis. Pediculosis is a problem of people living in unhygienic and over crowded environment. It is usually seen among inmates of jails, barracks, concentration camps juvenile homes, etc.

The human lice are of three kinds : Head louse (*Pediculus humanus* capitis), Body louse (*Pediculus humanus corporis*) and Public louse (*Pthirus pubis*).

The first two kinds have the same morphological features and life cycle, except for slight difference such as habitat. The head louse inhabit the head (or scalp) and the body louse inhabit the body (chest).

The differences between the head louse and body louse are shown in **Table 15.4**.

Table 15.4 Differences between head and body louse

	Head louse	Body louse
Nomenclature	• It is pediculus *humanus capitis*	It is pediculus *humanus corporis*
Habitat	• It is found on hairs of scalp	Found on body hairs and seems of clothes
Oviposition	• Eggs are laid in occipital region. About 150 eggs are laid at the rate of 5–6 daily	Eggs are laid on body hairs and clothes. About 300 eggs are laid at the rate of 8–10 daily
Longevity	• Four weeks	Six weeks
Mode of spread	• Usually spreads from person to person when they are in close contact or through common items like combs	Usually it spreads through the medium of clothes, combs, caps, towels, bed-sheets or pillow covers, etc.

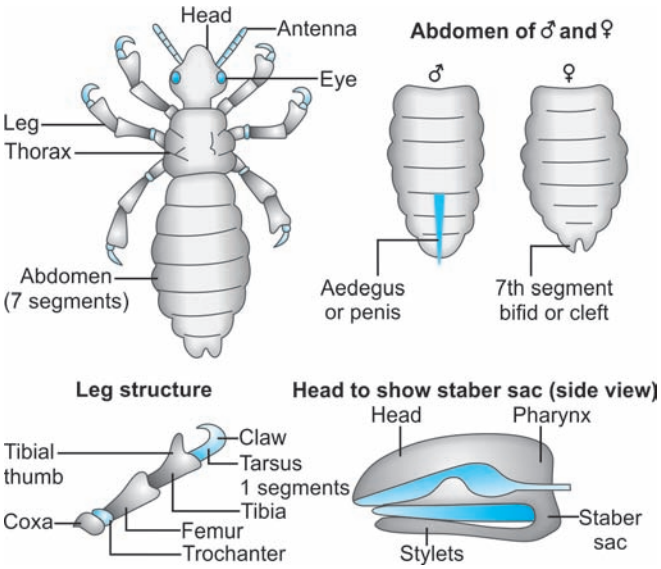


Fig. 15.26 Louse ♀ (*Pediculus humanus*)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Morphology

Body is dorsoventrally compressed and so appears flat. The body is divisible into head, thorax and abdomen.

Head: Head is pointed anteriorly and constricted posteriorly, giving the impression of a neck which does not actually exist. The head bears a pair of eyes, a pair of antennae and a median proboscis. Palpi are absent **(Fig. 15.26)**. Each antenna consists of five segments. Proboscis is adopted for biting and sucking the blood. It is hidden in a pouch called 'Staber sac,' located on the ventral aspect of head.

Thorax: Thorax is rectangular in outline, consists of three segments, which are distinct only on the sides. Wings are absent. Three pairs of legs are attached ventrally to the thorax. The legs are strongly developed. The last segment bears a thumb, (tibial thumb) and terminates in claw, with which it holds or clings to the hairs of the host firmly. The forelegs are better developed than the middle and hind legs.

Abdomen: It is longer than head and thorax put together. It has seven visible segments. The last abdominal segment is cleft or bifid in females and rounded off in males, in which a spine like structure, aedeagus or penis is enclosed.

Life Cycle

The life cycle occurs in three stages, namely egg, nymph and adult and the metamorphosis is incomplete.

Egg Stage

The gravid female louse lays eggs, called 'nits' in groups. Each egg is a small oval shaped body having an operculated top with small nodules. It is attached to the shaft of the hair or a fiber of the cloth with its sleeve and cementing substance. About 150 to 300 eggs are laid in its life time. This stage lasts for about 6-7 days **(Figs 15.27A and B)**.

Larva or Nymph Stage

Under the warmth of the host's body, the eggs hatch and the 'nymph' emerges out by opening the operculum. It resembles the adult in its morphological features, except that it is smaller in size. It thrives exclusively on host's blood and grows. It passes through three moultings (instars) in about 9 days and becomes an adult.

Adult (Imago) Stage

The adult louse thrives on the blood of the human host. Mating is a frequent affair followed by oviposition. The gravid female lays 5 to 10 eggs at a time and the process is repeated about 20 times in the life span of a louse, which extends to 4 to 6 weeks.

Life history is completed in about 15 to 16 days.

Human lice, though obligatory ectoparasites, abandon their hosts at critical times like intense fever, intense sweating or death and migrate to another host. Migration is also facilitated by close contact of the people with lousy individuals or through the medium of clothes, combs, caps, towels, bed-sheets or pillow covers used by lousy individuals.

Diseases Transmitted

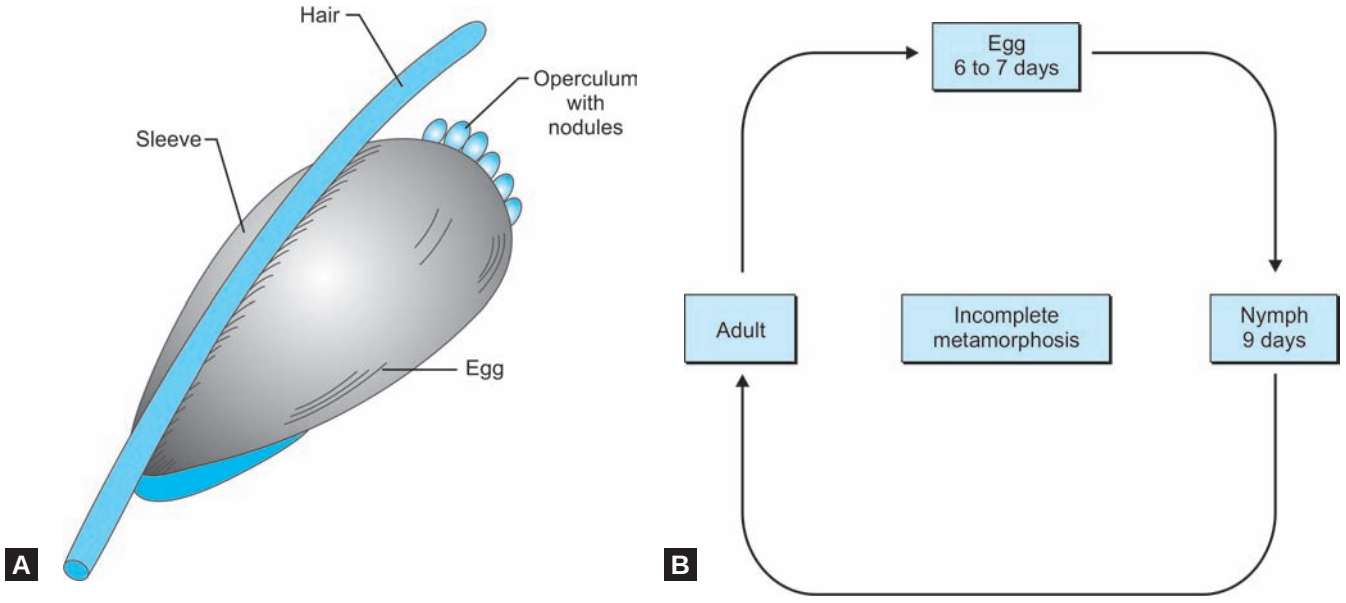
- Epidemic typhus caused by *Rickettsia prowazeki*.
- Relapsing fever caused by *Borrelia recurrentis*.
- Trench fever caused by *Rickettsia quintana*.

The bites by the lice cause considerable irritation and often itching. The secondary infection due to scratching can result in dermatitis.

Pubic Louse (Phthirus Pubis; Crab Louse)

Crab louse has the same morphological features as head louse and body louse and differs from them in that:

- It is shorter and broader
- Head is impacted on the thorax
- Hind legs are better developed than fore and midlegs
- Thorax is broader than the abdomen



Figs 15.27A and B A. Egg or nit of louse; B. Life-history of louse

Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

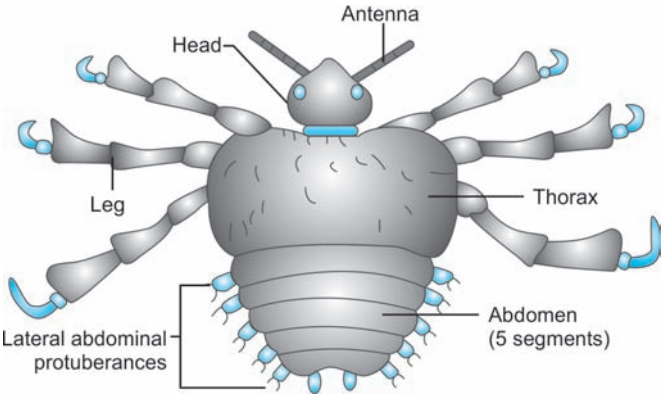


Fig. 15.28 Phthirus pubis (pubic or crab louse)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

- Abdomen has only five visible segments
- Each segment has visible lateral protuberances on either side
- Aedeagus is small and not clearly visible in male (Pubic or Crab louse).

Aedeagus is absent in female and the tip of the 5th abdominal segment is cleft or bifid **(Fig. 15.28)**.

The pubic louse as the name implies, is restricted mainly to the hairs of pubic and peri-anal region. Rarely it is found in other parts of the body. It adheres to the hairs very firmly and removal is a matter of difficulty. It is a very lazy creature. It hardly moves from the site of its birth. It thrives on the blood of the host.

Crab louse does not transmit any disease.

The gravid female lays about 50 eggs during its life time. Life cycle is similar to that of head and body louse—egg stage lasts for 7 to 8 days, Larva or Nymph for about 30 days, thus completing the cycle in 35 to 40 days, showing incomplete metamorphosis.

Control Measures of Lice

A. **Offensive measures:**
   a. Against head and crab lice:
      - Application of 0.5% malathion lotion followed by head bath after one day. Malathion destroys lice and nits also.
      - Tonsuring the head and clean shave in the pubic region.
      - Dusting with carbaryl is also effective.
   b. **Against body lice:**
      - Dusting with 1% malathion powder over the chest, axilla and to the inner surface of the cloths, socks and also into the trousers. Better to repeat the application after one week.

Other offensive measures are thorough washing of all clothes, bedsheets, pillow covers with hot water and soap, followed by drying in hot sun and hot pressing clothes is very effective procedure.

B. **Defensive measures:** Maintenance of high standard of personal hygiene by daily bath, regular changing of clothes and bed linen.

C. **Corrective measures** include health education of the people about the hazards of overcrowding and importance of personal hygiene.

BUGS

These insects are of varied shapes and sizes. They possess dorsoventrally flat bodies and the mouth parts are adapted for piercing and sucking. Some are winged and some wingless. They are oviparous and metamorphosis is incomplete.

The bugs of public health importance are the bedbug and the triatoma bug (reduviid bug)

Bedbugs

The species that survive on man are *cimex lectularius* in temperate countries and *cimex hemipterus* (or *cimex rotundotus*) in tropical countries like India, which are reddish brown in color **(Fig. 15.29)**.

They do not act as vectors in transmission of any disease. However they are suspected to transmit certain diseases like leprosy, plaque, kala-azar, typhus, relapsing fever and Rocky Mountain Spotted fever, but not proved.

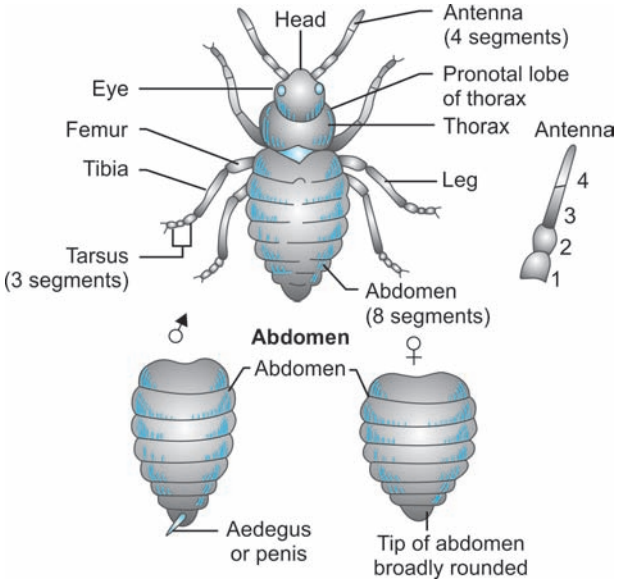


Fig. 15.29 Dorsal view of bedbug (Cimex)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Bionomics

Both sexes bite and suck blood. They are nocturnal in habit usually. The adults and nymphs resist starvation for six months or even more and look like a brown leaf. The moment they get blood-feed, they swell and regain normal reddish brown color. On the body they possess 'stink glands' and hence the bedbugs give out a peculiar smell described as buggish odor.

Eventhough the bed bug does not transmit any disease, it is mainly a source of nuisance due to the bite and consequently causes irritation, discomfort, excoriation of skin and disturbs sleep.

Control Measures

- Offensive measures consist of exposure of bug infested articles to direct sunlight or pouring boiling water on them. Application of direct heat (or flaming) to bug infested steel cots is also effective. Spraying of the insecticide, consisting of a mixture of BHC and malathion in their daytime hideouts like cracks and crevices of the walls, fissures in furnitures, etc. also help to achieve good results.
- Defensive measures consist of using repellants.

Triatoma Bugs (Reduviid Bugs)

(Synonyms: Cone nose bugs; Kissing bugs; Assassin bugs)

These are ectoparasites of mammals and birds. Various species are found in South America and Mexico. The important species are *Triatoma infestans* **(Fig. 15.30)**. These bugs are implicated as vectors in the transmission of Chaga's disease (*American trypanosomiasis*), caused by trypano-soma cruzi.

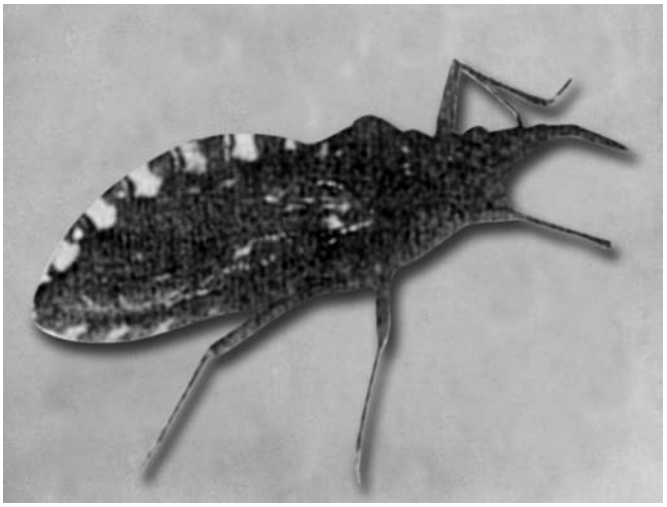


Fig. 15.30 Female *triatoma infestans*
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

These bugs occur in India but do not transmit any disease. They live in cracks, fissures and other hiding places of walls and ceilings during day time and emerge during night for feeding.

Morphology

Reduviid bugs are large, winged insects of about 25 to 28 mm long. The body consists of head, thorax and abdomen.

Head is cone shaped, bears a pair of eyes, a pair of antennae and a rostrum covering the mouth parts.

Thorax bears three pairs of legs ventrally and two pairs of wings dorsally, the hind wings are membranous.

Abdomen is broad in female and slender in the male.

It is pointed at the tip in the females and fully rounded in the males.

Life Cycle

The gravid female lays eggs, in singles or in groups, about one month after copulation. The eggs are oval, white colored when fresh and operculate. The eggs hatch after 30 days.

The nymphs coming out of eggs resemble adult in all respect, except that they do not possess wings. The nymphs undergo moultings five times and at each stage, they need blood meal before moulting.

The last nymphal stage later transformed into adult.

The life cycle is completed in about 300 days and metamorphosis is incomplete.

Control Measures

- Offensive measures are spraying the houses with residual insecticides like HCH or Dieldrin.
- Defensive measures are personal protection by using curtains at night.
- Corrective measures are cement plastering of cracks and crevices of the walls and periodical white washing of the houses.

CLASS ARACHNIDA

This includes ticks and mites. They are all blood sucking ectoparasites of vetebrate animals. Arachnida also includes spiders, scorpions and king crabs, which do not transmit any disease.

TICKS

Ticks are of two families—ixodidae (Hard ticks) and argasidae (Soft ticks). The differences between Hard ticks and Soft ticks are shown in **Table 15.5**.

Table 15.5 Differences between hard and soft ticks

Hard ticks	Soft ticks
• They belong to the family Ixodidae.	• They belong to the family argasidae.
• Capitulum is anterior in position.	• Capitulum is ventral in position.
• Scutum is present.	• Scutum is absent.
• Dorsally sexual dimorphism is well marked, i.e. scutum covers the entire dorsal surface in male and covers only a small portion in the female.	• Sexual dimorphism is absent dorsally.
• Spiracles exist behind the fourth pair of legs.	• Spiracles exist between the third and the fourth pair of legs.
• Festoons are present in some hard ticks.	• Festoons are absent.
• They cannot resist starvation. So they are always found on the body of the host (Day and night) (like lice)	• They can resist starvation for months. Therefore they are found on the body of the host only while feeding blood (i.e. only during night times) (like bedbugs).
• They require continuous blood meal.	• They require intermittent blood meal.
• They are always found on the body of their hosts.	• They are found in cracks and crevices during day time and on the body of the host during night times.
• Gravid female lays hundreds or thousands of eggs at one sitting.	• Eggs are laid in batches of 20-100 over a long period of time.
• Nymphal stage is one.	• Nymphal stages are five.
• Important species are *Dermacentor andersoni, Haemophysalis spinegera*.	• Important specimen is *Ormithodorus moubata* **(Figs 15.32A and B)**.
• Diseases transmitted are Tick typhus, (Africa) Tick paralysis, Tularemia, Viral encephalitis, Hemorrhagic fever (KFD) Human babesiosis. Rocky Mountain Spotted fever (USA), Q-fever (in US and Australia)	• Disease transmitted is Endemic Relapsing fever, caused by *Borrelia duttoni*, a spirochete.

Morphology

The body is oval or oblong shaped, measuring about 1 cm long, consists of one unit only, not distinctly divisible into head, thorax and abdomen and there are no segmentation also.

The head in hard ticks is located, anteriorly. It is called 'capitulum' and it is located ventrally in soft ticks. The mouth parts in the capitulum comprises, a median hypostome, a pair of chelicerae and a pair of pedipalps. Hypostome is a dart like structure, armed with rows of strong back-ward directed teeth, with which it secures a strong hold **(Fig. 15.31)**.

On the dorsal surface of the body exists a chitinous shield called 'scutum', which is present in hard ticks and absent in soft ticks, contributing to their softness. In the male hard ticks, the scutum covers the entire dorsal surface and in female hard ticks, covers only a small portion anteriorly.

On the ventral surface of the body, in the female, the genital opening is placed anteriorly and the anal orifice is placed posteriorly in both the sexes.

Ticks have four pairs of pointed legs terminating in claws. Spiracles are a pair of openings, existing on the ventral surface, for respiratory function.

In some hard ticks, the posterior margin of the body is divided into uniform rectangular areas called 'festoons', which are absent in soft ticks. Males are generally smaller than females.

Life Cycle

Though ticks are ectoparasites, yet the gravid female lays eggs on the ground (grass) and not on the host body.

- **Egg stage:** Eggs are laid, one by one, continuously, in one group. They are spherical. The female hard ticks lays about hundreds to thousands of eggs and dies thereafter. The soft ticks lay eggs in batches of 20 to 100 over a long period. This stage lasts for about 3 to 4 weeks, after which they hatch.
- **Larva stage:** Larva coming out of the egg, possesses three pairs of legs. It is also called 'Seed tick' **(Figs 15.33A and B)**. It climbs on the ground vegetation and reaches the tip of leaves of shrubs or on blades of grass, waiting for a suitable host, to which it attaches itself and feeds on the host for 4-6 days. When gorged, it drops on the ground and remains quiescent until the blood meal is completely digested. Meanwhile it moults to become nymph. The larval stage lasts for 1 to 2 weeks.
- **Nymph stage:** The nymph possesses four pairs of legs. It also waits for the suitable host for the blood meal, afterwhich drops to the ground, and develops into adult. This stage lasts for about 6 weeks. Soft ticks have 5 nymphal stages in the life cycle.
- **Adult stage:** Adults also raise to the heights on the top of the vegetation, until they manage to get a new host to lead ectoparasitic life.

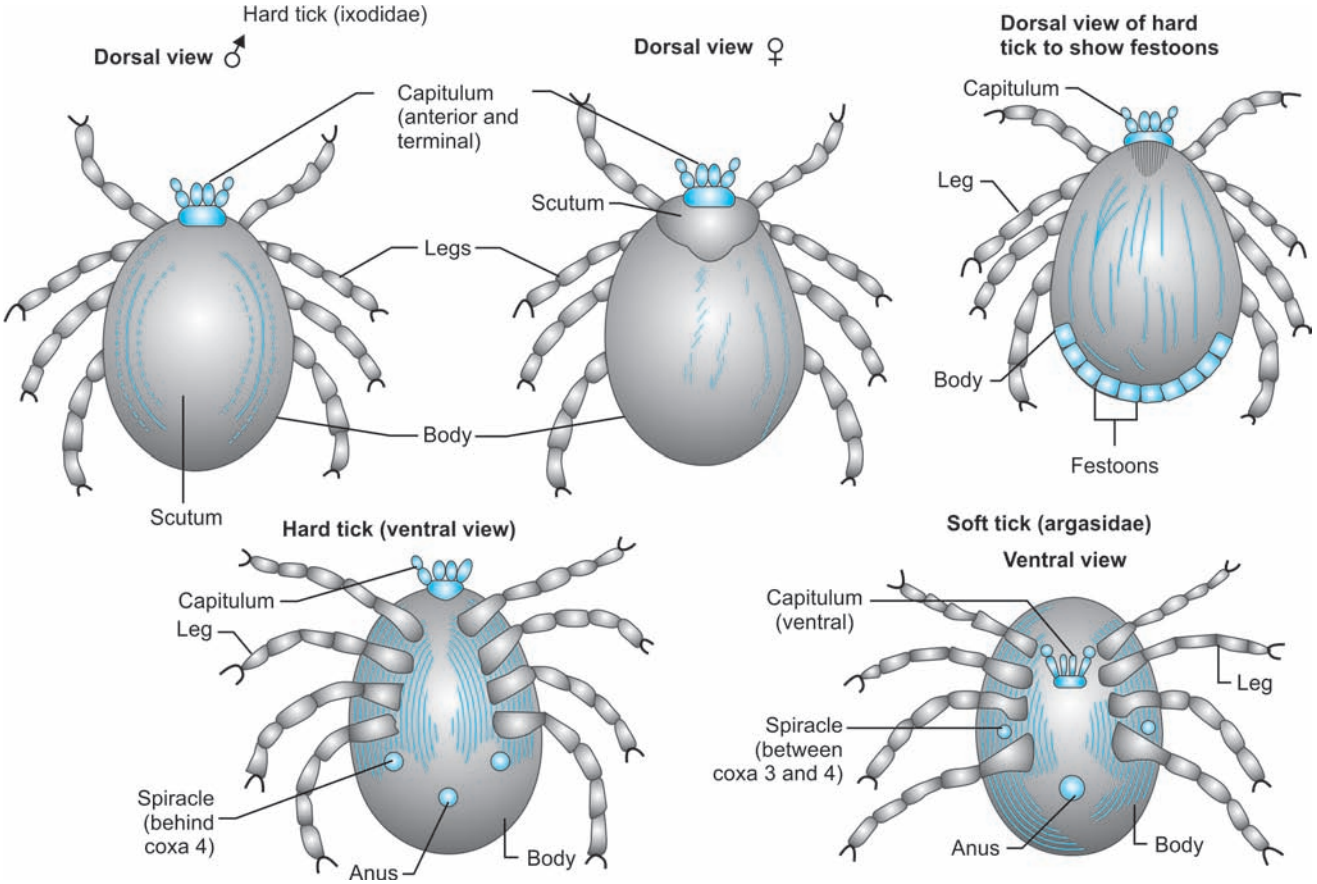


Fig. 15.31 Dorsal and ventral views of hard and soft ticks
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

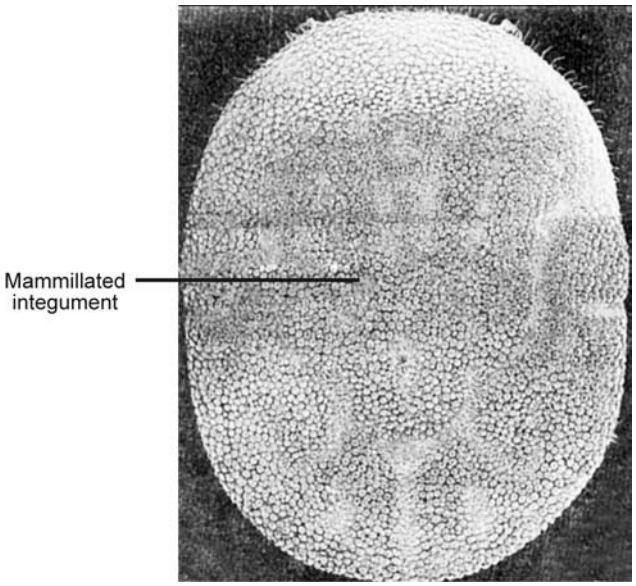


Fig. 15.32A Dorsal view of adult female *Ornithodorus moubata* (Soft tick)
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

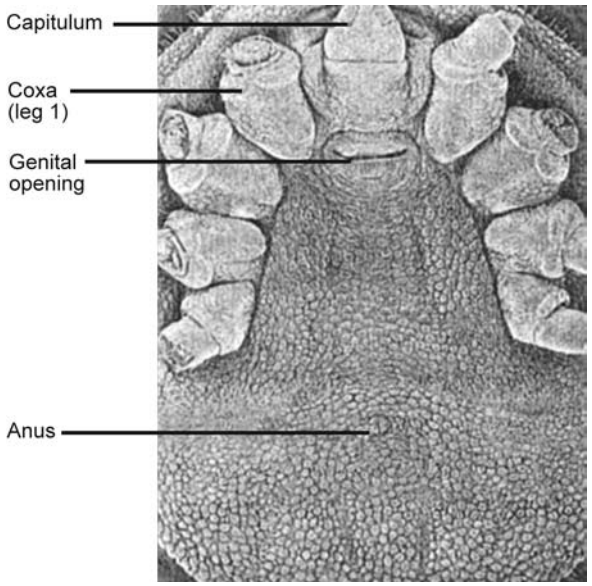
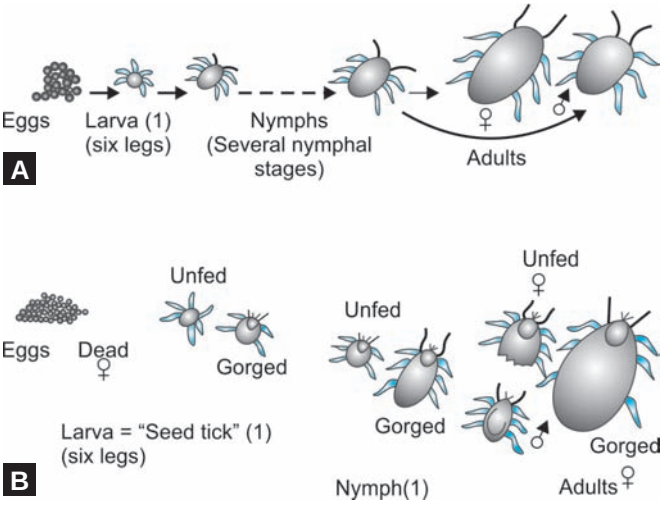


Fig. 15.32B Ventral view of adult female *Ornithodorus moubata*
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.



Figs 15.33A and B Tick life cycles : (A) Argasidae; (B) Ixodidae
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

It takes about 2 to 4 months to complete the life cycle. It is of incomplete metamorphosis.

Thus the life cycle is completed on 2 to 3 hosts, rarely on a single host. Mating takes place on the body of the host. After feeding on the host, the gravid female drops down to lay eggs, initiating the next life cycle.

It is important to note that in case of ticks, the pathogens can pass from one generation to another through eggs. This method of transmission is called 'Transovarian transmission.'

The pathogens of all the diseases transmitted by the infected ticks, except Q-fever, are found in the feces, saliva and coxal fluid of the infected ticks. (Coxal fluid is secreted by the coxal glands, located between the first and second legs) Infection takes place when the bitten wound is contaminated by the feces, the saliva or coxal fluid containing the pathogens.

In case of Q-fever, man gets infection through inhalation of dry feces of the infected tick.

Control Measures

- Offensive measures consist of disinfestation of animals by application of insecticides (tickcides) such as lindane or malathion either in the form of dusting powder or solution.
- Defensive measures consist of use of protective clothing impregnated with an insect repellent such as indalone, and diethyl toluamide.
- Corrective measures consist of environmental control measures, including removal of shrubs and vegetation near the dwellings and also health education of the people.

MITES (CHIGGERS)

These are comparatively smaller than ticks. They have a membranous body with profuse long hairs. Some are ectoparasites while some live on land.

They also possess four pairs of legs and body is not well demarcated into head, thorax and abdomen **(Fig. 15.34)**.

The important mites are Trombiculid mite and Itch mite.

The other mites of medical importance are the dust mites and blood sucking mites.

Trombiculid Mites (Harvest Mites)

The adult mites are spider like arthropods, the body consists of one unit only, having shape of the figure '8'. It measures about 1 to 2 mm and the whole body is covered with profuse hairs. They have extremely varied feeding habits. Adult trombiculid mite does not bite. It is free living. It feeds on vegetable juice. The larval stage is the biting stage.

The mouth parts consists of a rudimentary hypostome, a pair of medial chelicerae and a pair of lateral pedipalps. Each pedipalp ends in a claw like structure with opposing thumb like processes. The adult has four pairs of legs and the first pair of legs are well developed and longer than others.

The important species are Trombicula akamushi and Trombicula deliensis. The larva acts as a vector.

Life Cycle

Consists of four stages—egg, larva, nymph and adult.

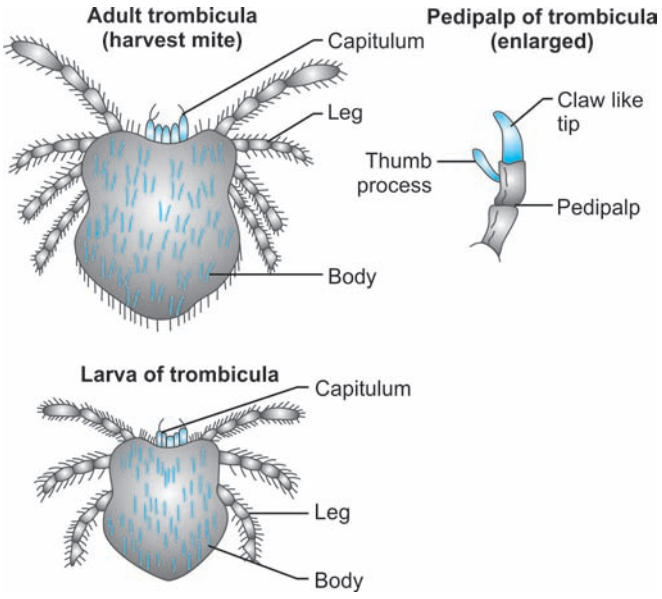


Fig. 15.34 Morphology of *Trombiculid mite*
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Egg stage: The gravid female *Tr. mite* lays eggs in singles, in damp but well drained soil in alluvial river banks, scrub jungles and grassy fields. This stage lasts for about one week.

Larva stage: The larva comes after hatching the eggs. The larvae are called 'Chiggers.' The larva has 3 pairs of legs and the mouth parts are developed for biting. Body is covered with hairs **(Fig. 15.35)**. They ascend on the tip of the grass blades and wait in search of the host. On finding the host, they attack at strategic locations such as inside the ears in rodents, around the eyes in birds and occasionally on the scrotum or around the waist of men. Chiggers neither burrow the skin of the host nor feed on their blood. They simply digest the host tissue partially with the help of saliva and suck it up as a fluid meal.

After feeding the larva drops down and moults. This stage lasts for 1 to 2 weeks **(Fig. 15.36)**.

Nymph stage: The nymphs (or imago) are popularly called 'velvet mites,' because of the dense red colored velvety hairs covering the body **(Fig. 15.37)**. They possess four pairs of legs and resemble adults in their shape. The nymphs lead a terrestrial, life. At the end of 2 to 3 weeks, they moult and develop into adults.

Adult stage: They resemble nymphs, in all respects, except that they are larger. In the process of reproduction, the males deposit spermatophores on a substrate and the females which walk over them get inseminated by the sperms contained therein. The gravid female eventually lays eggs and the cycle is repeated.

It takes about 40 days to complete the life cycle and it shows incomplete metamorphosis.

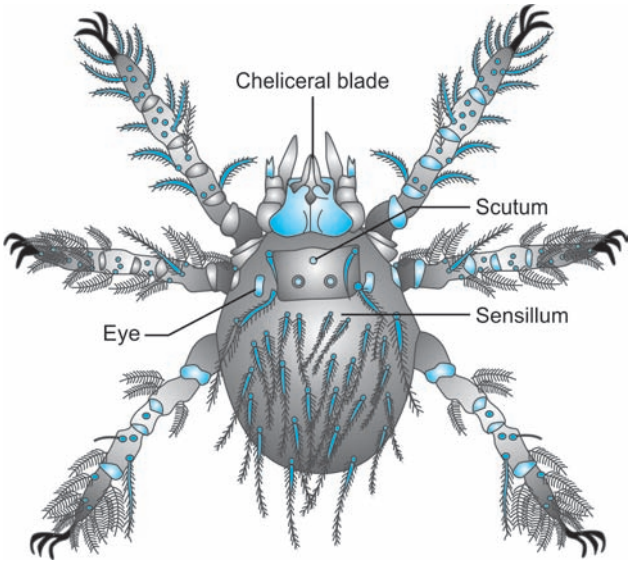


Fig. 15.35 Dorsal view of *Leptotrombidium deliense*
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

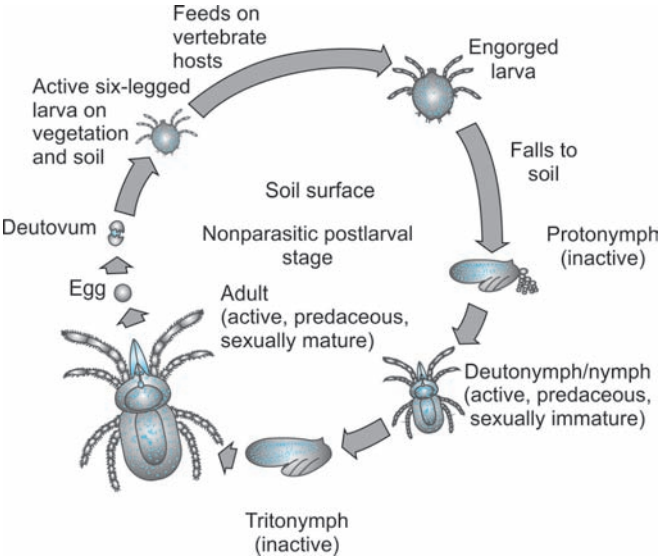


Fig. 15.36 Summarized life cycle of Trombiculid mites
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

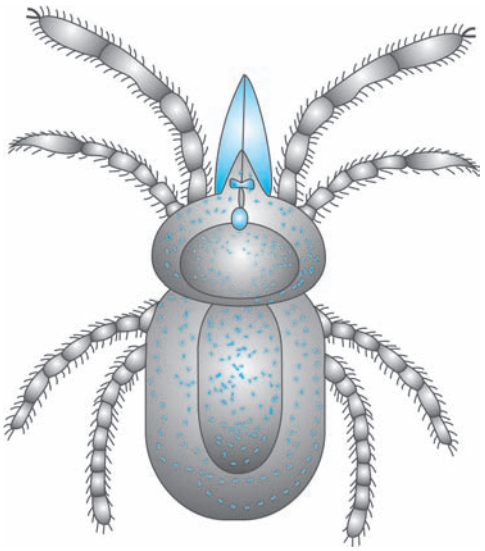


Fig. 15.37 Fully grown imago of *Leptotrombidium akamushi*
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

Diseases Transmitted

Vector (Larva of)	Disease	Pathogen
Trombiculid (Leptotrombidium) akamushi	Tsutsugamushi disease	Rickettsia orientalis
Tr. (Lepto) akamushi and deliensis	Scrub typhus	Ri. orientalis

Note : Larval stage is the biting stage. Therefore the diseases are transmitted by the larvae only. The larva bites only once

during its life time. When the larva bites the rodent infected with *Rickettssia orientalis*, the pathogens pass through the nymph stage, adult stage and to the eggs and larvae of next generation and larvae thus transmit the disease. This method of transmission is called 'Transovarian transmission.' Man gets the infection accidentally when bitten by the infected larva. It is to be remembered that the infection contracted in the larval stage can only be transmitted in the next larval stage.

Control Measures

- Offensive measures by using insecticides (tickcides) such as malathion or lindane, either by dusting or spray operations on grass lands and scrub jungles. This will destroy larva, nymph and adult stages of mite.
- Defensive measures consist of the use of protective clothing impregnated with insect repellent and also application of repellants.
- Corrective measures include the clearance of scrub vegetations around the human habitation and health education of the people.

Itch Mites (Sarcoptes Scabiei: Acarus Scabiei)

These are the ectoparasites of animals and human beings. Both are indistinguishable morphologically but distinguishable physiologically. These parasites cause 'Scabies' or 'Itch.' They themselves are the causative agents but do not transmit any disease. The animal itch-mite cannot flourish on human skin. Norwegian scabies is a severe form of scabies found among those, who do not appreciate the itching sensation as in lepromatous leprosy, severe malnutrition, old age, etc.

Morphology

Itch mite is an extremely small, globular and saccular creature, measuring about 0.2 to 0.4 mm in size, the females being larger than the males, body resembling like that of tortoise, round above and flat below. Body shows no demarcation into head, thorax and abdomen. However capitulum is distinct anteriorly. A fold of integument divides the body into dorsal and ventral surfaces. Dorsal surface shows transverse striations and possesses scales, hairs and bristles. Ventral surface possesses four pairs of jointed legs, two are directed anteriorly bearing five joints and two are directed posteriorly bearing four joints. The front legs end in suckers and the hind legs in female end in long bristles. The male has suckers in all the legs except the third pair, which has bristles and which distinguishes it from the female **(Figs 15.38 A and B)**.

Life Cycle

When the female itch mite comes into contact with the human skin, it starts burrowing the upper layers of epidermis, at the

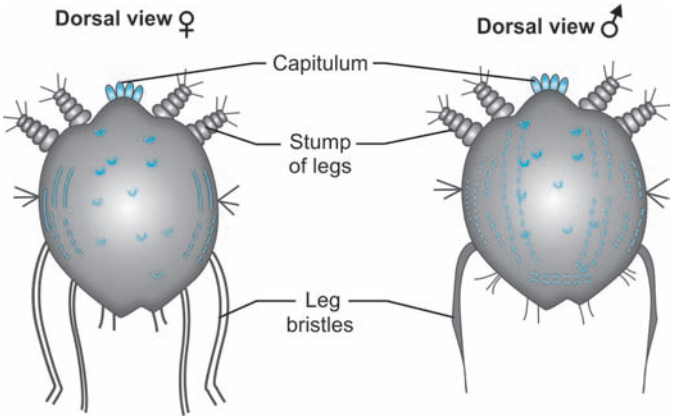


Fig. 15.38A *Sarcoptes scabiei*

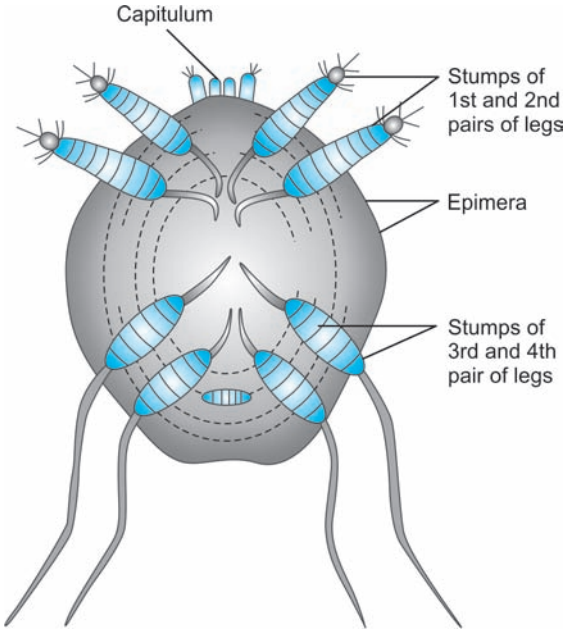


Fig. 15.38B Sarcoptes scabiei ♀ (Ventral view)
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

rate of 2 to 3 mm per day, being more active during night times. All along the sides of the tunnel (burrow), the female itch mite lays eggs, about 40 to 50 eggs, at the rate of 2 to 3 per day **(Fig. 15.38C)**. Since the eggs are laid in the tunnels it is called ovigerous tunnels. After laying the eggs, the female dies.

The eggs hatch into larvae within 3 to 4 days. The larvae possess three pairs of legs. They in turn make separate burrow from the parental burrow or enter the hair follicle for further development. Larval stage lasts for 2 to 3 days, after which it is transformed into nymph. The nymphs have four pairs of legs, resembling adults in all features except sexual maturity. They also dig into the skin of the host, resulting in papules at the

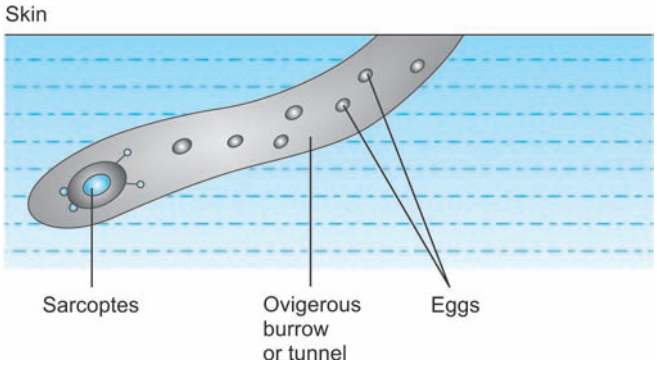


Fig. 15.38C Sarcoptes scabiei ♀ depositing eggs in tunnel inside human skin
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

site of digging, which cause considerable irritation, inducing irresistible scratching. The scratchings provide ways for the nymph to escape to the surface of the skin. Nymphal stage lasts for about one week. The small sized nymphs develop into male adults and larger nymphs develop into the female adults.

Copulation takes place soon after the emergence of adults. The male dies soon after mating and the female dies after laying eggs. The entire life cycle takes about 10 to 14 days. The metamorphosis is incomplete.

The parts of the body selected by female itchmite for oviposition are closed parts such as axilla, inguinal region, perineal region, scrotum, below the breasts, back of the knees, webs of fingers and toes. Since itching is the only symptom occurring, this parasite is called 'Itch-mite'. The itching is due to secretion of acrid fluid. The secondary infection resulting from itching, may destroy the parasites. Hence under such conditions, it is difficult to find them.

Control Measures

- Offensive measures consists of using (application) of sarcopticide to the infested persons and also the close contacts such as family members, irrespective of whether they have infestation or not. Simultaneous treatment of all household contacts is called 'Blanket treatment.' 25 percent Benzyl Benzoate (BB) emulsion is an effective sarcopticide. Before applying this, thorough scrub bath is given with hot water and soap, so that the vesicles rupture exposing the parasite to the effect of benzyl benzoate. The BB emulsion is applied with the help of a paint brush to the entire body surface, below the chin, including the soles of the feet and allowed to dry. BB is not applied to the face because it is irritant to the eyes. The application is repeated after 12 hours. Bath is given after further 12 hours. All the clothes are then changed. Repeated after one week if necessary. All the changed clothes, bedsheets, towels, pillow covers, etc. are all soaked in hot water, washed with soap, dried in the sun-light followed by hot pressing will be more effective in the control of itch-mites.

  Other effective sarcopticides are single application of permethrin ointment, twice application of crotamiton ointment, thrice application of tetmosol solution and four times application of sulphur ointment.
- Defensive measures are avoidance of contact with the infested person and avoidance of using towels and bedsheets of infested persons.
- Corrective measure consists of maintaining a high standard of personal hygiene.

Other Mites

The other mites of medical importance are dust mites and blood sucking mites. However, they do not transmit any disease.

Dust Mite (Dermatophagoides Pteronyssinus)

This is commonly found in house dust **(Fig. 15.39)**. It can cause in sensitized individuals bronchial asthma as well as extensive dermatitis. It feeds mainly on desquamated skin scales. The mites become air borne during bed-making and could then be inhaled; not only the living mites but also dead

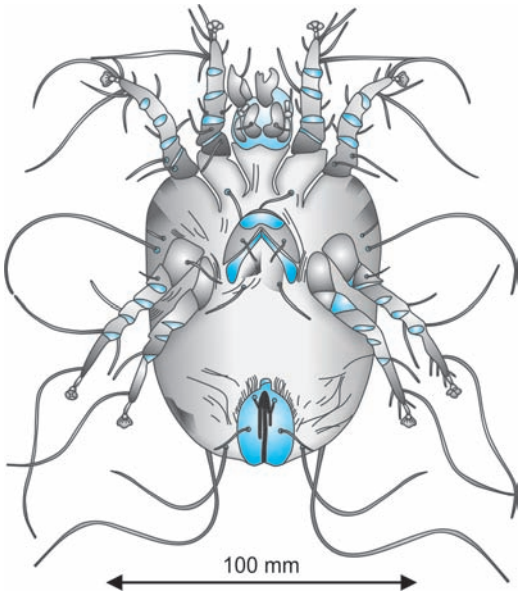


Fig. 15.39 *Dermatophagoides pteronyssinus* the house dust mite (Ventral view)
Source: Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.

one and mite feces contain potent allergens. The best method of controlling the mites would appear to be treatment of beds and settees with insecticides followed by thorough vacuum cleaning to remove dead mites and feces, as these could cause symptoms.

Blood Sucking Mite

The blood sucking mites are chicken mite, rat mite, bird mite and poultry mite. These can cause dermatitis in man. They attack the human host in the absence of their natural hosts. Rat mites are found in ware houses, bird mites in the eves of houses and in air conditioning ducts and may be blown into houses when the air conditioning is switched on.

Forage mites are pests of stored food products such as cheese, copra, vanilla pods, flour and macaroni. Persons handling such materials may be bitten or suffer from simple contact allergy named as grocers' itch, copra itch and bakers' itch, indicating the occupational nature of these dermatoses. When these mites are swallowed or inhaled, can cause gastric disturbances or respiratory symptoms. The mites do not breed in the body but may be recovered from feces or sputum.

CLASS CRUSTACEA

This group consists of crabs, lobsters, prawns, shrimps and cyclops, which are all acquatic in their life. The one of medical importance is cyclops.

CYCLOPS (WATER FLEA)

It is so named because of its characteristic jerky movements in the water while swimming. Two important diseases transmitted by cyclops as an intermediate host are Dracontiasis or Guineaworm infestation also called Dracunculiasis caused by Dracunculus—medinensis and Diphyllobothriasis (or Fish tapeworm infestation), caused by Diphyllobothrum-latum. This is not found in India but found in N. America, Europe, China, Korea and Phillipines.

The important species acting as vectors in the transmission of Dracontiasis are cyclops leukarti and cyclops hyalinus.

Morphology

Cyclops is a small, pear shaped, semi-transparent creature, of about 1 mm size and just visible to the naked eye. It has broad cephalothorax and a narrow abdomen, ending in caudal fork.

The cephalothorax consists of two parts. The anterior part is formed by the fusion of the head and the first segment of the thorax. The posterior part consists of the remaining thoracic segments. Anteriorly, there is a small, pigmented, single eye, like that of the giant of Greek mythology, thus deriving the name. On either side of the eye, there are two pairs of antennae. The first pair is long and called antennules and the second pair is short. Antennules not only help in locomotion but also help in seizing the female cyclops during copulation **(Figs 15.40A to C)**.

On the ventral surface of cephalothorax, anteriorly lie the mouth, surrounded by two pairs of maxillae and 1 pair of mandibles. Posteriorly, on the ventral surface, out of 6 thoracic segments, the first four segments bear each a pair of jointed feet with oar like or paddle like tips adapted for swimming in the water, hence called 'swimming feet'. The fifth segment bears a pair of rudimentary feet. The sixth or the last thoracic segment bears the genital aperture and is fused with the first abdominal segment.

Abdomen is composed of five distinct segments. The fifth segment branches into two 'caudal fork' and each fork terminates in a feathered filament or caudal hairs.

At the junction of the cephalothorax and abdomen, in female cyclops, exists a bag like structure on either side, in which eggs develop. It is called 'External ovisac' or egg-sac, which is absent in male cyclops, an important distinguishing feature.

Life Cycle

After copulation, as the eggs are fertilized in the ovisac, the sac gets detached from the body of the female cyclops. The eggs come out of the sac and are dispersed in the water. After 2-3 days, eggs hatch and larvae come out.

There are two stages of larva. The first stage is called 'Nauplius'. It is so called because of its resemblance to ships on sail. Nauplius is a minute boat shaped creature having a median eye and three pairs of legs. After 5 days, nauplius develops into the next stage, metanauplius, characterized by the addition of two more pairs of appendages and resembles adult. This stage lasts for about 7 days.

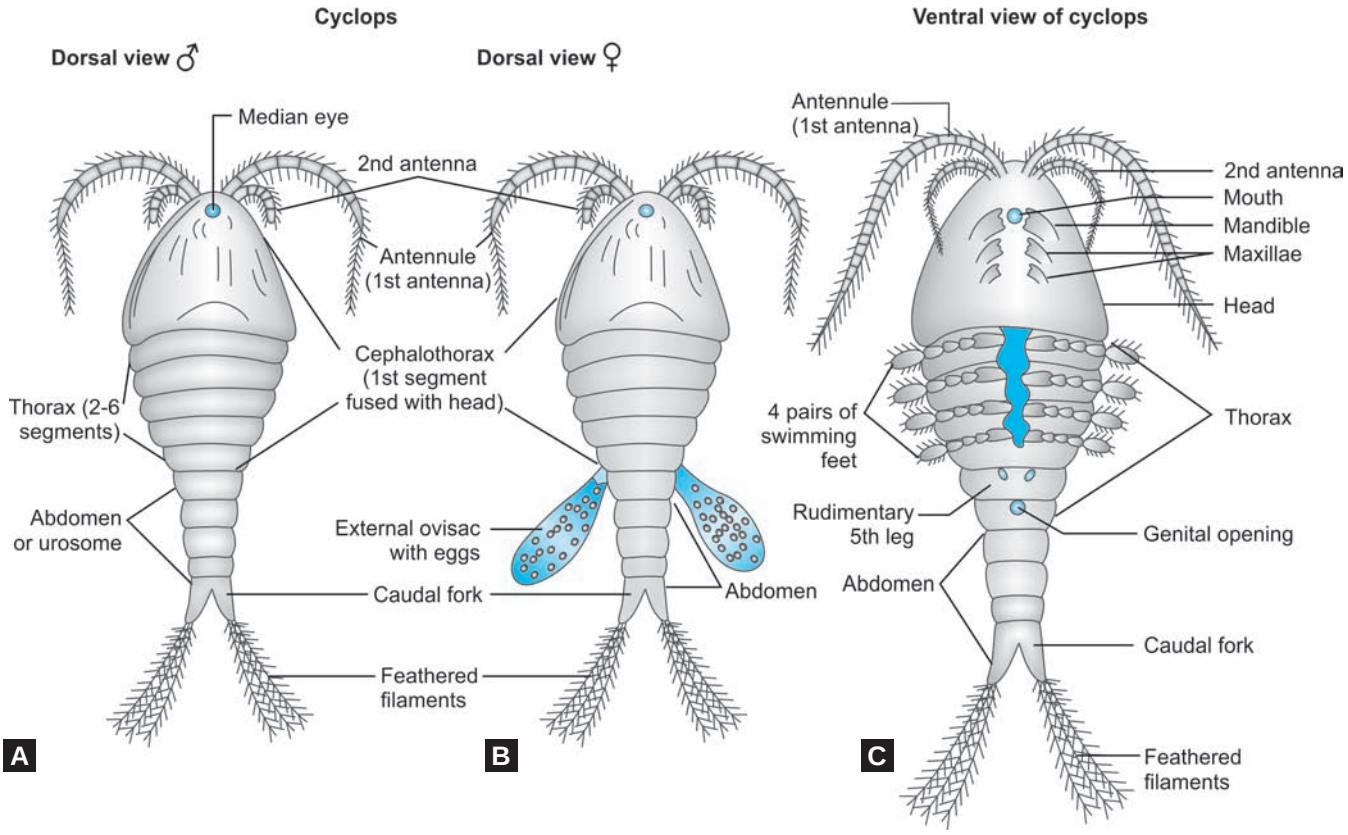
Adult cyclops emerge from metanauplius. Life cycle is complete in about 15 days, showing incomplete metamorphosis. Adults have a maximum life span of 3 months. They inhabit tanks, ponds and step-wells. When the females mature and develop ovisacs, they copulate and the life cycle repeats.

The constrasting features between rat flea and water flea are shown in **Table 15.6**.

Control Measures of Cyclops

Cyclops can be controlled by physical, chemical and biological measures.

a. **Physical measures:** These are the defensive measures. This consists of the following methods.
   i. *Straining:* Water is strained through a fine cloth which can arrest cyclops.
   ii. *Boiling:* Water when boiled, kills the cyclops.



Figs 15.40A to C Cyclops. (A) Dorsal view ♂; (B) Dorsal view ♀; (C) Ventral view
Source: Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

Table 15.6 Constrasting features between rat flea and water flea

Rat flea	Water flea
• Belongs to class-Insecta	• Belongs to class-Crustacea
• Adapted to terrestrial habitat	• Adapted to acquatic habitat
• Bilaterally compressed body	• Pear shaped body
• Possesses one pair of antennae, one pair of eyes and three pairs of legs	• Possesses one median eye, two pairs of antennae and five pairs of legs
• Walks freely through the hairs of the host and jumps with the help of its powerful legs	• Swims in the water showing jerky movement with the help of antennules and swimming feet
• Life cycle shows complete meta-morphosis comprising egg, larva, pupa and adult	• Life cycle shows incomplete metamorphosis showing egg larva and adult

b. **Chemical measures:** These are the offensive measures. This consists of the following methods:
   i. *Chlorination of water:* Chlorine in the concentration of 5 ppm destroys cyclops and the larvae of the guinea worm also.
   ii. *Addition of lime water:* Lime in the concentration of 1 gram per litre water destroys the cyclops.
   iii. *Addition of Abate to water:* Abate in the concentration of 1 ppm destroys cyclops and larvae of guinea worm also.

c. **Biological measures:** This is also an offensive measure consisting of using cyclopsivorous fish such as Ambassis ranga (glass fish), Etroplus macutatus and Trichogaster fasciatus, which feed on cyclops. These fish were employed successfully in the eradication of dracontiasis.

The most satisfactory and permanent method of control of cyclops consists of corrective measures such as provision of chlorinated piped water supply to the community and filling the infested water bodies or converting step wells into draw wells.

DISINSECTION

This consists of three components:
- Insecticide formulations
- Disinsection equipments
- Disinsection methods.

Insecticide Formulations

Insecticide formulations are solutions, suspensions, emulsions, dusts and granules.

Solutions

It is a liquid formulation in which the solid insecticide (solute) is dissolved in the liquid medium (solvent) to prepare a homogeneous formulation (solution) of uniform strength. Such solutions are best suited for absorbent surfaces like mud walls in which the solution sprayed seeps in and the walls retain the insecticidal effect for a long period.

Suspension

This is also a liquid formulation but the solid insecticide is not miscible with the solvent. Therefore a suspending agent is added to the immiscible mixture, which keeps the insecticide particles uniformly dispersed in the liquid medium. Each insecticide particle receives a coating of the suspending agent which prevents it from separating out and settling down. Such insecticide suspensions are also suited for spraying on the absorbent surfaces like mud walls, retaining the residual insecticidal effect.

Emulsion

This is also a liquid formulation, prepared by mixing the oily liquid insecticide with water (solvent), but both are immiscible liquids. A suitable emulsifying agent is added to the water so that the oily insecticide is dispersed uniformly through the medium of water in the form of minute oily droplets and also the emulsifying agent facilitates the retention of insecticide on non-absorbant surfaces like wood surface, cemented floor, cemented wall, etc.

Dust

Insecticidal dust is a mixture of solid insecticide and an inert diluent like chalk powder, limestone powder, Kieselguhr, bentonite, clay, etc. which is subjected for grinding in a micromizer to a fine dusty powder. Such insecticidal dust is suitable for treating rubbish dumps and manure pits.

Granules

Insecticidal granules are prepared by impregnating the coarse particles, such as sand, prophyllite or vermiculite with an insecticide. These particles act as insecticide carriers. Such insecticide granules are more effective than sprays as they release the insecticide over a long period, resulting in a sustained effect.

Disinsection Equipment

The commonly employed disinsection equipment are sprayers and dusters:

Sprayers

These are used for spraying the liquid insecticide formulations, e.g. Stirrup pump sprayer, knapsack sprayer, power operated sprayer, etc.

i. **Stirr-up pump sprayer:** In this equipment, the liquid insecticide is delivered under hydraulic pressure with the help of a plunger pump. The pump is clamped to a bucket containing the insecticide and is connected to a hose pipe leading to a hollow metal rod which terminates in a nozzle releasing a jet of insecticide formulation. The stirrup is operated manually as long as the operation continues.
ii. **Knapsack sprayer:** In this equipment, the liquid insecticide comes out under the pressure of compressed air. This has a piston type pump connected to an air chamber. Air pressure is created by up and down movement of the level of the pump. The sprayer is fitted on the back of the worker with the help of two straps. It is carried like a knapsack.
iii. **Power operated sprayer:** It is a heavy duty hydraulic spraying equipment, consisting of a pump driven by an engine, a liquid tank containing insecticide formulation and a delivery system, consisting of a hose pipe, lance and nozzle. The sprayer is mounted on a truck or trolley for free mobility. Thus it is used for disinsection of a large area.

Duster

This is employed to spray the insecticidal powder. A duster consists of a container containing the insecticide powder and an agitator that raises the dust and allows it to be carried by a current of air, which discharges the insecticide dust in the form of a cloud. Different types of dusters are the plunger type, the bellow type, the rotary crank type and the power duster.

Disinsection Methods

The important methods are space spraying, residual spraying and area spraying.

Space Spraying

This method consists of spraying the insecticide. Usually in the rooms, (closing the doors and windows) in the form of fine droplets, which remain in the air like a mist. Room is kept closed for about 20 minutes. The flying arthropod like

mosquitoes and flies, while passing through the 'mist' die instantaneously by the rapid knock-down (contact) poisonous effect. When the insecticide droplets fall down on the surface, they kill the resting insects like cockroaches and fleas. Since the space spraying does not leave any residual effect, spraying has to be done frequently. The principal insecticide employed for this purpose is pyrethrum extract. Space spraying is done either by hand sprayer or by aerosol dispenser. This method is not of much public health importance but may be carried out as a supplementary measure.

Residual Spraying

This method consists of spraying the long-acting insecticides on the walls and ceilings (not floors) of the dwellings to obtain long lasting residual effect of the insecticides. Organochlorine, organo-phosphorus and carbomate insecticides are all suited for residual spraying. This method is especially suited for the rural areas because of mud walls, which absorb the insecticide and retains the effect for a long time. Spraying is also done in dark corners, under-surface of furnitures, cots, and also in cattle-sheds and stables. Spraying is done using knapsack sprayers.

Area Spraying

This is an antilarval measure carried over stagnant water bodies, such as ponds, pools, swamps, etc. using insecticidal dust. This is also done over the refuse dumps and manure heaps to control larvae of houseflies.

Area spraying is also done over large areas of agricultural fields for the control of pests and flying mosquitoes by aerial method using air crafts. The insecticide is sprayed in the Ultra Low Volume (ULV) technique (explained under Japanese Encephalitis).

INSECTICIDE TOXICITY

The toxic effects of the insecticides occur either due to continued exposure or due to negligence of precautions. The effects depend upon the type of the insecticides used.

Organochlorine Compounds

DDT is now not used. HCH and Dieldrin are commonly employed. These enter the human system by inhalation and by absorption through the skin. These are nerve poisons. They cause excitation of nervous system. Clinically characterized by excitability, apprehension, headache, dizziness, confusion, disorientation, disequillibrium, weakness, tremors, convulsions and in extreme cases coma. Nausea and vomiting are common following ingestion.

Treatment

Stomach wash followed by barbiturates will be effective.

Organophosphorus Compounds and Carbamates

These are also absorbed through inhalation and by dermal contact. They act by inhibiting the enzyme choline-esterase in the synapses, resulting in the accumulation of acetyl-choline, inhibits the transmission of nerve impulses and hyperactivity of the parasympathetic system characterized by excessive lacrimation, salivation, urination, perspiration, nausea, vomiting, diarrhea. Associated other features are headache, dizziness, apprehension, confusion, hallucination, depression, convulsions and neuromuscular paralysis. Carbamates however have milder toxic effects.

Treatment

Atropine is the specific antidote for the organophosphorus poisoning. Dose—1 to 2 mgm, given intramuscularly every 30 minutes. Other specific drugs are 2 PAM iodine, 2 PAM chloride and P2S. Atropine should be combined with one of these drugs.

Pyrethrins and Pyrethroids

Due to their irritant property, they cause conjunctival congestion, irritation of nose, throat and their ingestion results in nausea, vomiting and other intestinal disturbances.

BIBLIOGRAPHY

1. Manson Bhar, Bell DR. Manson's Tropical Diseases. ELBS, 19th edn, 1987.
2. Ratnaswamy GK. A Handbook of Medical Entomology and Elementary Parasitology. 1st edn, 1974.

SECTION 3

Nutrition and Health

- Macronutrients
- Micronutrients
- Food Groups
- Balanced Diet
- Milk Hygiene
- Meat Hygiene
- Food Related Diseases
- Assessment of Nutritional Status
- Diet Survey
- National Nutrition Policy

CHAPTER 16

Nutrition and Health

INTRODUCTION

Food

It is a substance consumed, other than water and drugs, for maintaining the health, well-being and vitality of the individual. Sometimes foods are eaten raw. But most of the time, they are eaten after some culinary processes such as cooking, boiling, frying, baking, etc. After such treatment, the food becomes 'diet' (meal).

Nutrient

It is a chemical factor (active ingredient) present in food item, which determines the quality of food and in turn the health of the individual. For example, proteins, fats, carbohydrates, vitamins and minerals.

Nutrition

It is that branch of science, which deals with the study of a dynamic process, in which the consumed food is utilized for nourishing the body (a process of assimilation of food).

Dietetics

It is the science that deals with the study of nutrition in health and disease (i.e. planning of meals for the healthy and the sick).

Balanced Diet

It is the diet consisting of right kinds of foods in right proportions, as to provide the required energy and proximate principles for maintaining the health, vitality and well-being and makes small provision to withstand short duration of illness.

All the nutrients together with water form the main bulk of food. The human body is built up from all the six constituents (5 types of nutrients and water).

'Man is a mass of proteins (muscles), built upon minerals (bones), protected by fats (adipose tissue), energized by carbohydrates and activated by vitamins.'

CLASSIFICATION OF FOODS

By origin: Foods of animal origin; Foods of vegetable origin.

By chemical composition: Proteins, fats, carbohydrates, vitamins and minerals.

By function: Body building foods (Foods rich in proteins. For example, meat, fish, milk, egg, pulses, etc.). Energy yielding foods (Foods rich in fats and carbohydrates. For example, cereals, sugar, ghee, oil, etc.). Protective foods (Foods rich in vitamins and minerals. For example, fruits, vegetables, etc.).

By nutritive value: Cereals and millets, pulses, vegetables, nuts and oil seeds, fruits, animal foods, fats and oils, sugar and jaggery, condiments and spices, miscellaneous foods.

NUTRIENTS

These are grouped into two groups—macro- and micro-nutrients.

Macronutrients

They are so called because they are required in large quantities and so they constitute the main bulk of the food. They are often called 'Proximate principles'. For example, proteins, fats and carbohydrates. Their contribution in the food is as follows:

Proteins—7 to 15 percent
Fats—10 to 30 percent
Carbohydrates—65 to 80 percent

Micronutrients

They are so called because they are required in small quantities (varying from micrograms to milligrams). For example, vitamins and minerals.

MACRONUTRIENTS

PROTEINS

Means they are of prime importance. They are complex compounds consisting of carbon, hydrogen, oxygen, nitrogen and sulfur. Proteins differ from carbohydrates and fats in that they contain nitrogen.

Each molecule of protein is made up of large number of units called 'amino acids', linked by peptide chains. There are about 22 amino acids, which are grouped into 'Essential' and 'Non-essential' amino acids. Essential ones are 8 in number and they are so called because they are not synthesized in the body in required amounts and they are essential to the body. Therefore they have to be obtained from dietary proteins. They are leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. In addition, growing children require Histamine. Non-essential amino acids are so called because they are synthesized in the body. It does not mean that they are not essential to the body. Both essential and non-essential amino acids are needed for synthesis of tissue proteins.

Proteins are of two types—complete and incomplete, biologically. A complete protein is one, which contains all the essential amino acids in required quantities. It is also called 'First class protein' or 'Protein of high biological value'. For example, animal proteins such as egg, milk, fish, etc.

An incomplete protein is one, which is deficient in one or more essential aminoacids. They are also called 'Second class' proteins or proteins of 'low biological value'.

For example, vegetable proteins such as cereals, pulses, etc.

But there are exceptions. Gelatine obtained from animal source has low biological value and yeast derived from vegetable source soybean has high biological value.

Supplementary Actions of Proteins

Cereal proteins are deficient in lysine and threonine. Pulses are deficient in methionine, maize in lysine and tryptophan. These are known as 'Limiting amino acids'. When cereals and pulses are eaten together in combination, for example, Rice and Dal, their deficient amino acids supplement each other providing a protein comparable to first class protein in respect to essential amino acids. This is known as 'Supplementary actions of proteins'.

Functions of Proteins

- They are essential for growth and development of the body (Body building)
- They are essential for the repair of the tissues (wear and tear)
- They are the constituents of enzymes, hormones, antibodies, plasma and hemoglobin
- They maintain osmotic pressure and thus maintain fluid balance in the body
- They provide energy (1 g provides 4 kcals of energy)
- They maintain the hydrogen ion concentration of the body fluid thus maintain the acid-base balance.

Daily Requirement

Since proteins cannot be stored in the body, its daily requirement is essential.

The daily requirement of proteins is 1 g/kg body weight for adults. It is more for growing children, during pregnancy, during lactation, during infections, infestations, stress and during recovery from diseases.

The recommended allowances are as follows, for different groups of individuals **(Table 16.1)**.

Sources: There are two main sources:

A. **Animal sources:** Meat, milk, egg-white, fish, cheese, etc. All these animal proteins contain all the essential amino-acids. Hence they are called First class proteins. However, the egg-proteins are considered to be the best animal protein, because of its high biological value and digestibility. Hence, egg protein is called 'Reference protein'.
B. **Vegetable sources:** These are cereals, pulses, beans, nuts, oil-seed cakes, etc.

Table 16.1 Safe dietary intakes of protein

Age groups	Safe protein allowance (g/d)
Infants	
0–6 months 6–12 months	1.16 g/kg/d 1.69 g/kg/d
Children	
1–3 years 4–6 years 7–9 years 10–12 yrs-boys 10–12 yrs-girls 13–15 yrs-boys 13–15 yrs-girls 16–18 yrs-boys 16–18 yrs-girls	15.7 20.3 29.6 39.3 40.4 54.2 51.9 61.5 52.1
Adults	
Men Women Pregnant women* Lactating women 0–6 months 6–12 months	60.0 55.0 82.2 (55 + 27.2) 77.9 (55 + 22.9) 70.2 (55 + 15.2)
*For weight gain of 10 kg in pregnant women	

Source: 1(a)

They are poor in essential amino acids. They are called second class proteins. Still, they are the main sources of protein in India, because they are cheap, easily available and consumed in bulk compared to animal sources and majority are vegetarians.

Mixed Vegetable Proteins (Vegetable Blends)

This is the supplementary action of the proteins of vegetable sources. Examples are:

- *Indian multipurpose food:* This consists of 25 percent roasted Bengal gram flour and 75 percent groundnut cake, fortified with vitamins and minerals.
- *Mysore food A:* This is Indian multipurpose food fortified with lysine.
- *Mysore food B:* This consists of 25 percent roasted Bengal gram flour, 50 percent groundnut cake and 25 percent sesame flour enriched with lysine.
- *Balahar:* It is a mixture of groundnuts, wheat, Bengal gram and jaggery fortified with vitamins and minerals.

Evaluation (Assessment) of Proteins

Proteins are evaluated by the following parameters:

i. Digestibility coefficient
ii. Biological value
iii. Net protein utilization
iv. Amino acid score
v. Protein efficiency ratio
vi. Protein-energy ratio.

Digestibility Coefficient

Digestibility coefficient (DC) is the percentage of ingested proteins that is absorbed in the blood stream (i.e. ingested nitrogen minus fecal excreted nitrogen).

Biological Value

Biological value (BV) is the percentage of nitrogen retained (after its excretion in the feces and urine) out of the nitrogen absorbed from the diet (i.e. absorbed nitrogen minus nitrogen excreted in urine).

$$BV = \frac{\text{Nitrogen retained}}{\text{Nitrogen absorbed}} \times 100$$

Net Protein Utilization (NPU)

It is the proportion of ingested protein or nitrogen that is retained in the body, for the maintenance and growth of the tissues (i.e. percentage of nitrogen utilized by the body tissues).

It is the product of digestibility coefficient and biological value divided by 100. It is directly related to the dietary intake of nitrogen. If net protein utilization (NPU) is low, the protein requirement is high and vice-versa. A NPU value above 50 is considered satisfactory.

$$NPU = DC \times BV/100$$

$$\text{or } NPU = \frac{\text{Nitrogen retained}}{\text{Nitrogen absorbed}} \times 100$$

1 g of protein is assumed to be equivalent to 6.25 g of nitrogen.

Essential Amino Acid Score (Chemical Score)

It is the concentration of the essential amino acid in the test protein, expressed as percentage of that essential amino acid in the reference protein (i.e. egg-albumin).

$$\text{Amino acid score} = \frac{\text{Milligram of one essential amino acid in 1 g of test protein}}{\text{Milligram of the same amino acid in 1 g of reference protein}} \times 100$$

The lowest score of any essential amino acid indicates the limiting amino acid. The score is about 50 to 60 for starches and 70 to 80 for animal foods.

Protein Efficiency Ratio

It is the weight gain in an young growing animal per unit weight of protein consumed.

$$\text{PER} = \frac{\text{Weight gain (g)}}{\text{Protein intake (g)}} \times 100$$

Though applied to laboratory animals like rats, this is also used in investigations based on human infants.

A high protein efficiency ratio (PER) (> 2.5) is assigned to proteins that are efficient in promoting growth. These are first class protein (animal proteins). The PER between 0.5 and 2.5 is assigned to proteins that are efficient in supporting life but not growth. These are vegetable proteins; found in pulses, nuts and cereals.

Protein Energy Ratio

Protein energy (PE) is the percentage of the energy value obtained from the protein content of the food.

$$\text{PE percent} = \frac{\text{Energy obtained from protein}}{\text{Total energy in the diet}} \times 100$$

A diet providing less than 5 or 8 percent of the calories from proteins does not meet the requirement of an adult or child respectively. It is recommended that protein should account for approximately 15 to 20 percent of the total daily energy intake.

New tissues cannot be formed unless all essential amino-acids (EAA) are present in the diet. The requirement of EAA decreases as the age advances. Thus the quality of the diet is far more critical for an infant than for the adult.

FATS

These are the compounds of glycerol (glycerin) and fatty acids. The latter are made up of carbon, oxygen and hydrogen. Fats are the solid forms and oils are the liquid forms. Lipid is a comprehensive term consisting of both fats and oils. Fats and oils are the richest source of energy.

Lipids include simple lipids (e.g. triglycerides), compound lipids (e.g. phospholipids) and derived lipids (e.g. cholesterol). About 99 percent of the body fat in the adipose tissue, is in the form of triglycerides. The adipose tissue constitutes about 10 to 15 percent of body weight.

Fatty acids: These are grouped into 2 groups—saturated and unsaturated.

Saturated fatty acids: These are primarily derived from animal sources (except coconut oil). For example, lauric, palmitic and stearic acids. They can be synthesized in the body during the catabolism of proteins and carbohydrates.

Unsaturated fatty acids: These are primarily derived from vegetable sources. These are further divided to monounsaturated (MUFA, e.g. Oleic acid) and polyunsaturated fatty acids (PUFA, e.g. Linoleic acid) former can be synthesized in the body but the latter cannot be synthesized in the body.

Essential fatty acids (EFA): These are those which are not synthesized in the body and they are essential to carry out the following functions and they have to be derived only from the food (vegetable oils). For example, Linoleic acid, linolenic acid, arachidonic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Functions of EFA

- They maintain the integrity of the skin (smoothness and healthiness)
- They (EPA and DHA) reduce the serum cholesterol in the blood by transportation
- They maintain enzyme system in the body
- They help in the synthesis of prostaglandins
- DHA is especially active in retina and cerebral cortex.

Deficiency of all EFA in the diet may result in growth retardation, reproductive failure, skin disorders (like phrynoderma), increased susceptibility to infections, decreased myocardial contractility, renal hypertension and hemolysis. Deficiency of omega-6 fatty acids (Linoleic and arachidonic acids) leads to skin changes while that of omega-3 fatty acids (Linolenic acid, DHA and EPA) to visual and neurological symptoms.

Daily requirement of EFA is about 5 g. It is slightly more in infants, growing children, pregnant and lactating mothers. EFA are present mainly in vegetable oils.

The saturated fatty acids are mainly obtained from animal fats and unsaturated fatty acids from the vegetable oils. However, there are exceptions. For example, fish oil even though it is from animal source, it contains unsaturated fatty acids. (i.e. 10%). Similarly, coconut oil and palm oil even though they are vegetable oils, they are rich in saturated fatty acids (i.e. 92 and 46% respectively).

Sources of Fats (Table 16.2)

Animal Sources

These are ghee, butter, milk, cheese, egg yolk, meat and fish. These are rich sources of saturated fatty acids (except fish).

Vegetable Sources (Edible Oils)

These are groundnut oil, mustard oil, gingelly oil, linseed oil, safflower oil, rapeseed oil, coconut oil and palm oil.

These are rich source of unsaturated fatty acids (except coconut oil and palm oil).

Certain amount of fat is also found among cereals (3–4%), pulses, and other vegetables. It is called invisible fat.

Functions

- Fats are the most concentrated source of energy. Each gm supplies 9 kcals of energy. In the form of subcutaneous fat-depot, fat acts as a storehouse of energy.
- Animal fats are the main sources of vitamins A, D, E and K

Table 16.2 Fatty acids content of different fats (Percent)

	Fats	Saturated fatty acids	Unsaturated fatty acids
Animal fats	Butter	60	20.0
	Meat	10–20	0.5
	Egg	13.3	0.3
	Buffalo milk	7.5	0.5
	Cow's milk	3.8	0.5
	Fish oil	2.0	10.0
Vegetable oils	Groundnut oil	20	40
	Mustard oil	08	15
	Safflower oil	10	45
	Sunflower oil	08	45
	Coconut oil	92	04
	Palm oil	46	25

Source: ICMR (1990)

- Fat acts as cushion to viscera like heart, kidney, intestine, etc. and gives support to them
- Subcutaneous fat acts as an insulator against cold
- Fat gives smooth contour to the body
- It is a structural unit of some tissues in the body like nervous tissue
- Fats prevent proteins from being used up for energy. Hence, the fats are called 'Protein sparers'
- It increases the palatability, taste and flavor of the food.

Hydrogenation of Oils

Hydrogenation of vegetable oils removes the color and odor. During the process, the liquid oils are converted into semi-solid and solid fat. The solid fat is called 'Vanaspati' or vegetable ghee, which is a popular cooking medium. Thus it improves the keeping quality.

Meanwhile, in the process, the unsaturated fatty acids are converted into saturated fatty acids and the EFA content is drastically reduced. For example, the EFA content of groundnut oil is reduced from 20 percent to hardly 2 percent. Even though there is formation of saturated fatty acids Vanaspati is deficient in fat soluble vitamins. Therefore, vanaspati is fortified with vitamin A and D.

Refined Oils

When vegetable oils are treated with steam, alkali etc., not only the oil is deodorized but also becomes free from free fatty-acids, vitamin A and D and rancid materials, thereby the taste is improved. However, there is no change in the unsaturated fatty acid content of the oil. Thus the quality of the oil is improved, except for the deficiency of vitamins A and D.

Daily Requirement

Indian Council of Medical Research (ICMR) has recommended 20 percent of total energy requirement through fats (and not more than 30%), i.e. about 40 g per day for an adult man, about 25 g from the visible fat (Groundnut oil) and remaining from the invisible form.

Applied Aspects

- A diet rich in fat, predisposes for obesity.
- Deficiency of essential fatty acids is associated with dry and rough skin, i.e. Phrynoderma, characterized by horny papular eruptions on the posterior and lateral aspects of limbs, which can be cured by administration of safflower oil, rich in EFA.
- High fat intake, more than 40 percent of the total energy per day, containing high proportion of saturated fatty acids, is a major risk factor for Coronary Heart Disease (CHD), because it increases the serum cholesterol level. (Hypercholesterolemia), which in turn predisposes for the development of atherosclerosis and coronary heart disease.

If the serum cholesterol level is between 150 and 200 mg/dl, the risk of CHD is twice as much as when it is less than that. If it is between 201 and 250, the risk of CAD is three times and the risk becomes 4 times, if it is more than 250 mg/dl.

Normally, a class of lipoproteins called 'High Density Lipoproteins' (HDL) transport cholesterol from the peripheral tissues to liver. Thus, HDL exerts a protective effect against the development of atherosclerosis and CHD.

Another class of lipoproteins called 'Low Density Lipproteins (LDL) and Very Low Density Lipoproteins (VLDL)' are atherogenic and predispose for the development of CHD. The risk of CHD is 2 times, if LDL level is between 130 and 160 mg/dl and 3 times if it is more than 161 mg/dl. Thus, LDL is a real 'risk marker' of coronary artery disease.

Therefore, HDL is good for health and LDL is bad for health. If LDL is high and HDL is low and the ratio of LDL to HDL if more than 5, it indicates the risk of coronary artery disease.

Thus, there is an inverse relationship between EFA intake and CHD mortality and direct relationship between saturated fatty acids intake and CHD mortality.

Therefore, to avoid CHD, not more than 30 percent of the calories required are obtained from fats and not more than 10 percent are derived from saturated fatty acids.

CARBOHYDRATES

This constitutes the main bulk of our diet. They are so called because each unit of carbohydrate (CHO) consist of carbon, hydrogen and oxygen. Depending upon the number of

units, the carbohydrates are grouped into monosaccharides (having single unit, e.g. glucose, galactose, fructose, ribose). Disaccharides (having two carbohydrate units, e.g. lactose, maltose, sucrose) and polysaccharides (having more than two units, e.g. starch, cellulose).

Mono and disaccharides are sweet and are soluble in water, whereas polysaccharides are not sweet and are insoluble in water.

Starch is present in cereals, millets, roots and tubers. Thus it is the chief source of our energy.

Cellulose is a fibrous substance (dietary fiber) present as lining in the cereals and pulses, fruits and vegetables. It has no nutritive value.

Functions

1. Carbohydrate serves as a main source of energy. One gram of CHO yields 4 kcals of energy.
2. It is essential for the oxidation of fat (Fats are burnt in the fire of carbohydrate).
3. Carbohydrate is stored as glycogen in the liver and muscles. The reserve is rapidly exhausted when the person starves.
4. Excess of carbohydrate is stored as fat in the body.
5. It acts as a structural unit of nervous system, as cerebroside.
6. It exerts protein sparing action.
7. It adds flavor and texture to the food and increases palatability.

Sources

Main sources of CHO are cereals, pulses, fruits, roots and tubers. Sugar, jaggery and honey are 100 percent carbohydrates. The CHO content of flesh foods is negligible.

Daily requirement: It is 400 to 500 g. CHO should constitute nearly 60 to 70 percent of total energy requirement of the body.

$$\left(\frac{2400}{100}\times 70=\frac{1680}{4}=420\text{ g}\right)$$

Carbohydrate and Disease

- High intake of sweets (sucrose rich foods, e.g. candy, cake, ice cream, etc.) predisposes for obesity.
- High intake of sucrose causes sharp rise in blood glucose, which in turn exerts more work on beta-cells of islets of Langerhans in the pancreas. This might eventually leads to exhaustion of beta-cells and consequent diabetes.
- Sucrose favors the growth of bacteriae in the oral cavity. These bacteriae produce acid, which has a corrosive effect on dental enamel leading on to the development of dental caries.

Dietary Fiber

This is an inert component of carbohydrate with little nutritive value. It is a non-starch polysaccharide. It is found in vegetables, fibrous fruits (pineapple), brans and whole grains as lining. It is hardly found in animal foods. It includes cellulose and non-cellulose polysaccharides such as hemicellulose, pectin, lignin, inulin.

Functions

Major part is not digested in the gut but they are degraded by the microflora in the colon. Only a small part is digested by the bacterial flora to help themselves for multiplication and gas production. The gas is entrapped in stool and makes the stool bulky and soft. The rectal distention stimulates the defecation reflex. Conversely deficiency of fiber not only leads to constipation but also increases the hardness of the stool. Hard stool needs straining, which inturn increases the intra-abdominal pressure predisposing for the development of hemorrhoids, hernia, diverticulosis, and varicose veins.

- Dietary fiber (soluble fiber) will bind cholesterol of the food and prevents its absorption and eliminates it through stools, reduces serum cholesterol level. Thus it is associated with reduced risk of atherosclerosis.
- Low fiber diet is associated with less fecal volume and constipation, resulting in higher concentration of carcinogens ingested in the food. Bowel mucosa exposed to this higher concentration of carcinogens for an unduly long period, predisposes for cancer of colon.
- Fiber acts as a scavenger-cum-vehicle to remove tissue debris and other unwanted materials from intestine through stools.
- Fiber facilitates, the normal peristaltic movements of the intestine.
- Soluble fiber prevents gallstones and obstructive jaundice. It also slows down the absorption of glucose, hence good for diabetics.
- Thus, fiber is an essential nutrient in its own way, even though by itself is a non-nutrient. An average diet should include 40 g of fibers per day.

MICRONUTRIENTS

They are so called because they are required in tiny amounts (few µg to mg per day). They include vitamins and minerals. They are so important that normal healthy living is not possible without them. Of all the micronutrients, four are most important, namely iodine, iron, zinc and vitamin A. They are important for immunity, intelligence, reproduction and work capacity. They cannot be synthesized endogenously and have to be supplied in diet. The term micronutrient

malnutrition refers to deficiency of these. Micronutrient deficiencies result from inadequate dietary intake, poor absorption from gastrointestinal tract, excessive losses, increased requirements or a combination of these factors.

The micronutrients include vitamins and minerals:

VITAMINS

They are so called because they carry out vital functions in the body. They do not provide energy unlike macro-nutrients, but they enable the body to use other nutrients. They are not synthesized in the body (except vitamin B complex) and therefore, they have to be obtained in the food.

Vitamins are grouped into 2 groups:

I. *Fat soluble vitamins:* These are vitamins A, D, E and K.
II. *Water soluble vitamins:* These are vitamin B complex group and vitamin C.

FAT SOLUBLE VITAMINS

Vitamin A

This occurs in two forms, as retinol in animal foods and as β-carotene in plant foods. Carotene is converted into retinol in the intestine, which is then absorbed and stored in the liver as retinol-palmitate.

Functions

- Vitamin A helps in the synthesis of a pigment called 'Rhodopsin' in the retina of the eye, which is necessary for the normal vision, especially in the dim-light for dark adoptation. Thus vitamin A is indispensable for normal vision.
- It maintains the integrity of the skin and mucous membrane of the conjunctiva, cornea, respiratory, alimentary and urinary system.
- It promotes skeletal growth.
- It increases the immune response. Thus it is anti-infective.
- It may protect some epithelial cancers such as carcinoma of bronchus.

Sources

Vitamins A is widely distributed in the nature in both animal and plant foods **(Fig. 16.1)**.

Animal Sources (as Retinol)

These are meat, liver, fish, egg-yolk, milk, cheese, butter, ghee. Richest source is fish liver oil (Cod liver oil and shark liver oil).

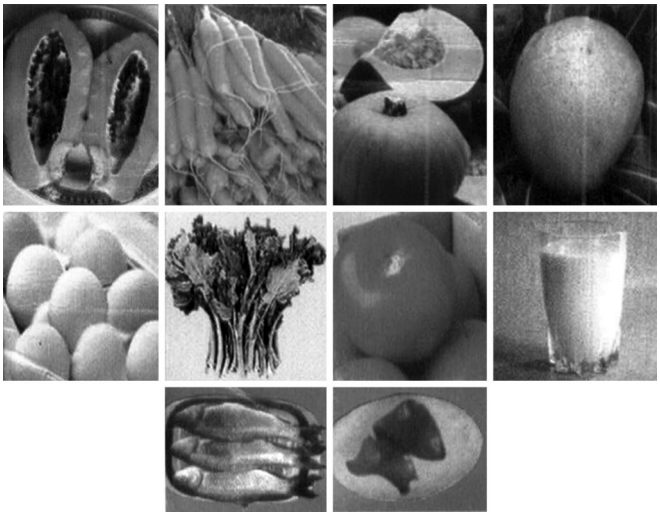


Fig. 16.1 Sources of vitamin A

Vegetable Sources (as β-carotene)

Cheapest source is green leafy vegetables, e.g. spinach, amaranth. Darker the green color of the vegetables, higher the carotene content.

Richest source is red palm oil. Other sources are yellow fruits like mango and papaya. Some roots like carrots are also rich in β-carotene.

Vitamin A content of some common foods (Table 16.3) (as µg of carotene per 100 g of edible portion):

The human liver has enormous capacity to store vitamin A in the form of retinol-palmitate. Therefore, under normal conditions, a well-fed person has sufficient reserve of vitamin A to meet his needs for 6 to 9 months. But a newborn child is not having any reserve and it depends upon vitamin A everyday. Thus, an young child is always at a risk of deficiency.

Free retinol is active and toxic. Therefore, it is always transported along with a binding protein called 'Retinol binding protein', which is produced by the liver.

In severe protein deficiency and liver diseases, there will be decreased production of the binding protein resulting in decreased mobilization of liver retinol reserves.

Deficiency of vitamin A: The signs and symptoms are grouped into ocular and extraocular manifestations.

Ocular manifestations: All the ocular manifestations are due to decreased synthesis of rhodopsin in the retina and due to dryness of conjunctiva and its consequences. All the ophthalmic manifestations due to vitamin A deficiency are included under the term 'Xerophthalmia' (Xerosis = dryness; dry eye). The features occur in the following stages:

a. **Night blindness (Nyctalopia):** That means inability to see in the dim light by an young child as the evening sets in.

Table 16.3 Vitamin A content of some common foods (µg of carotene per 100 gm of edible portion)

Plant foods	Vitamin A content	Animal foods	Vitamin A content
Green leafy vegetables	5500	Milk	160
Carrot	1890	Butter	3200
Tomato ripe	350	Ghee (cow)	2000
Mango	2743	Ghee (buffalo)	900
Papaya	666	Egg-yolk	600
Coriander	6918	Cod liver oil	10,000

Source: ICMR (1990)

This is because of failure in the dark adoptation because of decreased synthesis of rhodopsin in the retina. The classical complaint by the mother is that her child cannot find her or dashes against the wall as the dark sets in. Nyctalopia is the earliest clinical feature. If not managed at this stage, it passes on to the next stage.

b. **Conjunctival xerosis:** The normal, smooth, shiny conjunctiva over the sclera becomes dry, dull and wrinkled giving a smoky appearance. Often this occurs following chronic exposure to dust and smoke also, but among adults.
c. **Bitot's spots:** These are triangular, foamy, pearly-white or yellowish spots on the bulbar conjunctiva, usually lateral to cornea and often bilateral. It is characteristic of vitamin A deficiency.
d. **Corneal xerosis:** The smooth, shiny, transparent cornea looks dull and dry, eventually it becomes opaque. If not managed at this stage, it leads on to corneal ulceration. Thus the involvement of cornea constitutes medical emergency.
e. **Corneal ulcer:** The ulcer may be big or small, which after healing leaves behind a permanent scar, which affects vision.
f. **Keratomalacia:** As the deficiency of vitamin A continues, the entire cornea or a part of it becomes soft and later it is liquefied. This constitutes a grave medical emergency, because the soft cornea may burst open, leading on to prolapse of iris. If the eye collapses, vision is lost. Keratomalacia is one of the major causes of preventable blindness in India and is often associated with PEM.

Extraocular Manifestations

- Retardation of growth
- Follicular hyperkeratosis (Phrynoderma)
- Anorexia
- Increased incidence of respiratory and alimentary infections
- Development of urinary calculi.

Assessment of Vitamin A Deficiency

Since the ophthalmic manifestations are many due to deficiency of vitamin A, WHO has recommended to consider any one of the following criteria as an evidence of xerophthalmia problem in the community, as per the surveys done among preschool children, aged 6 months to 6 years **(Table 16.4)**.

The recommended intake of vitamin A for different age group is shown in **Table 16.5**.

Hypervitaminoses A

An excess intake of retinol causes anorexia, vomiting followed by sleep disorders and skin desquamation. Other features are hepatomegaly, papilledema, bony exostoses (swelling over the long bones), brittleness of the bones and often fractures. The teratogenic effects of massive doses of vitamin A is the most recent focus of interest.

Vitamin D

There are two forms namely vitamin D_2 (calciferol) and D_3 (cholecalciferol). Chemically, these are steroids. D_2 is formed

Table 16.4 Criteria of vitamin A deficiency

Criteria	Prevalence (among children 6 months to 6 years)
Night blindness	> 1%
Bitot's spots	> 0.5%
Corneal xerosis	> 0.01%
Corneal ulcer/keratomalacia	> 0.05%

Source: WHO. TRS. No. 672, 1982.

Table 16.5 Recommended intake of vitamin A

Groups		RDA 2009 (Retinol Equivalents mcg/d)	
		Retinol	β carotene*
Adults	Man Woman Pregnant woman Lactating woman	600 600 800 950	4800 4800 6400 7600
Infants	0–6 months 6–12 months	350	- 2100
Children	1–3 years 4–6 years 7–9 years	400 600 600	3200 4800 4800
Adolescents	10–12 years 13–15 years 16–18 years	600 600 600	4800 4800 4800
* β Carotene = 8 times retinol			

Source: 1 (a)

by the irradiation of ergosterol in the plants and is not obtained. D_3 is the naturally occurring vitamin D, obtained from animal fats and fish liver oils. It is also naturally synthesized in the body, on exposure of 7-dehydrocholesterol (present as provitamin D under the skin) to ultraviolet rays of sun. It is then stored in the liver and fat depots.

Functions

- Vitamin D promotes the absorption of calcium and phosphorus in the intestine
- It helps in the mineralization, i.e. calcification of bones and their hardening.

Sources (Table 16.6)

Vegetable foods do not contain this vitamin:

a. Vitamin D is naturally synthesized in the body in adequate amount on exposure of skin to UV rays of sun (explained).
b. Animal foods rich in vitamin D are fish liver oil, butter, milk, ghee and egg-yolk.

Table 16.6 Food sources of vitamin D

Food	Vitamin D_3 content (µg per 100 g)
Shark liver oil	30–100
Cod liver oil	200–500
Halibut liver oil	500–10,000
Egg–yolk	1.5
Butter	1.0
Fish	05–30

Source: ICMR (1990)

Deficiency

Causes: Rickets among children and Osteomalacia among adults.

Rickets

Due to vitamin D deficiency, the calcification of cartilage cells is incomplete and calcification is also irregular. Bone becomes less rigid and soft predisposing for deformation and fractures due to body weight itself as the child grows. So the features are common among infants and preschool children.

Craniotabes is the earliest manifestation (The pressure over the occipital or posterior part of parietal bones, is felt like a ping-pong ball, if compressed and released, due to soft membranous bones of the skull). Bossing of frontal and parietal bones becomes evident later. Costo-chondral junctions over the chest look like beads, described as 'rickety-rosary', the sternum projects forwards, (pigeon shaped chest), a horizontal depression along the line of insertion of diaphragm over the lower chest, is described as 'Harrison's groove'. Eruption of primary teeth is delayed. Moderate degree of scoliosis, kyphosis, or lordosis may occur. Epiphyses of long bones are widened and appear clinically as widening of wrist. As the child starts bearing weight, long bones of the legs bend resulting in knock-knees, bow-legs and coax-vera. Abdominal muscles become flabby due to hypotonia and abdomen becomes protuberant (pot-belly).

Deficiency of vitamin D in early infancy results in bilateral lamellar cataracts.

Investigations

Early radiological changes are seen in the lower end of radius and ulna. X-ray of wrist shows a cup shaped depression. The epiphyseal plate appears widened. Large gap is seen between epiphysis and metaphysis. Alkaline phosphatase is high and serum phosphorus low.

Osteomalacia

This is more common among women specially during pregnancy and lactation when requirements of vitamin D are increased. There is difficulty in usual movements like standing, climbing stairs, etc. A waddling gait may be seen. X-ray shows rarefaction of bones with typical Looser's zones.

Daily Requirement (Table 16.7)

The required amount of vitamin D_3 is obtained from exposure to sunlight. Therefore, rickets is rare in India. Dietary Vitamin D is essential only when exposure is inadequate.

One µg of cholecalciferol = 40 IU (To convert IU to µg, divide by 40).

Table 16.7 Daily requirement amount of vitamin D

Infants	5.0 µg (200 IU)
Children	10.0 µg (400 IU)
Adult	2.5 µg (100 IU)
Pregnancy/Lactation	10.0 µg (400 IU)

Source: ICMR (1990)

Hypervitaminosis D

The margin between the daily requirement dose of vitamin D and the toxic dose is narrow. Overdose results in nausea, vomiting, anorexia, thirst, drowsiness. Hypercalcemia may result not only in calcification of the tissues but may also result in cardiac arrhythmias and renal failure.

Vitamin E (Tocopherol)

Its role in human beings is not understood completely. But in experimental animals, its deficiency has been shown to be associated with miscarriage and sterility. It has been found to have anti-oxidant property and protects membrane phospholipid from free radical induced peroxidase damage.

As an anti-oxidant, it is used as a free radical scavenger. Its beneficial effect on coronary thrombosis, ischemic heart disease, healing of wounds have been postulated. Some menopausal symptoms like hot flushes, depression, sweating are diminished after the intake of vitamin E.

Foods rich in polyunsaturated fatty acids, e.g. vegetable oil, cotton seed oil, sunflower oil, wheat germ oil, soybean, corn-oil, green leafy vegetables, egg-yolk and butter are good sources.

A normal adult requires about 10 µg (15 IU) of vitamin E per day. Infants require only 3 µg (5 IU) of alpha-tocopherol per day.

Vitamin K

This occurs in two forms vitamin K_1 and K_2. Vitamin K_1 is found in green leafy vegetables, fruits, cheese, egg-yolk and liver. Cow's milk is rich in vitamin K_1 (60 µg/L) than human milk (15 µg/L).

Vitamin K_2 is synthesized by the bacterial flora in the human gut. Vitamin K is stored in the liver. It plays an important role in the formation of prothrombin, a coagulation factor.

Deficiency of vitamin K may result either by the decreased intake or by the long-term administration of antibiotic, suppressing the normal intestinal flora. However, deficiency is less frequent because of its natural synthesis in the gut.

However, deficiency of vitamin K leads to low prothrombin activity resulting in hemorrhages, by prolonging the blood clotting time.

Daily requirement is about 0.03 mg per kg for an adult and that is obtained by a combination of dietary intake and its synthesis in the gut.

Since the newborns are often deficient in vitamin K due to not only minimal store but also due to lack of intestinal flora. They bleed more from the umbilical cord. Such bleeding can be prevented by giving 1 mg of aqueous vitamin K immediately at birth.

WATER SOLUBLE VITAMINS

Vitamin B Complex Group

This includes the following compounds. Thiamine (B_1), riboflavin (B_2), niacin, pyridoxine (B_6), folic acid (B_{11}), cyanocobalamin (B_{12}), pantothenic acid, para-amino benzoic acid. Biotin, carnitine and choline also belong to this group, but their role in human nutrition is not fully understood.

Being water soluble, excess amounts are excreted in the urine, thereby rarely poses a threat of toxicity. Since they are not stored in the body they must be obtained in the daily diet, failing which characteristic deficiency symptoms occur.

Thiamine (Vitamin B_1)

This is essential for the carbohydrate metabolism. It helps in the complete oxidation of pyruvic and lactic acids. Since the nervous system is almost entirely dependent upon the metabolism of carbohydrate for its energy needs, the ill effects of thiamine deficiency are predominant on nervous tissue (i.e. neurological disturbances).

Thiamine is obtained from unmilled cereals, pulses and groundnuts. It is very low in meat, fish and eggs. Milk is an important source of thiamine for infants and if mothers are deficient in thiamine, the infants are at risk of thiamine deficiency.

Thiamine is lost during cooking, because it is present in the outer pericarp of the cereal and it leaches into the water while cooking. Hence food should be cooked in minimal water to conserve its thiamine content. It is less in the milled rice than in the raw, home pounded rice, because vitamin B_1 is lost during milling and polishing.

During milling, outer pericarp and germ of the rice is lost, which is rich in vitamin B_1. It is further lost, if cooked with baking soda.

Daily requirement: 1 to 2 mg per day **(Table 16.8)**.

Thiamine content of common foods is shown in **Table 16.9**.

Table 16.8 Recommended allowances of B-complex vitamins for Indians

Groups	Category	B_1 (mg/d)	B_2 (mg/d)	B_6 (mg/d)
Man	Sedentary work	1.2	1.4	1.9
	Moderate work	1.4	1.6	2.2
	Heavy work	1.7	2.1	2.8
Woman	Sedentary work	1.0	1.1	1.5
	Moderate work	1.1	1.3	1.8
	Heavy work	1.4	1.7	2.3
	Pregnant woman	+0.2	+0.2	2.5
	Lactating woman 0–12 months	+0.3	+0.4	2.5
Infants	0–6 months	0.3	0.3	0.4
	6–12 months	0.3	0.4	0.5
Children	1–3 years	0.5	0.6	0.8
	4–6 years	0.7	0.8	1.1
	7–9 years	0.8	1.0	1.4
Boys Girls	10–12 years	1.1 1.0	1.3 1.2	1.8 1.6
Boys Girls	13–15 years	1.4 1.2	1.6 1.4	2.2 1.9
Boys Girls	16–18 years	1.5 1.0	1.8 1.2	2.4 1.7

Source: 1 (a)

Table 16.9 Thiamine content of common foods (in mg/100 g)

Food	Content
Whole wheat	0.45
Raw, home pounded rice	0.21
Raw, milled rice	0.06
Groundnut	0.9
Bengal gram dhal	0.48
Gingelly seed	1.00
Hen's egg	0.10
Cow's milk	0.05

Source: ICMR (1989)

Deficiency

It is common among those who subsist on milled rice. Thiamine deficiency results in a condition called 'Beriberi' and 'Wernicke's encephalopathy'.

Beriberi is of three types—Dry beriberi, wet beriberi and infantile beriberi. The first two are common among growing children.

Dry beriberi: In this type, there is involvement of the nervous system. It is characterized by polyneuropathy. The calf muscles become tender, progressively become weak and wasted. The tendon reflexes are sluggish. The child finds it difficult to stand from sitting position. All these are due to accumulation of pyruvic acid and lactic acid in the muscles. Apart from these symptoms, the child will also have anorexia, dyspepsia, constipation, slow growth and emaciation.

Wet beriberi: In this type, there is involvement of mainly cardiovascular system. It is characterized by palpitation, tachycardia, dyspnea and edema feet.

Infantile beriberi: This occurs among breastfed infants if the mothers are thiamine deficient. The child becomes restless, cries often, passes less urine and develops puffy face.

Wernicke's encephalopathy and Korsakoff's psychosis are the cerebral forms of thiamine deficiency. The former is common in Europe and North America. It is common among alcoholics. It is characterized by bilaterally symmetrical ophthalmoplegia, nystagmus and ataxia. Later the state of confusion progresses to stupor and coma.

Korsakoff's psychosis is characterized by memory defects and disorientation.

Nowadays the incidence of beriberi is reduced because of the changes in the food habits and improvement in the socioeconomic conditions.

Riboflavin (Vitamin B_2)

It is a cofactor of certain enzymes concerned with cellular oxidation and cellular growth.

Sources: Rich sources are milk, liver, and green leafy vegetables. Fair sources are cereals and pulses. But rice is particularly a poor source. Germination of pulses increases the riboflavin content.

Deficiency: The features are confined to skin and mucous membrane. The condition is called 'Ariboflavinosis', characterized by angular stomatitis, glossitis (sore, red, glazed, smooth tongue), cheilosis (cracking at the angle of the mouth), nasolabial dyssebacia (scaly desquamation at nasolabial folds), scrotal dermatitis and vascularization of cornea and keratitis, resulting in watering of eyes, photophobia, and blurring of vision. It is also often associated with impaired neuromotor function.

Riboflavin deficiency is common among malnourished children and adults of low socio-economic status. It almost always occurs in association with deficiencies of other B-complex vitamins such as pyridoxine. Thus, it is usually a part of multiple vitamin deficiency syndrome.

Daily requirement: It is about 1 to 2.3 mg **(Table 16.8)**.

Niacin (Nicotinic Acid) (Vitamin B_4)

It differs from the other vitamins of the B-complex group in that an essential amino acid tryptophan is its precursor. 1 mg of niacin is synthesized from 60 mg of tryptophan. Another feature is that it is not excreted in the urine (being water soluble) but is metabolized.

Functions: Niacin is an important component of co-enzymes required for metabolism of proteins, fats and carbohydrates and tissue oxidation.

Sources: Foods rich in tryptophan are liver, kidney, meat, fish, milk, poultry, pulses and groundnuts. In cereals, specially maize, it occurs in a bound form niacytin, which cannot be broken down by the digestive juices and hence cannot be availed of by the body.

Deficiency: Deficiency of niacin results in a condition, called 'Pellagra', characterized by 3 D's—Dermatitis, Dementia and Diarrhea. Dermatitis is bilaterally symmetrical and is found on those surfaces of the body exposed to sunlight, such as face, hands and legs. The skin becomes pigmented, scaly and cracked. It is often associated with itching and burning sensation. Diarrhea is often associated with anorexia, nausea, vomiting, dysphagia and dyspepsia.

Dementia (mental changes) includes depression, irritability and delirium.

Pellagra is usually reported among those people, whose main diet is maize and jowar, because these cereals are rich in leucine, which interferes in the conversion of tryptophan to niacin.

Daily requirement: It is about 15 mg.

Pyridoxine (Vitamin B_6)

This occurs in three forms—Pyridoxine, pyridoxal and pyridoxamine. It is necessary for the metabolisms of amino acids. It is poor in egg, fruits, milk and vegetables.

Deficiency: Deficiency is associated with peripheral neuritis, edema and loss of weight. Deficiency can also be caused by intake of drugs like INH. So pyridoxine supplement is a must for patients receiving INH.

Deficiency among pregnant mothers results in morning sickness.

Daily requirement: It is 2 mg for adults and 2.5 mg during pregnancy and lactation **(Table 16.8)**.

Folic Acid (Pteroylglutamic Acid; Folacin) (Latin, Folia = Leaf)

This occurs in the food in both free folates and bound folates, the former is rapidly absorbed.

Folic acid is necessary for the synthesis of DNA in the rapidly multiplying cells like RBCs. It is also necessary for the maturation of normoblasts to RBCs.

Liver, soybean and dark green leafy vegetables are the rich sources, providing 150 µg, 30 µg and 30 µg, respectively.

Deficiency impairs the synthesis of DNA in the cells resulting in abnormal cell division. Tissues with rapidly dividing cells such as intestinal mucosa and bone-marrow are affected in folic acid deficiency. Therefore, megaloblastic anemia and diarrhea are predominant symptoms. The former is more commonly observed in children and pregnant mothers.

Folic acid supplementation during pregnancy has been found to increase the birth weight of newborns and thus decreases the incidence of low birth weight babies.

Daily requirement: For adults (male and female)—100 µg. During pregnancy extra 400 µg, during lactation extra 250 µg and for children 100 µg **(Table 16.10)**.

Table 16.10 Recommended intake of folic acid and vitamin B_{12}

Groups		Folic acid (mcg/d)	Vitamin B_{12} (mcg/d)
Adults	Man	100	1.0
	Woman	250	1.0
	Pregnant woman	500	1.2
	Lactating woman	350	1.4
Infants	0–12 months	25	0.4
Children	1–6 years	80–100	0.6
	7–9 years	120–140	0.8
Adolescents	10–12 years	120–140	0.8
	13–15 years	150–250	0.8
	16–18 years	150–250	1.0

Source: 1(a)

Cyanocobalamin (Vitamin B_{12})

It is a red crystalline substance containing cobalt atom.

It plays an important role in the synthesis of DNA, particularly in the rapidly multiplying cells such as RBCs. It acts as a co-enzyme in amino acid metabolism and also it is necessary for myelin formation. Vitamin B_{12} combines with 'intrinsic factor' present in the gastric juice to form 'Vitamin B_{12} intrinsic factor complex', which reaches the ileum and attaches itself to specific receptor sites on the brush border of the cells. The vitamin is then absorbed leaving behind the intrinsic factor. After absorption, it is stored mainly in the liver. Although cobalamin is synthesized by the bacterial flora of the intestine, it is not available for absorption.

Vitamin B_{12} malabsorption is observed in blind loop syndrome, tropical sprue, Crohn's disease and intestinal tuberculosis. Vitamin B_{12} deficiency is also observed in breast fed infants of Vitamin B_{12} deficient mothers.

Deficiency of Vitamin B_{12} impairs the synthesis of DNA, leading to arrest of erythropoiesis in the bone marrow resulting in megaloblastic anemia (i.e. macrocytic normochromic anemia) and demyelination of large nerve fibers of spinal cord especially the long tracts of lateral and posterior columns. Paresthesia of fingers and toes is the special feature.

Sources: Vitamin B_{12} is present in the foods of animal origin only. Rich amounts are provided by liver (90 µg per 100 g).

Fish, egg and meat are fair sources. Plants do not need this vitamin for their existence and hence plant foods are devoid of this. Therefore, strict vegans (vegetarians) are at risk of deficiency.

Recommended daily allowance by ICMR is 1 µg per day for an average adult (man and woman) and 1.4 µg during lactation. Infants require 0.2 µg **(Table 16.10)**.

Vitamin C (Ascorbic Acid)

This is another water soluble vitamin. It is very sensitive to heat.

Vitamin C is necessary for the formation and maintenance of intercellular cement (collagen), which provides a supporting matrix for the blood vessels and connective tissues and also for bones and cartilage. Thus it maintains the vascular integrity. It also helps in tissue oxidation and absorption of iron.

Deficiency of Vitamin C causes 'Scurvy', characterized by loss of vascular integrity resulting in bleeding gums, hemorrhages from the mucous membranes, subcutaneous bleeding (petechial hemorrhage), delayed healing of the wounds, joint pains, anemia and weakness. Among children the hemorrhages in periosteum of long bones causes painful swelling and epiphyseal separation, giving rise to sharp and angular prominence of costochondral junction. This is called 'scorbutic rosary' (In rickets, the costochondral junction is dome shaped and semi-circular).

Sources

Fresh fruits, particularly citrus fruits like lemon, amla, and Indian gooseberry are very rich sources of this vitamin. Tomato, orange also contain good amount. Fresh green leafy vegetables, cabbage also contain vitamin C. Germinating pulses also contain good amount. Guavas are another cheap but rich source. However, animal foods are poor in vitamin C.

Considering that 50 percent of vitamin C is lost in cooking, daily allowance of 40 mg is recommended for adults and 25 mg for infants.

MINERALS

These are inorganic salts of elements. They are required for growth, repair and for performing metabolic functions. They are divided into two groups:

1. Those that are required in appreciable amounts, called 'Major minerals', which include calcium, sodium, potassium, magnesium and phosphorus.
2. Those that are required in minute amounts, called 'Trace elements', which include iron, iodine, fluorine, zinc, copper, cobalt, chromium and manganese.

Calcium

It is a major mineral essential for several life processes. It is stored mainly in the bones and teeth. The blood level of calcium is about 10 to 11 mg/dl. There is a dynamic equilibrium between the calcium in the blood and that in the skeleton. This equilibrium is maintained by the interaction of vitamin D, parathyroid hormone and calcitonin.

Calcium is required for formation of bones and teeth. It is also required for coagulation of blood. It controls neuromuscular excitation, contraction of muscles and helps in membrane permeability.

Richest source of calcium among animal foods is milk and milk-products (like butter-milk, skimmed-milk and cheese), eggs and fish. Among the vegetable foods, green leafy vegetables and millets like ragi are very good sources of calcium. 100 ml of cow's milk provides 120 mg of calcium and human milk about 30 mg. Calcium occurs in the milk as calcium-cesinogenate which is readily assimilated by the body. The calcium absorption from the green leafy vegetables and cereals are restricted due to the presence of oxalic acid and phytic acid respectively, which forms respectively calcium oxalate and calcium phytate, which are insoluble. Additional source of calcium is drinking water.

Calcium content of common sources (mg/100 g)

Leafy vegetables	–	200–400
Ragi	–	344
Cow's milk	–	120
Human milk	–	30
Fish	–	150–3500
Sitaphal	–	800
Cheese	–	790

Table 16.11 Calcium requirements for Indians

Groups			Calcium (mg/d)
Adults	Man		600
	Woman		600
	Pregnant woman		1200
	Lactating woman		1200
Infants	0–12 months		500
Children	1–9 years		600
Adolescents	10–12 years	Boys	600
		Girls	700
	13–15 years	Boys	800
		Girls	700
	16–18 years	Boys	600
		Girls	600

Source: 1(a)

Absorption of calcium is enhanced by vitamin D and decreased by phytates, oxalates and fatty acids.

No clear-cut disease has even been observed due to calcium deficiency. On the other hand, no deleterious effects have been observed as a result of increased intake of calcium. However, it has been observed that dietary deficiency of calcium leads to depletion of calcium from bones, resulting in osteoporosis. In children, the deficiency leads to growth retardation.

Daily requirement is 600 mg for adults, and growing children and 1200 mg during pregnancy and lactation **(Table 16.11)**.

Iron

Human body contains about 4 g of iron, of which about 3 g are present in the blood as hemoglobin and 1 g as storage iron.

Iron is necessary for the synthesis of hemoglobin, which in turn is necessary for oxygen transport and cell respiration. Iron is also necessary for the development and functions of brain, for the regulation of body temperature. It is a component of myoglobin, cytochrome and catalase. Iron is also necessary for the production of antibodies.

There are two forms of iron—hem iron and nonhem iron. Hem iron is obtained from animal sources such as liver, meat, fish and poultry and nonhem from vegetable sources such as green leafy vegetables, ragi, jaggery and dried fruits.

Hem iron is better absorbed than nonhem iron and the former promotes the absorption of the latter, however

it is often interfered by the phytates, oxalates, carbonates and phosphates in the intestine. Eggs and tea also interfere with iron absorption, because of phosphate and tannin respectively. The absorbed iron, which is less than 5 percent, is transported as plasma ferritin and stored in the liver, spleen, kidney and bone marrow. When the red cells are broken down, the released iron is reutilized for the formation of new red cells.

The total daily iron loss is about 1 mg in an adult male and about 2 mg in a menstruating woman.

Deficiency of iron result in iron deficiency anemia (IDA). This is due to the following reasons:

a. *Decreased intake:* This is either due to cereal and pulse based diet which are poor in iron or due to social factors like poverty and inability to eat animal food. Non-availability of green leafy vegetables during summer often contributes to seasonal variations in the incidence of anemia. Milk based diet, which is poor in iron, also predisposes for anemia among young children.
b. Increased demand can also result in deficiency of iron under circumstances of pregnancy and infections.
c. Excessive loss of iron can result from hemorrhages, which can be:
   i. Physiological—such as menstruation, puberty menorrhagia, childbirth, etc.
   ii. Pathological—such as ankylostomiasis, peptic ulcers, bleeding hemorrhoids, ulcerative colitis, etc.
d. Other causes of iron deficiency are repeated pregnancies, chronic infections, presence of interfering factors like phytates of wheat, phosphates of egg-yolk, tannin of tea, oxalates of vegetables, etc.

Detrimental effects of iron deficiency anemia: The deficiency is clinically evident only in the later stages of the disease and therefore may result in grave consequences. They are:

i. *Work capacity:* Since anemia results in easy fatiguability, exhaustion and tiredness there will be decreased efficiency, decreased production and increased accidents in the industries, affecting the economy of the country.
ii. *During pregnancy:* Anemia during pregnancy will end up in abortions, premature births, (LBW), still-births, hemorrhages thus resulting in increased infant mortality and maternal mortality rates.
iii. *Infections:* Since anemia impairs the immune functions, the susceptibility to infections increases.
iv. *Growing children:* Anemia not only results in growth failure among children but also interferes with their learning and education process. Decreased motor development results in decreased physical activity. It also increases the susceptibility to infections. The daily requirements of iron is shown in **Table 16.12**.

Table 16.12 Requirements for iron and zinc for Indians

Groups			Iron (mg/d)	Zinc (mg/d)
Adults	Man		17	12
	Woman		21	10
	Pregnant Woman		35	12
	Lactating Woman		25	12
Children	1–3 years		9	5
	4–6 years		13	7
	7–9 years		16	8
Adolescents	10–12 years	Boys	21	9
		Girls	27	9
	13–15 years	Boys	32	11
		Girls	27	11
	16–18 years	Boys	28	12
		Girls	26	12

Source: 1(a)

Iodine

It is an essential trace-element (micro-nutrient). It is a mineral. It was discovered in 1811 by Courtois, a Frenchman that iodine is present in the body in very small amount (15–20 g) and it is necessary for the synthesis of thyroid hormones, Triiodothyronine (T_3) and Thyroxine (T_4), which are essential for the normal metabolism, growth, development and well-being of all of all human beings.

Sources

Iodine is a crystalline solid, grayish black in color, never found in nature uncombined. Natural sources of iodine are food and water. Rich sources of iodine are sea-foods (such as sea-fish, shrimps, prawn, crab, oyster, lobster-fish, etc.) and vegetables grown on iodine rich soil. Cereals, pulses, fruits and vegetables constitute the common source and the iodine content of these depends upon the iodine content of the soil. The iodine content of fresh water varies from 1 to 50 mg per liter.

Thus, 90 percent of iodine requirement is obtained from the foods we eat and remaining 10 percent from water we drink. It is the iodine content of the soil, which determines its presence in the food and water. Thus, deficiency of iodine is geo-chemical in nature.

Daily requirement (in mcg)

Adult	–	150
Pregnant woman	–	200
0–11 months	–	050
12–59 months	–	090
School children	–	120

Iodine Cycle

The iodine present in the soil, has been leached from the surface soil by glaciation, snow and rain and are carried by wind, floods and rivers into the sea. Thus most iodine is present in the ocean. The atmosphere absorbs iodine from the sea and then it returns through the rain or snow to the mountainous regions. It is then carried by rivers to the lower hills and plains, eventually returning to the sea. Iodine occurs in the deeper layers of soil. So water from the deep wells can provide a good source of iodine. The most likely areas to be leached are mountainous areas. Heavy rain fall, landslide, snow-fall, flooding and such other eco-degradative activities are mainly responsible for increasing the prevalence of iodine deficiency in the mountainous areas, because the iodine present in upper layer of the soil is flushed out.

Iodine is present in the food and water as inorganic iodide. It is readily and completely absorbed from the gut and stored in the thyroid gland by a concentrating mechanism, where it is utilized for the synthesis of T_3 and T_4 hormones.

When there is deficiency of iodine intake, in the food and water, the T_3 and T_4 hormone levels are also decreased, thereby stimulating the anterior pituitary gland to produce Thyroid Stimulating Hormone (TSH) which results in compensatory hyperplasia of thyroid gland cells to trap all the available iodine in the blood to maintain the iodine balance in the body.

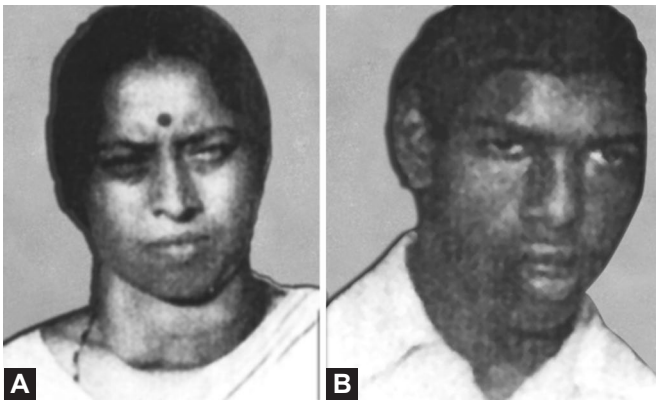
This compensatory hyperplasia of the thyroid gland due to iodine deficiency is called 'Goiter'. Thus, Goiter is a non-inflammatory, non-neoplastic and non-toxic swelling of the thyroid gland. Goiter was also called 'Galganda' by ancient Hindu physicians Sushruta and Charaka in 500 BC.

Goiter can also occur due to the presence of goitrogenic substances such as thiocynates and cyanoglycosides in the foods like cabbage, cauliflower, radish, turnip, etc. These goitrogenic substances interfere with iodine uptake. Thus they play a contributory role.

Grading of Goiter (WHO 1994)

Grade 0: No palpable or visible goiter (no goiter)
Grade 1: Goiter palpable but not visible in the normal position of the neck.
Grade 2: Visible and palpable goiter.

Deficiency: Deficiency of iodine results in a spectrum of conditions affecting people of all age groups and both the sexes, mothers and children being hit hardest. These are called 'Iodine Deficiency Disorders' (IDD). They are abortions and still-births among pregnant mothers; congenital anomalies, cretinism, mental retardation among neonates; dwarfism, speech and hearing defects among growing children (i.e. retarded physical and psychomotor development) and hypothyroidism (goiter and myxedema) among adults **(Figs 16.2A and B)**.



Figs 16.2A and B (A) Nodular goiter; (B) Mental retardation

Daily requirements of iodine is 150 μg for an adult. It is less than one tea spoonful for his entire life time. Though the requirement is very small, its implications are enormous, if not available to human beings.

Fluorine

It is most abundant element in nature. It is never found in gaseous form because it is highly reactive. So it is always found in combined form as fluoride.

Fluorine is essential for mineralization of bones and formation of dental enamel. It prevents dental caries probably by reducing the solubility of the enamel in the acids produced by the bacteriae of the mouth.

The main sources are drinking water and foods. The other sources of fluoride are black tea, black salt, supari, tinned food and fruit juices. The recommended fluoride level in the drinking water is 0.5 to 0.8 mg per liter. The foods rich in fluorides are sea fish, tea and cheese.

Fluorine is often called 'Double edged sword', because neither it should be consumed in excess nor in deficiency. Prolonged ingestion of fluoride through drinking water containing more than 1 mg/L results in dental and skeletal fluorosis and inadequate intake results in dental caries, i.e. with fluoride level below 0.5 mg/L of water.

An indicator of dental caries in the community is the 'DMF-Index' (D = Decayed; M = Mottled, F = Fallen).

The onset of fluorosis is marked by non-skeletal changes, which can easily be reversed by safe drinking water and nutritional intervention.

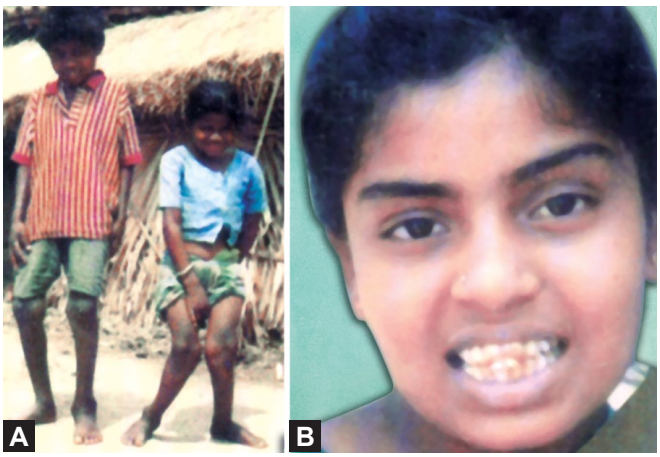
If left untreated, the disease progresses into non-curable dental and crippling skeletal fluorosis.

Magnitude of the problem: Fluorosis is endemic in India. The affected population is 25 million and at risk is 66 million.

High-risk groups: These are children, elderly people, pregnant and lactating mothers and patients with renal and cardiovascular diseases.

Dental fluorosis is characterized by loss of shiny appearance on teeth, appearance of chalky-white patches (mottling) over the teeth. Patches later become brownish/black. In severe cases pitting occurs to give the teeth corroded appearance. It is seen commonly in incisors and molars and not seen in deciduous teeth. It becomes a permanent feature. However, dentist can modify the appearance by esthetic dentistry.

Skeletal fluorosis is characterized by the calcification of tendons and ligaments. It starts with pain in the joints of extremities and later pain and stiffness of back **(Figs 16.3A and B)**. Radiological changes include new bone formation (exostosis) and calcification in tendons and ligaments. Fluorosis is a public health problem in Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Rajasthan and Punjab. Genu valgum a manifestation of skeletal fluorosis is often seen in children, due to osteoporosis, as reported from Nalgonda District of Andhra Pradesh.



Figs 16.3A and B (A) Skeletal fluorosis; (B) Dental fluorosis

Laboratory Investigations

- High levels of fluoride in drinking water, blood or urine
- Anemia with changes in RBC structure
- X-ray showing increased girth, thickness and density of bones.

Fluoride Testing

A variety of methods such as calorimetric, photometric and ion-selective methods for testing fluoride are available. The most accurate method for testing fluoride in the water is ion-selective method using ion-meter.

Prevention and Control

Dental caries can be prevented by fluoridation of water supplies. Fluorosis can be prevented by defluoridation of water by 'Nalgonda technique', at domestic level, as recommended by National Environmental Engineering Research Institute, Nagpur **(Fig. 16.4)**.

This can be carried out in a bucket with a tap 3 to 5 cm above the bottom of the container. 40 L of raw water is taken in the bucket, mixed slowly with adequate amount of alum (500 mg/L), followed by lime or sodium carbonate (30 mg/L) and bleaching powder (120 mg/40 L). Water is stirred slowly for 10 to 20 minutes and allowed to settle for nearly one hour. The settled sludge will be below the tap level. The supernatant water becomes less in fluorine (i.e. permissible limit of fluoride) and is withdrawn through the tap for consumption. The settled sludge is discarded.

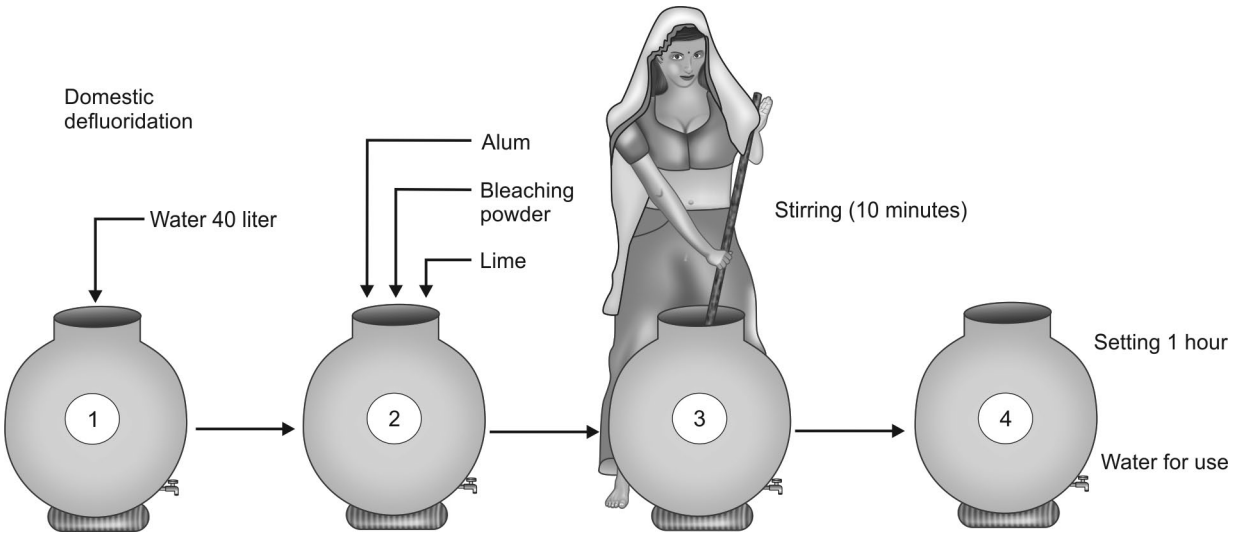


Fig. 16.4 Defluoridation at domestic level (Nalgonda technique)

Reverse osmosis technique removes not only fluoride but also nitrates and sulfates from drinking water.

Domestic filters are also available based on activated alumina technology.

Daily requirement of fluoride is 0.5 to 0.8 mg/L of drinking water (i.e. 0.5–0.8 ppm).

OTHER TRACE ELEMENTS

Zinc

It is necessary for RNA, DNA and ribosome stabilization and for the functioning of biomembranes. It is a component of many enzymes, e.g. carbonic anhydrase. It is required for immunity function. The adult body contains 1.4 to 2.3 g of Zinc. Plasma level is 96 µg per 100 ml.

A syndrome of growth failure, hypogonadism, anemia and hepatomegaly has been reported in zinc deficiency. Low plasma level of zinc has been associated with chronic diarrhea, dermatitis, immune deficiency, alopecia, lesions of eyes and nails, pernicious anemia, thalassemia and myocardial infarction. Zinc deficiency in pregnant women is associated with neural tube defects of the fetus and intrauterine growth retardation.

Animal foods such as meat and fish are rich sources of Zinc. Wheat, pulses and nuts also provide zinc. Cysteine and histidine enhance zinc absorption while phytates inhibit zinc absorption.

The daily requirement for different age groups is shown in **Table 16.12**.

Copper

It is an ingredient of many enzymes such as amine-oxidases, ferroxidases, cytochrome co-oxidases, etc.

Copper is essential for connective tissue formation, iron metabolism, myelin production and melanin synthesis.

Liver, kidney, shellfish, nuts and dried legumes are good dietary sources.

Deficiency is accompanied with hypocupremia, anemia, osteoporosis, metaphyseal fraying and fractures. Neutropenia is the best documented abnormality of copper deficiency. Genetic defects in copper metabolism may result in Menke's kinky hair syndrome and Wilson's disease (Hepatolenticular degeneration).

Infants require 80 µg per kg per day, children require 40 µg per kg per day and adults 30 µg per kg per day.

Cobalt

It is an ingredient of vitamin B_{12} (cyanocobalamin). Its deficiency is not reported in human beings. Cobalt addition to beer (foaming agent) has caused epidemics of cardiomyopathy and pericardial effusion. Acute poisoning causes diarrhea, tinnitus and loss of hearing. Chronic poisoning causes polycythemia and goiter.

Chromium

It influences the metabolism of carbohydrate, lipid and protein by potentiating the action of insulin. Deficiency may be partially responsible for impaired glucose tolerance, hyperglycemia, glycosuria and insulin refractoriness.

Selenium

It is essential for the production of glutathione peroxidase— a red cell enzyme. Selenium functions as an antioxidant along with vitamin E. Its deficiency results in Keshan disease (a form of cardiomyopathy endemic in China) and Kashin-Beck disease (an endemic osteoarthritis of adolescents in China). Its deficiency may occur in Protein Energy Malnutrition and administration of selenium among such children, resulted in significant weight increase.

Meat and sea foods are rich in selenium. Infants require 10 to 15 µg per day, while adults require 70 µg per day.

Excessive intake of selenium is associated with selenosis. (loss of hairs and nails).

Ultratrace Minerals

These are the elements whose dietary requirements are less than 1 mg/day. These include arsenic, boron, bromide, cadmium, molybdenum, nickel, silicon, tin and vanadium.

Antioxidants

A free radical is an atom or a molecule with an unpaired electron. The unpaired electrons are highly reactive and therefore they destroy our cells and tissues resulting in not only the onset of certain diseases but also cause ageing faster.

These free radicals are released during the normal metabolic processes.

The damage can be prevented by anti-oxidants by converting the free radicals to neutral forms. The antioxidants also help to boost immunity and fight diseases and ageing.

These antioxidants are vitamin A, C, E and minerals such as selenium, iron, copper and zinc. The antioxidants present in the cell are glutathione, Vitamin E and superoxide dismutase and those present in the plasma are albumin, bilirubin, ceruloplasmin.

The exact role that they play is the subject of current research.

FOOD GROUPS

These have been grouped into the following groups :

- Cereals and millets
- Pulses
- Vegetables
- Nuts and oil seeds
- Fruits
- Milk and milk products
- Egg, meat and fish
- Fats and oils
- Sugar and jaggery
- Condiments and spices
- Miscellaneous.

Cereals

These constitute the bulk of out diet. The common cereals are rice, wheat, maize, corn, oats, barley. The first two form the major staple food.

Cereals constitute the main source and an economical source of energy (carbohydrates), mainly contributed by starch and fat. They also constitute a significant source of proteins, (6–12%) minerals and vitamin of B-group. Cereals contribute 70 to 80 percent of total energy intake and more than 50 percent of protein intake in our diet.

Cereal proteins are of low biological valve, being deficient in the essential amino acid, Lysine. This is complimented by the protein of the pulses. Thus cereals and pulses provide a balanced and complete protein. Whole grain cereals are considerable sources of iron, phosphorus and thiamine.

Cereals are easily digestible, supply roughage and have a laxative property. Incorrect cooking practices lead to loss of water soluble vitamins, i.e. cooking in large volume of water and draining away the excess of it **(Table 16.13)**.

Rice

The grain is oval in shape and consists of three parts—the germ (embryo) situated at the pole, the inner endosperm, which constitutes 70 to 80 percent of the grain and the outer pericarp (aleurone layer).

Rice contains about 6 to 9 percent of the protein and rice protein is rich in Lysine and therefore, rice protein is considered of better quality (than wheat protein). Limiting amine acids are threonine and to some extent methionine. Even though iron is present in the rice, it is not available to the body because it combines with phytic acid (also present in rice) and is excreted in the feces. The outer coat of rice is a good source of thiamine, niacin, pyridoxine and riboflavin. It does not contain vitamins A and C.

Milling

Before milling the rice, the paddy is cleaned from foreign matters like stones, clay particles, straw and dirt. Then paddy is dehusked and finally milled (polished).

The effect of milling is destructive. The outer pericarp and the germ, which are rich in nutrients are removed. The important nutrient lost is thiamine and to some extent riboflavin and protein. The resulting white or polished rice, although attractive in appearance, is poor in nutritive value. Thus the people subsisting on milled rice, are prone to develop 'beriberi'. Therefore, under-milled rice or parboiled rice is advocated.

The rice grain is further subjected to loss of other essential nutrients (specially water soluble vitamin of B-group) during the process of washing and cooking in large quantity of water and draining away the water. So it is best to cook rice in just sufficient water and not draining the water.

Parboiling

Means partially boiling the rice. This helps in preserving the nutritive value of rice. There are many methods of parboiling. The one recommended by Central Food Technological Research Institute (CFTRI), Mysore is 'Hot Soaking Process.'

This process consists of soaking the paddy in hot water of about 70°C for 3 to 4 hours, followed by draining the water and subjecting the soaked paddy to steam for about 10 minutes. The paddy is then dried and later homebounded or milled.

Effect of Parboiling

During the process of soaking in hot water, the vitamins and minerals present in the outer pericarp, percolate into the inner endosperm. Then during drying process, the germ gets

Table 16.13 Nutritive value of cereals (values per 100 g)

Name of the cereal	Protein (g)	Fat (g)	Carbohydrate (g)	Thiamine (mg)	Niacin (mg)	Riboflavin (mg)	Iron (mg)	Energy (kcal)
Rice, raw-milled	6.8	0.5	78.2	0.06	1.9	0.06	0.6	345
Wheat flour	12.1	1.7	71.2	0.45	5.0	0.17	1.5	346
Maize	11.1	3.6	66.2	0.42	1.8	0.10	1.5	342

Source: ICMR (1989)

Table 16.14 Nutritive value of millets (values per 100 g)

Millet	Protein (g)	Fat (g)	CHO (g)	Calcium (mg)	Iron (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Energy (kcals)
Jowar	10.4	1.9	72.6	25.0	4.1	0.3	1.3	3.1	349
Ragi	7.3	1.3	72.0	344.0	3.9	0.2	0.18	2.3	328

Source: ICMR (1989)

attached more firmly to the grain (unlike in milling). Further when subjected to steam, the outer pericarp becomes harder and resistant to insect invasion and becomes more suitable for storage than raw-rice. Meanwhile the starch of endosperm also gets gelatinized, which improves the keeping quality of rice.

Thus, parboiling not only improves the nutritive value but also the keeping quality. But the only disadvantage is its 'Off-flavor', which can be eliminated by using 0.05 percent sodium chromate in the soak water, as recommended by CFTRI, Mysore.

Processed rice products are rice flakes and puffed rice.

Wheat

Unlike rice, which is cooked as such, wheat is ground to flour, rava or maida. Next to rice, wheat is the most important cereal. The protein content of wheat is Gluten, which is deficient in lysine. Between the rice protein and the wheat protein, quantitatively wheat protein is better (about 12 g%) and qualitatively rice protein is better (because it is rich in lysine).*

Wheat flour contains gluten, which is sticky in nature, enables the dough spongy and stretchable, to be made into bread. Suji (Semolina) is prepared from the outer part of the wheat and is rich in vitamins and minerals and is used for puddings. Thus maida is rich in protein (gluten) but poor in vitamin and minerals.

Processed products are bread, biscuits, toast, etc.

Maize (Corn; Bhutta)

This ranks next to rice and wheat for consumption among the cereals. It is also used as food for cattle and poultry. Yellow variety contains significant amount of carotenoid pigments. It is rich in fat compared to other cereals. Chief protein is glutelin and zein. The limiting amino acids are lysine and tryptophan. Some strains contain excess of leucine, which interferes with the conversion of tryptophan into niacin and aggravate pellagrogenic action of maize.

The products are hominy grits and corn-flakes. Maize flour or corn flour is widely used in the preparation of custards and table desserts.

Millets

These differ from cereals in that they are ground and consumed without removing the outer coat. Jowar and Bajra are major millets and Ragi, Kodo and such others are known as minor millets or pseudocereals **(Table 16.14)**.

Jowar (Sorghum; Kaffir Corn; Milo)

It is one of the major crops grown in India. It is a staple diet. It is fairly rich in protein, but the limiting amino acids are lysine and threonine. Certain varieties of jowar have high leucine content and thus associated with pellagragenic action.

Ragi

It is the cheapest and a very popular millet in Karnataka and Andhra Pradesh. Ragi is rich in calcium and iron. It contains traces of iodine also.

Pulses (Legumes)

These are dry seeds of leguminous plants. The common pulses of our diet are grams, peas, lentils and beans.

- Grams are also known as dals. They are red gram (tur) Bengal gram (Chana) green gram (moong) and black gram (urd). Kesari dal commonly consumed in Northern India is associated with lathyrism.
  - Peas are *P. sativum* (matar)
  - Lentils are Lens esculenta (masoor)
  - Common beans are soyabeans.

Pulses are next to cereals as a source of energy. They are rich in proteins (20–25%). Although pulses are called 'Poor man's meat' they are eaten by the rich and poor alike in India. The limiting amino acids are cystein and methionine. On the other hand, they are rich in lysine. Red gram is deficient in tryptophan also. The biological value of proteins in pulses is better than that of cereals and millets. Soya bean is exceptionally rich in protein (40%). It is a first class protein. Therefore, it is used for various baby foods. Pulses

* Sieving of wheat flour removes 5 to 10 percent bran leaving behind "maida", which is used to prepare bread. Sieving also removes proteins, vitamins and minerals

Table 16.15 Nutritive value of pulses (values per 100 g)

Pulse	Protein (g)	Fat (g)	CHO (g)	Calcium (mg)	Iron (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin	Vitamin C	Energy (kcals)
Bengal gram	17.1	5.3	60.9	202	4.6	0.3	0.1	2.9	3	360
Red gram	22.3	1.7	57.6	73	2.7	0.4	0.1	2.9	0	335
Soybean	43.2	19.5	20.9	240	10.4	0.7	0.3	3.2	0	432

Source: ICMR (1989)

are rich in minerals and B-group vitamins. Minerals are not absorbed because they combine with phytic acid. However it is destroyed by heat. Germination of pulses like Bengal gram and green gram increase the concentration of certain vitamins like ascorbic acid, nicotinic acid, riboflavin and folic acid. Fermentation increases digestibility, palatability and availability of amino acids. Roasted Bengal gram is an ingredient of supplementary foods like Hyderabad mix and Indian multipurpose food **(Table 16.15)**.

Vegetables

They are included under 'Protective foods' because they are rich in vitamins and minerals. Water is the major constituent of vegetables (99%). Vegetables contribute to the bulk of the diet and are low in calories, proteins and fats. They contain varying amount of dietary fiber.

The vegetables are grouped into 3 groups:

Green Leafy Vegetables (GLVs)

These include spinach (palak), coriander (Kothmir), fenugreek (methi) amaranth, etc.

Green leafy vegetables (GLVs) are poor in carbohydrates and proteins. On the other hand, they are good sources of vitamins such as beta carotene, thiamine, riboflavin and folic acid and minerals like calcium and iron. The darker the green leaves, greater is the nutritive value. The bioavailability of the calcium and iron from GLVs is rather poor because of the presence of oxalates.

Vegetables are of great use in weight reducing diets for obese people, as they provide satiety due to bulk and contribute low calorie value (25–50 kcals per 100 g). The bulk and water content along with the dietary fiber helps to relieve constipation. Green leafy vegetables (GLVs) are recommended for diabetics because of low caloric value, for antenatal mothers because of minerals and to young children because of vitamin A.

Recommended daily intake of GLVs is 40 g for an adult man and 100 g for an adult woman.

Other Vegetables

These include brinjal, ladies finger, tomato, cauliflower, cucumber, bottle gourd (bhopla), etc. These add variety to the diet. They are also good sources of vitamins, minerals and dietary fiber. Recommended daily intake is about 60 to 70 g.

Roots and Tubers

These include potato, sweet-potato, carrot, radish, onion, colocasia, tapioca, yam, etc. Potato and tapioca are good sources of carbohydrates. Carrots and yellow yam are rich in beta-carotene. Recommended daily intake of roots and tubers is 50 to 60 g, for an adult.

Nuts and Oil Seeds

This group includes pea-nut (ground nut), cashew nut, walnut, almond, pistachio, mustard seeds, sesame seeds, (til or gingelly), cotton seeds, sunflower seeds, safflower seeds (Kusum), linseed and rapeseed. Coconut is not a nut but a stone fruit.

From these, cooking oils are extracted. They are good sources of energy. Nuts contain appreciable amount of carbohydrates, vitamin B group and minerals. Proteins is of good quality in small amounts in the nuts, whereas in oil seeds, proteins are of inferior quality as they lack methionine. But they are rich in lysine **(Table 16.16)**.

Groundnuts (Peanuts; Monkey Nuts)

They contain 27 percent protein, 40 percent fats and 2 percent minerals. Vitamins present are thiamine, niacin and riboflavin. The protein predominantly 'arachin', is deficient in lysine and methionine.

After extracting the oil, the left over residue is called groundnut cake. It contains 41 percent protein and 39 percent carbohydrates. Protein becomes richer in the cake than in the seeds.

Groundnut flour from the groundnut cake, is used in the manufacture of Indian Multipurpose Food, Balahar and balanced malt food.

Groundnuts for consumption must be properly stored in a dry container, because presence of moisture content facilitates the growth of fungus '*Aspergillus flavus*', which results in 'Aflatoxicosis'.

Table 16.16 Nutritive value of nuts and oil seeds (values per 100 g)

Nuts	Protein (g)	Fat (mg)	CHO (mg)	Iron (mg)	Carotene (µg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Energy (kcals)
Groundnuts	25.3	40.1	26.1	2.5	37	0.9	0.13	19.9	567
Cashewnut	21.2	46.9	22.3	5.8	60	0.6	0.19	1.2	596
Almond	20.8	58.9	10.5	5.1	00	0.2	0.57	4.4	655

Source: ICMR (1989)

Table 16.17 Nutritive value of some common fruits (values for 100 g of edible portion)

Fruit	CHO (g)	Iron (mg)	Calcium (mg)	Carotene (µg)	Vitamin C (mg)	Energy (kcals)
Apple	13.4	0.6	0	0	1	59
Banana	27.2	0.5	10	78	7	110
Grapes	16.5	1.5	20	0	1	71
Guava	11.2	0.3	10	0	212	51
Mango	16.9	1.3	14	2210	16	74
Papaya	7.2	0.5	17	2740	57	32
Dates		7.3	120	44	03	317

Source: ICMR (1989)

Table 16.18 Nutritive value of milk (per 100 g)

Milk	Protein (g)	Fat (g)	CHO (g)	Iron (mg)	Calcium (mg)	Carotene (µg)	Thiamine (mg)	Riboflavin (mg)	Energy (kcals)
Human	1.1	3.4	7.4	0.2	28	137	0.02	0.02	65
Cow	3.2	4.1	4.4	0.2	120	174	0.05	0.19	67
Buffalo	4.3	6.5	5.1	0.2	210	160	0.04	0.10	117
Cheese	21.4	25.1	6.3	2.1	–	273	–	–	348

Source: ICMR (1989)

Fruits

Fruits are the protective foods. They are valued for their vitamins, minerals and digestible fiber. They differ from other foods in that they can be eaten raw and fresh. This makes the easy availability of the nutrients.

Citrus fruits (like amla) and guava are rich in ascorbic acid (Vitamin C). Amla provides 600 mg percent vitamin C. Yellow fruits (mango, papaya) are rich in carotenoids (precursor of Vitamin A). Banana is a source of carbohydrate and acts as a mild laxative. Fruits are not good sources of iron, calcium and phosphorus. However, dry fruits like dates, grapefruit are fair sources of iron and calcium **(Table 16.17)**.

Milk and Milk Products

Milk is a very wholesome food, because it contains almost all the nutrients, except iron and vitamin C. In fact it has been described as the 'nearly perfect food' of the nature. It is easily digestible and is very essential for the young for their growth and development.

The principal milk protein is casein. It is always combined with calcium and occurs as calcium carcinogenic. The other proteins are lactalbumin and lactoglobulin. Milk proteins contain all the essential amino acids. Therefore, it is of high biological value. Milk fat is a good source of carotene. It contains saturated fatty acids. The carbohydrate in the milk is lactose. Milk is the only natural source of lactose. It is readily fermented by lactic acid bacilli. Milk is a rich source of calcium and a poor source of iron. It is a good source of all vitamins except vitamin C **(Table 16.18)**.

Milk is species specific.

Milk cannot serve as a main element of our diet because the following demerits such as:

- Milk contains 85 percent water and a poor source of energy.
- It is costly.

- It can easily be adulterated.
- It is a poor source of iron and vitamin C.
- It is good medium for the organisms to grow.

Milk Products

Milk is consumed in a variety of forms—as whole milk, butter, ghee, dried and condensed milk, khoa, panir, etc.

Fermented milk products are yogurt, curds and cheese.

Types of Milk (Derived Milk)

Homogenized milk: Normally, fat in the milk is present in the form of droplets, (or globules) varying from 1 to 10 microns in diameter. When milk is heated on low fire, the fat droplets coalesce to form 'scum' (cream), which rises to the surface and floats thereon.

When milk with cream is allowed to pass through small orifices under high pressure, the fat globules are broken up mechanically to less than 1 micron in diameter, so that they do not rise to the surface to form cream. This is called 'Homogenized milk'. Such a milk is readily digested by infants than ordinary milk. Disadvantage is that fat cannot be separated from such milk.

Standardized milk: In this type, the fat content is maintained at 3 percent and Solids Not Fat (SNF) at 8.5 percent in cow's milk and 6 percent fat and 9 percent SNF in case of buffalo's milk.

Skimmed milk: It is a milk from which fat is skimmed off, i.e. removed either by hand or by machine, but total solids remain not less than 8.7 percent. Since it does not contain fat, it is devoid of fat soluble vitamins like A, D, E and K. Therefore, it should not be fed to infants. However, it is rich in milk protein (3%) and calcium. So it is used as a supplement to older children and adults. When dried, it becomes skimmed milk powder. Skimmed milk powder is an important ingredient of 'Hyderabad mix', a supplementary food.

Evaporated milk: This is the milk, reduced to 50 percent of its volume by evaporation.

Condensed milk: This is the milk, reduced to 25 percent of its volume by evaporation. Such milks are sweetened with sugar, which helps their preservation.

But the condensed milks are of less nutritive value than pure milk and are ideal for the growth of bacteria. Hence it is avoided for infants.

Dried milk (Milk powder): This is prepared by passing the milk through steam heated rollers or rotating drums, so as to reduce it to a fine powder. The powder forms a thin film over the drum. It is then scraped off.

Toned milk: It is a mixture of 1 part of water, 1 part of milk and 1/8 part of skimmed milk powder. It has a composition nearly equivalent to cow's milk.

Milk Standards

Following standards have been prescribed under the Prevention of Food Adulteration Act, 1954, for milk and milk-products. Milk should be free from peculiar smell and taste. Specific gravity should be between 1028 and 1032.

Cow's milk: It should not contain less than 3.5 percent of fat and 8.5 percent of SNF.

Buffalo milk: Milk fat at least 6 percent and SNF 9 percent.

Skimmed milk: SNF at least 8.5 percent.

Toned milk: Fat 3 percent and SNF 8.5 percent.

Khoa: Fat 20 percent.

Ice-cream: Fat 10 percent and total solids 36 percent.

Cream: Fat 23 percent, no added substance.

Egg, Meat and Fish

Egg

A single egg of hen weighs about 60 g.

Composition (by weight):	Shell—12 percent
	White—58 percent
	Yellow (yolk)—30 percent
Nutritive value (per egg):	Protein—6.0 g (ovalbumin)
	Fat—6.0 g (cholesterol—250 mg per egg)
	Calcium—30.0 mg
	Iron—1.5 mg
	Energy—70.0 kcals

Two eggs without shell weigh about 100 g. The nutritive value for 100 g is Protein = 13.3 g percent Fat = 13.3 g percent and Minerals = 1.3 g percent.

Egg contains all the nutrients, except carbohydrate and vitamin C. Egg protein is biologically a complete protein (it contains all the essential amino-acids) and the net protein utilization is 100 (i.e. high biological value and high digestibility coefficient). Therefore, egg-protein is called a 'Reference Protein'.

1. Egg protein being an animal protein can result in allergic reactions.
2. Egg protein also contains 'Avidin' which interferes with the absorption of biotin, a B-complex vitamin.

A raw egg is often contaminated with *Salmonella*. So consumption of raw egg transmits Salmonellosis (Zoonotic disease).

Raw egg-white is not assimilated by the intestinal mucosa. Therefore, boiling the egg not only destroys the organisms and avidin but also facilitates the assimilation of egg-white. Thus a boiled egg is nutritionally superior to raw egg.

Egg-yolk being an animal fat, is a very good source of all fat-soluble vitamins A, D, E and K and also it is rich in saturated

fatty-acids, increasing the risk of coronary heart disease, especially among middle aged, diabetics, hypertensives and obese people. So it is not recommended for them.

Duck's egg contains 'Trypsin-inhibitor', which can be destroyed by boiling. Therefore, it should not be eaten raw.

Nutritive value of the egg can be preserved by blocking the pores of the shell by smearing with oil or grease or by immersing it in a solution of sodium silicate (Glazing). It prevents bacteriae from entering in.

Egg can also be preserved by refrigeration.

In the laboratory, egg is used for the preparation of tissue culture vaccines, by inoculating the material into the chorio-allantoic membrane.

Tests for freshness of egg

- **Candling:** A fresh egg looks translucent and yellow is seen floating in white.
  A rotten egg is opaque and if there is gas, it looks transparent.
- **Floating:** A fresh egg sinks in 10 percent saline or water and remains horizontal or vertical and not tilted. A rotten egg floats.

Fish

Fish contains 15 to 20 percent protein of high biological value and about 2 to 5 percent fat. Fish do not contain carbohydrates. Fish bones when eaten constitute a good source of minerals (1.5 g%) like calcium and phosphorous. Sea fish contain iodine and fluorine also. Oysters and lobsters sea-fish are richest in iodine.

Fish proteins are easily digested. The fat of the fish is rich in unsaturated fatty acids and vitamins A and D. Fish liver-oils are the richest source of vitamins A and D.

Most of the fish are edible but a few are poisonous.

Meat

The term meat is used to all flesh foods like beef (of cattle), pork (of pigs), mutton (of goats and sheep), veal (of calves), poultry (or birds), etc. Meat is a source of good quality proteins (i.e. of high biological value) 20 to 22 percent. Qualitatively, it is less than that of pulses. Fat content is about 15 to 20 percent, consisting of saturated fatty-acids. It does not contain carbohydrates. Mineral content is about 1 percent. Important minerals present in meat are iron, phosphorous, potassium and zinc. Meat is rather poor in vitamins, except B_{12}.

Edible organs are liver, kidney, heart, spleen and brain. Liver is extremely rich in many nutrients such as iron, thiamine, niacin, cyanocobalamin, retinol and vitamin D.

High meat diet is advised to patients with anemia and protein-energy malnutrition. Gout patients should avoid liver and kidney as they are rich in nucleoproteins, which might further precipitate the condition.

Fats and Oils

Fats are the solid and oils are the liquid forms of fat at room temperature. They are good sources of energy (1 g yields 9 kcals). Fats also provide fat soluble vitamins. Fats of animal origin are rich in saturated fatty acids whereas fats/oils of vegetable origin are rich source of essential polyunsaturated fatty acids, except coconut oil and palm oil.

Fats and oils are valued for their flavor, richness and satiety they give to meals.

Hydrogenation of cooking oil and marketing as Vanaspati is popular cooking medium. Margarine is made from vegetable oils and is fortified with vitamins A and D.

Sugar and Jaggery

These are carbohydrate rich foods, prepared from sugarcane, used as sweetening agents in beverages and various foods. This increases the palatability. Refined sugar is pure sucrose and contains no other nutrients.

Jaggery provides iron and carotene.

Honey consists of 75 percent sugars, mostly fructose and glucose. Excessive consumption of refined sugar is associated with obesity, ischemic heart disease and dental caries. Recommended intake is 30 g per day.

Condiments and Spices

They have limited nutritive value, but still they have indispensable position in cooking. Not only they add flavor to the cooked food, but also they add taste and increase the palatability.

Condiments and spices are appetizing ingredients. For example, Asafoetida, cardamom, ginger, garlic, cloves, mustard, pepper, tamarind, chillies, turmeric, etc.

Tannin in spices inhibits iron absorption. Garlic is known to have antibacterial property and also cholesterol reducing property. Excessive consumption of condiments and spices may lead to pepticulcers.

Miscellaneous

This includes beverages (drinks) which are classified into three groups:

a. Coffee, tea and cocoa
b. Soft drinks such as aerated water, fruit-juice, pepsi-cola, lemonade, etc.
c. Alcoholic beverages such as beer, wine, whisky and traditional preparations.

Coffee, Tea and Cocoa

Coffee contains caffeine 0.6 to 2 percent, a stimulant of nervous system. It also contains tannin. When the seeds are roasted, tannin is destroyed, proteins are coagulated and pleasant aroma is liberated.

Tea contains caffeine 2 to 6 percent, tannic acid 6 to 12 percent and traces of theophylline and volatile oils, which give aroma. When milk is added, the casein of the milk combines with tannin and thus casein is unavailable for absorption.

Cocoa: This is obtained from cocoa beans. It is rich in fat (8%). It contains theobromine, a stimulant.

Soft Drinks

The principal ingredients are carbon dioxide, sugars, acids such as citric acid or tartaric acid, coloring and flavoring agents. Fruit beverages like squashes and cardials are diluted with water before consumption.

Alcoholic Beverages

These are beer, whisky, brandy, rum, gin, etc. The ethyl alcoholic content varies from 5 to 6 percent in beers to 45 to 50 percent in whisky, brandy, rum and gin. Alcohol provides 7 kcals of energy per ml.

Country liquor prepared from unconventional sources contains methyl alcohol, which leads to loss of vision.

Chronic consumption of alcoholic drinks not only leads to addiction, a social problem, but also is associated with peptic ulcer, cirrhosis of liver, ischemic heart disease, etc.

Natural vinegar prepared from fruits, malt and molasses, contains about 3.7 percent of acetic acid.

Salt

This is an important additive to the diet. A food-additive is a non-nutritious substance, added intentionally to food, to improve the appearance, flavor and to preserve the nutritive value. Natural salt, prepared from sea-water, contains sodium-chloride only. Average consumption of salt in India is about 15 g/day, which is more than the recommended because of high sodium loss through the sweat in a tropical country like India.

Recently, attention has been given to fortification of salt with iodine and iron to control iodine deficiency disorders and anemia.

Medicated salt is described elsewhere.

ENERGY REQUIREMENTS

Energy obtained from the food items is necessary for the promotion, protection and maintenance of health in all the age groups and of both the sexes and also for the growth and development of children and adolescents and also for maintenance.

For this purpose, energy is required for basal metabolism, routine light activity, professional work and to a small extent, for specific dynamic action of food.

Energy for basal metabolism: It is the energy required to maintain the basic vital functions (circulation, respiration, etc.) in the body. The amount of energy consumed per hour, per square meter of the body surface, is called 'Basal Metabolic Rate (BMR)'. The rate is determined after the subject has been at complete physical and mental rest, in a room at a comfortable temperature, 12 to 18 hours after last meal.

An Indian Reference Man (as defined by Indian Council of Medical Research, ICMR) is a one, aged between 18 and 30 years, weighing 60 kg, has a body surface area of 1.62 square meter and BMR 35.5 kcals/hour/m^2, who is free from the disease and physically fit and mentally alert **(Table 16.19)**. On each working day he is employed for 8 hours in occupation, 8 hours in bed, 4 to 6 hours in sitting and moving around and two hours in walking, household work and recreation. Such a person requires minimum of 2318 kcals of energy per day.

India has entered the era of dual nutrition burden while undernutrition and micronutrient deficiencies remain as major public health problems, obesity is emerging as a major problem, because of changes in life style during the last two decades. The ICMR expert committee considering these factors worked out and recommended reduction in the nutrient and energy requirements for Indians **(Table 16.20)**.

An Indian Reference Woman is one, aged between 18 and 30 years of age, healthy, weighing 5 kg with a body

Table 16.19 Reference body weight of Indians (NNMB)*

Groups	Age (years)	Weight (kg)
Infants	0–6 months 6–12 months	5 8
Children	1–3 years 4–6 years 7–9 years	12 18 25
Boys	10–12 years 13–15 years 16–18 years	34 47 55.5
Girls	10–12 years 13–15 years 16–18 years	35.0 46.6 52.1
Adults		
Men	18–30 years	60.0 Height 172 cm BMI 20.3
Women	18–30 years	55.0 Height 161 cm BMI 22.2

*National Nutrition Monitoring Bureau

surface area of 1.4 sq. meter and BMR is 31.6 kcals/hour/m^2. She is engaged for 8 hours of work, 8 hours in bed, 4 to 6 hours in sitting and moving around and 2 hours in walking or recreation or household duties. Such a woman requires minimum of 1900 kcals of energy per day. The concept of 'Reference man or woman' is adopted universally, for estimating the energy needs of a person, based on the weight, body surface area, BMR and activities. This was first devised by FAO committee, in 1950 and has been in use ever-since.

- **Energy required for light activity:** Light activity consists of routine activities such as sitting, walking, reading, writing, etc. About 40 kcals per hour are needed for such light work in addition to BMR. If this activity lasts for 8 hours, the extra calories required will be 8 × 40 = 320 kcals.
- **Energy required for occupational work:** This depends upon whether it is light work (sedentary work) moderate work or heavy work.

  Sedentary workers like office clerks, executives, doctors, etc. needs 50 kcals per hour (= 50 × 8 = 400 kcals for 8 hours). It is proportionately 2 to 3 times more for moderate worker and 4 to 6 times more for a hardworker.
- **Energy required for specific dynamic action (SDA) of food:** It is the energy required for digestion and absorption of the food. It depends upon the type of the diet. It is approximately 4, 6 and 12 percent of BMR for carbohydrate, fat and protein respectively. For a mixed diet, it is about 9 percent of BMR which amounts to 150 kcals.

  Thus, the energy requirement per day, for a sedentary male worker, weighing 50 kg will be as follows:

Basal metabolism	– 1440 (including 8 hrs of sleep)
For light activity	– 320
For occupational work	– 400
For specific dynamic action of food	– 150
Total	2310

Additional allowance recommended during pregnancy is 300 kcals per day and during lactation 550 kcals per day during the first 6 months and 400 kcals, daily during the next 6 months.

The energy requirements for a family or a group **(Table 16.20)**.

This can be assessed by employing 'Dietary coefficient' (DC) or consumption coefficient 1 DC = 2400 kcals. It is the energy requirement for an 'Indian Reference Man'. (Sedentary male adult). It is taken the standard.

Table 16.20 Recommended energy requirement

Age groups	Category	Requirements kcal/day	Difference from 1989 RDA kcal/day
Man	Sedentary work Moderate work Heavy work	2318 2727 3485	– 107 – 148 – 315
Woman	Sedentary work Moderate work Heavy work Pregnant woman* Lactating woman	1899 2234 2854 + 350	+ 24 – 9 – 71 + 50
Infants	0–6 months 6–12 months 0–6 months 6–12 months	+ 600 + 520 92 kcal/kg/day 79 kcal/kg/day	+ 50 + 120 – 16 kcal/kg/day – 19 kcal/kg/day
Children	1–3 years 4–6 years 7–9 years 10–12 years	1036 1350 1691 2189	– 204 – 340 – 259 —
Boys	13–15 years 16–18 years 10–12 years	2748 3017 2008	+ 298 + 377 + 48
Girls	13–15 years 16–18 years	2328 2070	+ 268 + 10

*For weight gain of 10 kg in pregnant women

Table 16.21 Dietary coefficients of different members of a group

Category		Dietary coefficient
Adult male	Sedentary worker Moderate worker Heavy worker	1.0 1.2 1.6
Adult female	Sedentary worker Moderate worker Heavy worker	0.8 0.9 1.2
Adolescents	12 to 21 years	1.0
Children	1 to 3 years 3 to 5 years 5 to 7 years 7 to 9 years 9 to 12 years	0.4 0.5 0.6 0.7 0.8

Source: ICMR (1989)

The different DCs of different members of a family or a group is as follows **(Table 16.21)**.

The dietary coefficient is meant for calculating the energy requirement and not for the nutrients.

BALANCED DIET

It is a diet that contains a variety of foods, in such quantities and proportions that the need for energy and all the nutrients (proteins, fats, carbohydrates, vitamins and minerals) is adequately met for maintaining health, vitality and general well-being for a person, including a small provision for extra nutrients to withstand the needs in future emergencies such as leanness **(Tables 16.22 and 16.23)**.

In constructing a balanced diet, the following principle should be adopted.

- Protein requirement should be 15 to 20 percent of daily energy intake.
- Fat requirement should be 20 to 30 percent
- Remaining food energy should be constituted by carbohydrates.

Suggested Substitution for Nonvegetarians

Food item which can be deleted from non-vegetarian diets:	Substitution that can be suggested for deleted item or items:
50 percent of pulses (20–30 g)	1. One egg or 30 g of meat or fish 2. Additional 5 g of fat or oil
100 percent of pulses (40–60 g)	1. Two eggs or 50 g of meat or fish One egg-30 g meat 2. 10 g of fat or oil

FOOD HYGIENE

Food is one of the physical environment. Adequately hygienic food is necessary for maintaining the health, vitality and wellbeing of an individual. Food also acts as an important vehicle of transmission of the diseases because of its liability for contamination at any point during its journey from the producer to the consumer. So due precautions must be taken while procuring, storing, processing and cooking of foods. Food hygiene is discussed under the following headings:

- Food additives
- Food preservation

Table 16.22 Balanced diets (the quantities are given in grams)

	Adult man			Adult woman			Children		Boys	Girls
Food item	Sedentary	Moderate work	Heavy work	Sedentary	Moderate work	Heavy work	1–3 yrs	4–6 yrs	10–12 yrs	10–12 yrs
Cereals	460	520	670	410	440	575	175	270	420	380
Pulses	40	50	60	40	45	50	35	35	45	45
Leafy vegetables	40	40	40	100	100	50	40	50	50	50
Other vegetables	60	70	80	40	40	100	20	30	50	50
Roots and tubers	50	60	80	50	50	60	10	20	30	30
Milk	150	200	250	100	150	200	300	250	250	250
Oil and fats	40	45	65	20	25	40	15	25	40	35
Sugar or jaggery	30	35	55	20	20	40	30	40	45	45

Source: ICMR (1990)

Table 16.23 Additional allowances during pregnancy and lactation

Food items	During pregnancy	Calories (kcal)	During lactation	Calories (kcal)
Cereals	35 g	118	60 g	203
Pulses	15 g	52	30 g	105
Milk	100 g	83	100 g	83
Fat	-	-	10 g	90
Sugar	10 g	40	10 g	40
Total		293		521

Source: ICMR (1990)

- Food processing
- Sanitation of food establishments
- Conservation of nutrients
- Food fortification
- Food adulteration
- Milk hygiene
- Meat hygiene
- Food allergy.

Food Additives

These are legally permitted 'non-food' substances added to improve the appearance, flavor, texture or storage properties. This also includes those substances that get incorporated into foods in the course of their packing, storage, transportation and handling. Thus, there are two categories of food additives—first and second categories.

First category or direct additives, are those which are deliberately added and they are safe. These include:

- Coloring agents, e.g. Saffron, turmeric, tartrazine, caramel.
- Flavoring agents, e.g. vanilla essence, cloves, ginger.
- Sweetening agents, e.g. saccharin, aspartame.
- Preservatives, e.g. sorbic acid, sodium benzoate.
- Palatability agents, e.g. citric acid, benzoic acid, etc.
- Stabilizing agents, e.g. gum, starch, dextrin, etc.

Second category or Indirect additives are those contaminants incidental through packing, processing-steps or while transportation and they are not safe. For example, pesticides, rodenticides, arsenic, etc.

Prohibited additives are lead chromate, metanil yellow, ferric sulfate and copper carbonate.

The harmful effects of food additives are allergy, food-poisoning, carcinogenicity, etc. Majority of processed food like bread, biscuits, cake, jam, jellies, soft-drinks, ketch-up, etc. all contain food additives.

Because of the harmful effects resulting in public health problem, in India, there are two regulations governing the food-additives-namely Prevention of Food Adulteration Act and Fruit Products Order. Any processed food containing the additives more than the permissible limit or that are not permitted, is considered to be adulterated. The nature and quantity of the additive must be clearly printed on the label.

Food Preservation

Objectives

- To preserve the nutritive value
- To prolong the life of food
- To add variety to food preparation
- To make the food available even in off the season
- To avoid wastage of food
- To save time in procurement.

Preservation of the food is necessary because food is liable for spoilage due to the action of micro-organisms (moulds, yeast, bacteriae, etc.) insects and enzymes. Moulds which look like cotton spread on food, develop in warm, damp and dark places. For example, Aspergillus flavus on ground-nuts produce aflatoxin, consumption of which results in Aflatoxicosis. Yeast grow on fruits and convert the sugar into alcohol and carbon dioxide. Anaerobic bacteriae usually spoil the tinned food and aerobic bacteriae spoil foods like milk, egg, meat, vegetables, etc.

Principles of Food Preservation

- It is to maintain asepsis and to prevent entry of the organisms, by air-tight package
- It is to make liquids free from bacteriae by filtration through porcelain-filters
- It is to destroy enzymes by blanching, e.g. pasteurization of milk
- It is to destroy pathogens by irradiation of fruits and vegetables, etc.

Methods of Food Preservation

There are two methods—bacteriostatic and bactericidal.

- *Bacteriostatic methods*

  Dehydration: For example, removal of moisture from fruits, chillies, preparation of milk powder from milk, etc.
  Coating (Glazing): For example, a coat of sodium silicate over the egg, closes the pores and prevents spoilage.
  Salting: For example, lemon is best stored by pickling.
  Chemicals: For example, benzoic acid is used for food preservation.
  Refrigeration (Chilling): For example, keeping the fruits, vegetables, milk, egg, meat, drinks, etc. in the refrigerator, prevents the growth of pathogens. Digestibility and food-values are not affected.

- *Bactericidal methods*
  Heating: For example, pasteurization of milk. However, spores are resistant to heat.
  Smoking: For example, smoking of meat and fish.
  Canning: For example, hot food is put inside the can and again heated. Then the can is sealed. This makes the can air-tight.
  Irradiation: For example, irradiation with ultraviolet rays for fruits and vegetables.

Food Processing

These methods improve the quality of foods. The different methods are as follows:

Parboiling: By this method, the nutrient lost is minimized in the rice.

Parching (Puffing): In this method, the cereals (Jowar, rice, maize) are moistened and then heated. While heating the escaping water causes the grain to swell. For example, murmura, popcorn, etc. Starches in the grain are broken down to simpler compounds, which improves their digestibility. It leads to some loss of lysine.

Sprouting (Germination): The pulse (green-gram, Bengal gram) grains are moistened and stored in wet condition for 24 to 48 hours. The grains sprout. The process increases vitamin C content by about 10 times. The content of thiamine, riboflavine and niacin is almost doubled. Iron becomes free and hence available. The digestibility increases due to breakdown of cell-walls. Sprouting of fenugreek (methi) seeds reduces its bitter taste.

Fermenting: In this method, the micro-organisms multiply under the processing conditions, e.g. making curd from milk, processing of rice and urid dal for idli, etc. In curds, the lactose is converted into lactic acid. The enzyme in the starch releases carbon dioxide to cause bubbles. Fermentation doubles the thiamine, riboflavin and niacin contents. Iron availability is also increased.

Liming: Means introduction of lime in foods like butter-milk, rasam, fermented mixture. It prevents destruction of thiamine and riboflavine.

Sanitation of Food Establishments (Restaurants, Eating Houses)

The following minimum standards have been suggested under the Model Public Health Act (1955), for restaurants:

Location: It should not be near any accumulation of filth or open drain, stable, manure pit and other sources of nuisance.

Floor: Should be higher than the adjoining land, made with impervious material and easy to keep clean.

Rooms: Should be accommodative for maximum of 10 persons.

Walls: Should be impervious and easily washable.

Lighting and ventilation: Should be adequate.

Kitchen: The floor to be impervious, smooth, non-slippery and easy to keep clean. Door and windows to be rat-proof, fly-proof and of self-closing type. There must be smoke pipe and ventilators.

Store room: There must be provision for storing the food grains and also cooked food separately.

Furnitures: Should be strong and easy to keep clean and dry.

Collection of refuse: There must be provision for collection, storage and transportation of refuse.

Water supply: Should be of independent source, continuous, adequate and safe.

Washing utensils: There must be provision for washing of the utensils and crockery-followed by disinfection in hot water.

Sanitation of food establishments not only depends upon the physical environment of the set-up, but also upon the state of personal hygiene and habits of the food handlers. They may be carriers of various diseases such as typhoid, diarrheal diseases, dysenteries, enteroviruses, viral hepatitis, amebiasis, ascariasis, strepto and staphylococcal infections. Therefore, the following measures must be taken care of the food-handlers.

- Prelacement thorough medical examination to exclude the presence or suffering of the systemic disease
- Day to day health appraisal should be made
- They should abstain from their duty whenever they develop septic skin lesions, respiratory and intestinal symptoms, otitis-media, or any other wound till they are cured bacteriologically
- They should undergo periodical medical check-up
- They should take the treatment promptly
- They are educated to maintain a high standard of personal hygiene on the following aspects
  Hairs: Use scarfs to prevent falling of the hairs on foods.
  Hands: Finger nails should be kept trimmed and free from dirt. Hands to be scrubbed and washed with soap and water before handling the food and after using toilet.
  Overalls: Clean and white overalls should be worn by them.
  Habits: The hazards of unguarded coughing, sneezing, in the vicinity of the food, smoking in the food premises, etc. must also be told.

Conservation of Nutrients

Before Cooking

- Foods should be kept clean and dry and stored in air-tight containers
- Undermilled or hand pounded rice to be preferably used
- Sprouting of the pulses improves the nutritive value
- Washing of the food item to be done with minimum quantity of water
- Too small cutting and too early cutting of vegetables before cooking to be avoided, to prevent the loss of vitamins and minerals
- Ghee, butter, oil, etc. should be kept sealed in a cool and dry place to prevent rancidity.

During Cooking

- Vegetables are put in the boiling water instead of boiling them in water
- Vegetables should not be cooked for more than 15 minutes
- Baking soda should not be used, because loss of vitamins is more in alkaline medium
- Potatoes and sweet potatoes should be cooked without peeling. It is preferable to cook them in cooker
- Milk should be rapidly brought to boiling point and then cooled quickly, as in pasteurization
- Eggs are best cooked below the boiling point
- Salt should be added late since addition of salt before boiling hastens the loss of nutrients
- Addition of little acid such as tamarind, lemon-juice, vinegar, citric-acid while cooking, conserves the nutrients
- Use of iron knives and cast iron pans increases the iron content
- Steam heating is preferable to use of boiling, because the loss of nutrients is almost nil
- Both shallow and deep frying of foods in oil causes loss of nutrients. Loss is less in deep frying because of the oil coating.

After Cooking

- Repeated reheating is avoided.
- Food to be eaten while it is hot.

Food Fortification

It is a process wherein nutrients are added in small quantities, to the foods, to maintain or to improve the quality of food aimed at prevention and control of some nutritional disorders, as a long-term measure.

Examples

- Addition of vitamin A and D to vanaspati and milk (2500 IU of vitamin A and 175 IU of vit D per 100 g)
- Addition of potassium or sodium iodide to common salt (iodization of salt) for the prevention and control of endemic goiter
- Addition of iron salts to common salt for the prevention of nutritional anemia
- Addition of lysine to wheat flour while making bread
- Twin fortification of common salt with iron and iodine
- Fluoridation of water for the prevention of dental caries
- For fortification, the nutrient and the vehicle should fulfill the following criteria:
  - The vehicle must be consumed consistently by the community as a part of the regular diet
  - The nutrient should not be hazardous
  - The nutrient should not undergo any change in taste, smell, appearance or consistency
  - The cost of fortification should not be beyond the reach of the people.

Food Adulteration

It consists of large number of practices such as mixing, substitution, removal, concealing the quality, selling decomposed products, misbranding, (giving false labels), addition of toxicants, etc. Food adulteration is a social evil. This is done by the traders because of their greed for money.

The disadvantages for the consumer are: (i) he is paying more money for a food stuff of lower quality, (ii) he is at a risk of ill-health, e.g. epidemic dropsy, allergy, gastritis, testicular damage, etc.

Examples of food adulteration are given in **Table 16.24**.

Table 16.24 Examples of food adulteration

Food materials	Common adulterant
Cereals (Rice, wheat)	Stone, sand, grit
Dals (Bengal gram)	Kesari dal (Lathyrism)
Milk	Addition of water, removal of cream, addition of starch (water borne disease)
Ghee	Addition of vanaspati
Butter	Starch, animal fat
Turmeric powder	Lead chromate powder (metanil yellow) (lead poisoning)
Black pepper	Dried seeds of papaya
Chilli powder	Brick powder
Tea leaves	Husk of blackgram, reuse of tea leaves
Coffee seeds	Tamarind seeds
Baking powder	Citric acid
Honey	Sugar, jaggery

Contd…

Contd...

Food materials	Common adulterant
Sugar	Chalk
Mustard seeds	Seeds of prickly-poppy (Epidemic dropsy)
Edible oil	Mineral oil
Ice-cream	Starch, cellulose, washing powder
Asafoetida	Resins, gums
Jaggery solution	Honey (or vice-versa)
Coffee powder	Chicory
Nonalcoholic beverages	Nonpermitted colors, saccharin, dulcin, lead, arsenic, copper, dirt and filth.

Tests for Adulterants

Physical tests

- Argemona mexicana seeds (prickly-poppy) are black in color but not uniformly smooth and round
- Kesari dal is wedge shaped
- Iron fillings in tea can be separated by using magnet
- Ergot seeds are lighter than bajra and float on water
- Sand, gravel, pebbles can be observed and removed physically.

Chemical tests (for the following adulterants)

Metanil yellow: This is used in haldi (turmeric) powder. Two gram of sample is added to 5 ml of alcohol and shaked. A few drops of concentrated HCl are then added. Pink color indicates presence of metanil yellow.

Starch: This is added to milk. Little iodine is added to the sample of milk. Development of blue color indicate the presence of starch in the milk.

Argemone oil: This is added to mustard oil. Five millimeter of nitric acid is added to 5 ml of suspected mustard oil and heated for about 5 minutes. Development of red color indicates the presence of argemone oil.

Artificial red color to chillies: A piece of cotton, soaked in liquid paraffin, is rubbed with a sample of chillies powder. Cotton becomes red with artificial color.

Prevention and control of food adulteration: By food standards and legal measures.

Food standards

Codex alimentarius: Codex Alimentarius Commission (CAC) is a principal organ of the joint FAO/WHO Food Standards Program. This has formulated food standards for the international market. The standards prepared by CAC has been accepted internationally.

PFA standards: These are the standards laid down under the Prevention of Food Adulteration Act (1954) by the Central Committee of the Food Standards, to obtain minimum level of quality of food stuffs. These standards are statutory and there is a legal backing to it. Any food that does not confirm to the minimum standards, is said to be adulterated.

Agmark standards: These are prescribed by the Directorate of Marketing and Inspection of the Govt. of India. This gives the assurance of quality of the food stuff.

ISI standards (Indian Standard Institution): These are prescribed by the Bureau of Indian Standards. The Agmark and ISI standards are not mandatory, but purely voluntary. They express degrees of excellence above PFA standards. The presence of ISI-mark also gives the consumer an assurance of the good quality of the product.

Legal measures

Prevention of Food Adulteration Act, 1954 (PFA-Act): With the objectives of ensuring pure and wholesome quality food to the consumers, to protect their health from the fraudulent practices of traders and to encourage fair trade-practices, Government of India enacted an Act called, 'The Prevention of Food Adulteration Act' (PFA-Act) in 1954 and amended three times respectively during 1965, 1976 and 1986 to make it more stringent. The State Government enforces the Act.

The Act provides protection against adulteration or contamination the food that may have deleterious effects on consumer's health. The Act also deals with the frauds that can be perpetrated by the dealers by supplying cheaper and adulterated foods. The Act regulates the use of chemicals, pesticides, flavors and other additives in food preparation. Dumping of sub-standards foods is also controlled under this Act. However provision is made under this Act for enrichment and fortification of foods.

It is defined that 'Adulterant' is a material, which is employed for the purpose of adulteration and an article is deemed to be adulterated:

- If it is sold by a vendor and is not of the nature demanded by the purchaser and is not of the quality which it purports to be
- If the article contains any other substance so as to affect injuriously the nature or quality there of
- If it is substituted wholly or partially by an inferior substance
- If the constituent of the article is abstracted partially or wholly, as to affect its quality
- If the article has been prepared, packed or kept under insanitary conditions and has become contaminated as to cause injury to the health
- If the article consists of filthy, rotten, putrid or decomposed substance and is unfit for consumption
- If the article is obtained from a diseased animal
- If the article contains any poisonous substance
- If the article contains prohibited preservative or coloring matter in excess of the prescribed limits
- If the quality of the article falls below the prescribed limits.

The rules are framed by an expert body called 'Central Committee for Food Standards'. According to the rules, any food that does not conform to the minimum standards is said to adulterated. Powers are given to the State Governments to appoint Public Analyst and Food Inspectors, who control the food supply, storage and marketing of foods. A chain of 82 State Food Laboratories and 4 Central (Regional). Food Laboratories are working in the country for the purpose of the PFA-Act. It is the duty of the food inspector to draw and dispatch the sample of suspected food article to the laboratory for testing.

If the adulteration is proved, the trader is awarded a minimum imprisonment of 6 months and a fine of ₹ 1000. If the adulteration results in grievous health problem or even death, the punishment will go up to life imprisonment and a fine of ₹ 5000.

With the amendment in 1986, the consumer and the voluntary organizations have been empowered to take the samples of food.

Milk Hygiene

Milk-borne diseases: Compared to any other food-item, milk is more responsible and efficient vehicle for spread of diseases. This is because it is a good medium for the organisms to grow and moreover, it is difficult to keep the milk clean, fresh and in a satisfactory condition and it is most commonly adulterated. Milk is liable for contamination also from animals, human beings and environments such as water, dust, flies, vessels, etc.

The milk-borne diseases are classified into two groups:

1. Diseases of animals transmitted to man through milk (Zoonoses).
   Such as salmonellosis, brucellosis, bovine tuberculosis, Q-fever. Foot and mouth disease, anthrax, etc.
2. Diseases of man transmitted to others through milk.

Such as water borne diseases (because of adulteration of milk by adding contaminated water), e.g. Viral hepatitis A and E, typhoid, diarrheal diseases, dysentry, amoebiasis, giardiasis, ascariasis, and also staphylococcal food poisoning if the milk handler is having staphylococcal lesions in the hands.

Features of milk borne epidemic:

- Children are the usual victims
- All cases occur almost simultaneously
- Similarity of signs and symptoms
- Usually confined to an area
- Source of milk supply is common in that area.

Prevention of milk-borne diseases: This is done by procuring clean and safe milk through hygienic diary, pasteurization and sterilization.

The requirements of a hygienic diary are:

- Animals should be free from diseases
- Milking house should be free from dust and flies (clean premises)
- Milk handlers should be free from communicable diseases and they should maintain a high standard of personal hygiene
- Wherever possible, milking machines must be used
- Utensils should be clean; water supply should be clean and safe
- Bottling, storage and chilling should be done in clean surroundings
- Facilities must be available for doing laboratory tests of milk.

Pasteurization

It is defined as a process of preservation of the milk, wherein the milk is heated to such temperature and for such a period of time so as to destroy all the pathogens in it and to preserve the nutritive value of it without changing the color, smell, taste, flavor and composition.

Thus pasteurization is the simplest, safest and cheapest and modern method of rendering the milk safe. It is an example of prophylactic (precurrent) disinfection procedure.

Methods of pasteurization: These are Holder method, HTST method and UHT method.

Holder method (Vat process; Holding process): In this method, milk is heated to 65°C (145–150°F) and maintained at this temperature for 30 minutes and then suddenly cooled to a temperature below 5°C. Rapid cooling prevents the growth of the organisms. It is a British method, slow method, recommended for small and rural communities.

High temperature and short time process (HTST) (Flash process) method: In this method, milk is heated to 72°C and maintained for at least 15 seconds and then rapidly cooled to less than 5°C. It is an American method, rapid method and most widely used. Recommended for urban areas to pasteurize large quantity of milk.

Ultra high temperature (UHT) process method: In this method, milk is heated in two stages. In the first stage, heating is done under normal pressure to 88°C for few seconds, then in the second stage, it is heated to 125°C under pressure for few seconds only. It is then rapidly cooled and bottled as quickly as possible.

In pasteurization, 90 percent of the pathogens and lactobacilli are destroyed and not the spores.

After bottling, the milk is kept cold, until it reaches the consumer, because with subsequent rise in temperature, bacteriae are bound to multiply.

Sterilization

This is done in milk cookers by heating milk to 100°C (212°F) for 20 to 30 minutes. This process not only destroys 100 percent of pathogens but also spores. This is not a popular method because it diminishes the nutritive value.

Tests for milk: These can be divided into two groups:
1. Tests for adulteration
2. Tests for pasteurization.

Tests for milk adulteration
1. *Specific gravity:* This should be between 1028 and 1032, under PFA-Act. Low specific gravity indicates addition of water. High specific gravity indicates addition of starch, sugar or skimmed milk powder. Specific gravity is recorded by using lactometer.
2. *Fat content:* This is estimated with fat-meter. Low fat content indicates addition of water or removal of fat.
3. *Iodine test:* Few drops of iodine are added to 5 ml of milk. Development of blue color indicates addition of starch.
4. *Cane-sugar:* Addition of sugar can be detected by adding hydrochloric acid and few grains of resorcin to test sample and then heated. Development of red color indicates addition of sugar.

Tests for pasteurization
1. *Phosphatase test:* This is based on the principle that the enzyme 'Phosphatase' is destroyed when the milk is heated as in pasteurization.

   To the sample of milk, a buffer 'disodium phenyl phosphate' is added and incubated. If the enzyme is present, it acts upon the buffer and liberates phenol, which is indicated by adding Felin's reagent, which turns the milk blue. Therefore, the development of blue color indicates that the enzyme is present. Thus positive test indicates that the milk is not pasteurized or raw milk is added.
2. *Methylene blue test:* This is to detect the destruction of bacilli. One milliliter of methylene blue is added to 10 ml of milk and incubated in water bath for 5 hours. Discoloration indicates presence of bacteria.
3. *Standard plate count:* Permissible limit is 30,000 bacteriae per ml pasteurized milk.
4. *Coliform count:* Coliform organisms are usually completely destroyed by pasteurization. So they should be zero or absent in any 1 ml of sample of milk. Presence of coliforms is an indication of either of improper pasteurization or postpasteurization contamination.

The comparison between pasteurization and sterilizaton is shown in **Table 16.25**.

Meat Hygiene

The term meat includes all flesh foods such as mutton, pork, beef, poultry, veal (of calves), goat-meat, etc.

Diseases transmitted through meat are cysticercus-cellulose of Taenea-solium through pork (when it is known as 'measly-pork'), cysticercus cellulosae of Tinea-saginata through beef (when it is known as 'measly-beef'), liver flukes through mutton of sheep, i.e. Fasciola Hepatica, Trichinella

Table 16.25 Comparison between pasteurization and sterilization

	Pasteurization	Sterilization
Method	Milk is just heated and not boiled. There are three methods: a. Holder process (65°C × 30') b. HTST process (72°C × 15") c. UHT process (88°C × few secs, then at 125°C × few secs)	Milk is heated to boiling. Only one method. 100°C × 20 to 30'
Bacteriological changes	90% of pathogens and 90% of lactobacilli are destroyed. Remaining 10% of lactobacilli take time to multiply and cause fermentation by converting lactose to lactic acid. Thus souring of milk is delayed or postponed. Spores are not destroyed.	100% of the pathogens and lactobacilli are destroyed. Therefore, souring of the milk is totally prevented. Spores are also destroyed.
Chemical changes		
Proteins	Only 5% lactalbumin is lost.	100% lactalbumin and 100% lactoglobulin are lost.
Fats	No scum (cream) is formed and so calcium and phosphorus are not taken up.	Scum is formed and so calcium and phosphorus are taken-up.
Carbohydrates	Lactose is not charred or caramalized (so no change in color)	Lactose is completely charred or caramalized (so milk becomes brownish)
Vitamins	Vitamin C is reduced	Vitamin C is lost
Minerals	Proportion of insoluble calcium salts is increased by 6%. Other salts are not affected	Calcium and magnesium salts are precipitated
Physical changes	There are no changes in the color, composition, taste, smell and flavor	Color becomes slightly brownish, taste is altered, smell is slightly changed, composition is also affected as above
Souring of milk	This is delayed or postponed	This is prevented completely

spiralis through pork and also bacterial infections such as anthrax, actinomycosis, tuberculosis and food-poisoning such as botulism through canned food.

Inspection of Animals (Antemortem Examination)

This should be done before slaughtering. The indications of health are: it should move about freely, should be able to get up with ease on lying down, quick bright eyes, red, bright and moist nostrils, tongue not protruding, respiration regular and skin glossy and smooth.

When diseased, hairs stand out and are not smooth, the nostrils are covered with frothy excretions, eyes dull, the tongue furred and hanging out of the mouth, respirations rapid and in febrile conditions the ears, feet and in milch cows, the teats are hot.

The causes of rejection of animals are emaciation, pregnancy, sheep-pox, foot and mouth disease, anthrax, brucellosis, actinomycosis, tuberculosis, rabies, etc.

Inspection of Meat (Postmortem Examination)

The characteristics of good meat are that it should be neither pale pink nor a deep purple tint, firm and elastic to touch, should have little or no odor, should not shrink on cooking and appearance should be marble.

The causes of rejection of meat are parasitic infestations (e.g. liver fluke, hydatid, cysticercus, etc.) and bacterial or viral infections.

Slaughter Houses

A slaughter house is one where animals are killed for the purpose of consumption of the flesh. The following standards have been prescribed under Model Public Health Act, 1955.

Location: It should be minimum 100 feet away from the residential area.

Floor: It should be above the ground level and made of impervious material, with a slope and channel.

Walls: It should be covered with tiles or glazed bricks to a sufficient height.

Water supply: It should be abundant.

Disposal of waste: All refuse, blood, manure and garbage are placed in vessels and removed as soon as possible.

Other animals: Like dogs should not be allowed, because of the danger of the infections.

Employees: Must be clean and wear clean outer clothes.

Butchers: It should also maintain personal hygiene and be healthy.

Instruments: It used must be sterilized.

Inspection of Fish

The signs of fresh fish are:

- Firm and stiff to touch (not soft or pulpy)
- When held flat on the hand, the tail should not drop
- Eyes should be clear and bright (not sunken)
- Gills should be bright red (not muddy or pale)
- Scales not easily detachable.

When decomposition begins, body becomes flaccid, blood will run out, on cutting, as a dull red liquid with offensive odor.

Consumption of stale fish is condemned.

Fish is an intermediate host of a tapeworm (Dibothriocephalus latus), being communicated to man. Fish may carry pathogens like vibrio parahemolyticus (resulting in food poisoning), *Salmonella* species (salmonellosis), *Clostridium botulinum* type E (botulism). Consumption of certain fish may give rise to 'fish poisoning' and urticaria.

Tinned Meat and Fish

These are often dangerous. Such tins are examined as follows:

On inspection, the tin should look fresh and new. There should not be indentations, holes or rust. Bulging of the tin indicates decomposition.

On palpation, springy feeling indicates loss of vacuum through a hole and a sense of resistance indicates internal pressure due to gas formation.

On shaking the tin, there should not be any sound. A loose sloppy sound indicates decomposition.

On opening the tin, the contents should not be blown out, which indicates decomposition.

Food Allergy

Some people will have inherent or acquired idiosyncrasy to certain foods like milk, meat, egg, fish, poultry, fruits, etc. and manifest as urticaria, asthma, eczema, diarrhea and sudden infant death syndrome (cot death). Sensitivity to gluten (wheat protein) is responsible for malabsorption syndrome.

FOOD RELATED DISEASES (PUBLIC HEALTH NUTRITION PROBLEMS)

These are the diseases caused due to defects in the foods consumed. The defects may be deficiency in intake or excessive consumption, or contamination of food or food intoxications or food poisoning. Thus the chief dietetic diseases are:

I. Deficiency diseases
II. Excess of food consumption
III. Food-borne intoxications
IV. Food poisoning
V. Food-borne diseases.

Deficiency Diseases

A. Protein energy malnutrition
B. Vitamin deficiency diseases
C. Mineral deficiency diseases

Protein Energy Malnutrition

Protein energy malnutrition (PEM) is a type of malnutrition resulting from deficiency of proteins and calories in the food over a long period of time. It is very common among young children, who are in the stage of rapid growth and development. Children below 5 years are usually affected and infants are hit hardest.

The most serious forms of PEM are kwashiorkor and marasmus. Nutritional marasmus is more frequent than kwashiorkor **(Figs 16.5A and B)**.

These are the extreme forms (2 poles) of a single condition. Eighty percent of the intermediate ones go unrecognized. Thus, they represent the tip of the ice-berg. For every frank case of malnutrition, there are about 10 cases, which are undernourished.

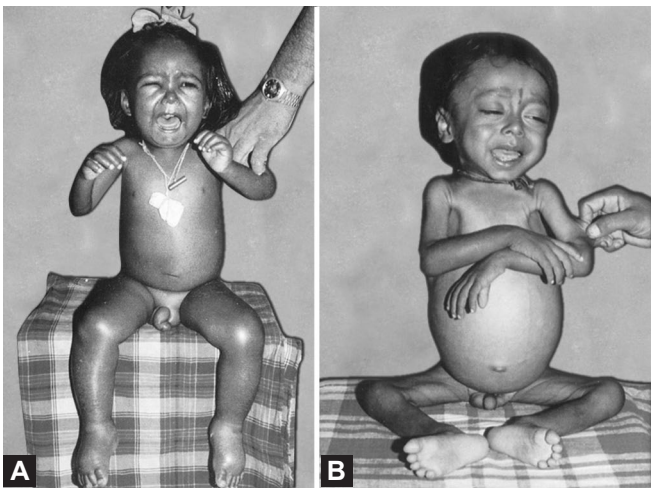
PEM is mainly a problem of all developing countries. In India, the incidence of extreme forms is 1 to 2 percent.

The adverse effects of malnutrition are growth failure, breakdown of immunity, increased susceptibility to infections, prolongation of the recovery period, impairment of mental capacity and motor skills, decreased alertness and physical capacity.

The PEM accounts for 5 percent of deaths among preschool children. Thus, PEM is not only a health problem, but also a social and economic problem.

Causes

- Decreased intake of food (i.e. inadequate diet both in quality and quantity)



Figs 16.5A and B (A) Kwashiorkor; (B) Marasmus

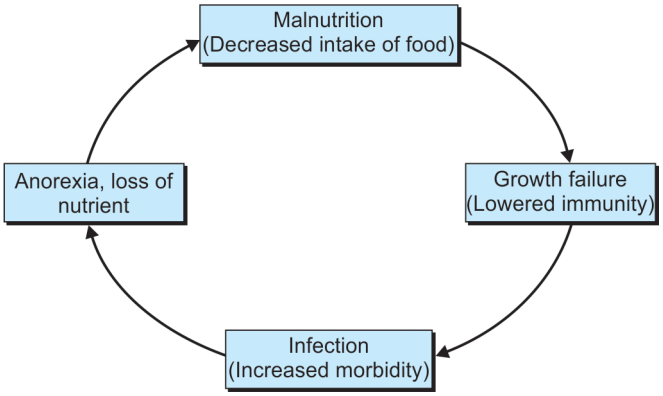


Fig. 16.6 Vicious cycle of malnutrition

- Excessive loss of proteins and calories (because of vomiting, diarrhea)
- Increased demand (or requirement) and decreased absorption and utilization (because of infections and infestations).

Infection contributes to malnutrition and malnutrition predisposes to the causation of infection, both act synergistically. Thus it is a vicious cycle **(Fig. 16.6)**.

Social factors: There are many social causes contributing for the development of malnutrition, such as poverty, illiteracy, ignorance, overcrowding, large family size, poor maternal health, failure of lactation, faulty feeding practices, improper weaning practices, food taboos, beliefs, cooking and cultural practices, etc.

Thus, PEM is multifactorial in origin.

Classification of PEM

1. **Clinical classification (Table 16.26):** Clinically malnutrition is of two types, namely kwashiorkor and marasmus.
2. **Anthropometric methods of grading malnutrition.** These are of the following types:
   a. Welcome's classification.
   b. Gomez classification.
   c. Jelliffe's classification.
   d. According to Indian Academy of Pediatrics.
   e. Waterlow's classification.

Welcome's classification (Table 16.27): This is based on the weight of the child and the presence of edema. The weight (in kgs) is compared with the 'Reference weight for age', which is 50th percentile of Harvard standard. Percentile means position of an individual in a grouped series of hundred, of the same age and sex, when the recorded weight is arranged in a definite order, either ascending or descending.

For example, suppose 100 children, all boys, of one year age, are weighed and recorded in an order and found to vary from say 9 kg (1st child) to 11 kg (100th child) and the position of 50th child being 10 kg, then the 50th percentile value of

Table 16.26 Kwashiorkor v/s Marasmus

Features	Kwashiorkor	Marasmus
Cause	Deficiency of mainly proteins	Deficiency of mainly calories
General condition of the child	Dull, apathetic, disinterest in the surroundings. Hardly moves from the sitting position	Child is alert but irritable
Face	Bloated moon like face	Shrivelled monkey like face.
Growth failure (Weight loss)	Less severe (moderate)	More severe (very severe)
Emaciation (muscle wasting)	Masked (present but not seen because of edema)	Obvious (skin and bone appearance)
Fat wasting	Fat is often retained	Severe loss of subcutaneous fat
Edema	Always present	Absent
Hair changes	Hairs are lusterless, show 'Flag sign'* positive, sparse distribution, loss of curliness and easily pluckable	Hairs show change in texture, thin and silky, show 'Flag-sign' negative
Skin changes	Skin shows paint like patches (Flaky paint dermatoses)	Skin changes are absent
Mental changes	Present	Absent
Liver enlargement	Often present	Absent
Prognosis	Bad	Good
Serum total proteins	Reduced	Normal
Serum cholesterol	Reduced	Normal
Urinary nitrogen	Reduced	Raised

* Hairs show alternate white and dark bands, indicating depigmentation and pigmentation, which are the phases of poor and good nutrition respectively.

Table 16.27 Welcome's classification of PEM

Body weight (% of reference weight for age)	Edema	
	Present	Absent
80–60	Kwashiorkor	Undernutrition
< 60	Marasmic-kwashiorkor	marasmus

Source: Reference 5.

Harvard standard is 10 kg and that is considered as 'Reference Standard' (or 100% value) for India. Because of the wide spread prevalence of malnutrition in India, up to 80 percent value (i.e. up to 8 kg for 1 yr age) is considered as normal nutrition and only below 8 kg (80% value) is considered as malnutrition and graded.

$$\text{Weight for age (\%)} = \frac{\text{Current weight of the child (in kg)}}{\text{Expected weight of the child, for that age (i.e. Reference weight)}} \times 100$$

The expected weight of an Indian child is the 50th percentile value of Harvard standard.

Gomez classification: This is based on only weight for age and not edema. In this system, the reference child is the 50th percentile of Boston standard. This helps to know the percentage of deficiency in a particular child by comparing with a normal child.

Accordingly, malnutrition is graded as follows:

- Between 90 and 110 percent—Normal nutritional status.
- Between 89 and 75 percent—1st degree, mild malnutrition.
- Between 74 and 60 percent—2nd degree, moderately, severe malnutrition.
- Below 60 percent—3rd degree, severe malnutrition.

However, this does not help to know whether it is an acute or chronic malnutrition.

Jelliffe's classification: This is also based on weight for age and is graded as follows. The reference weight is 50th percentile value of Harvard standard.

Between 90 and 81 percent — Grade I
Between 80 and 71 percent — Grade II
Between 70 and 61 percent — Grade III
Below 60 percent — Grade IV

Indian Academy of Pediatrics (IAP) classification:

Between 100 and 80% Normal nutrition status
Between 79 and 70% Grade I, mild malnutrition.

Between 69 and 60% Grade II, moderate malnutrition.
Between 59 and 50% Grade III, severe malnutrition.
Less than 50% Grade IV, very severe malnutrition

Waterlow's classification: This defines two types of malnutrition, namely stunting and wasting, depending upon height for age and weight for height respectively **(Table 16.28)**.

$$\text{Height for age} = \frac{\text{Current height of the child (cm)}}{\text{Expected height for that age}} \times 100$$

A drop in this ratio indicates stunted growth or chronic malnutrition.

$$\text{Weight for height} = \frac{\text{Current weight of the child (in kg)}}{\text{Expected weight of the child for that height}} \times 100$$

A drop in this ratio indicates 'wasting' or acute malnutrition. Wasting indicates the nutritional deprivation of shorter duration.

The master chart of classification of protein energy matnutrition (PEM) is shown in **Table 16.29**.

Laboratory investigations

1. Urine for sugar to rule out diabetes and urine for albumin and microscopic exam to rule out urinary infections, which is common among male children due to pinhole meatus.
2. Urine for culture and sensitivity test.
3. Stool for ova and cyst to rule of underlying infestations.

Table 16.28 Waterlow's classification of PEM

Nutritional status	% of height for age (stunting)	% of weight for height (wasting)
Normal	>95	>90
Mildly impaired	94–87.5	90–80
Moderately impaired	87.4–80	80–70
Severely impaired	<80	<70

Source: Reference 6.

Table 16.29 Master chart of classification of PEM

Grade/ Degree	(Weight for age in percentage)			Waterlow	
	Gomez	Jelliffe	IAP	Height for age (stunting)	Weight for height (wasting)
Normal	90–110	> 90	100–80	> 95%	> 90%
Mild (1°)	89–75	90–81	79–70	94–87.5	90–80
Moderate (2°)	74–60	80–71	69–60	87.4–80	80–70
Severe (3°)	< 60	70–61	59–50	< 80	< 70
Very severe (4°)	–	< 60	< 50	–	–

4. PPD (mantoux) test, if positive in a child below 2 years, it is considered as a case of primary complex and if negative does not rule out primary complex.
5. X-ray chest.
6. ECG and scanning if necessary.

Management of a case of protein energy malnutrition

Treatment of:

- Underlying infection with appropriate antibiotic.
- Treatment of underlying infestation with anthelmintic drug.
- Adequate diet as to provide 150 kcals of energy per kg per day, providing 3 to 4 g of protein per kg weight per day (This much can be fed to the child by giving small but frequent feeds).
- Correction of social factors if any.

Advice (Instructions) given to the mother for prevention of recurrence of malnutrition in the child:

a. *Growth monitoring:* The weight of the child is recorded every month and plotted in 'Road to Health' card to monitor the growth curve.
b. *Oral rehydration therapy:* This is to be given to the child with the onset of diarrhea.
c. *Breastfeeding:* Exclusive breastfeeding to be given to 6 months, followed by complimentary feeding. However, breastfeeding to be continued upto minimum 2 years.
d. *Immunization:* This is to be completed.
e. *Family planning:* Mother is advised to adopt contraceptive method, so that she can take better care of her child.
f. *Health education:* She is advised to take correct and complete treatment for her child for any illness. She is educated on maintaining personal hygiene and also she is educated to take recommended balanced diet for her, specially if she is a lactating mother.

Prevention and control of protein energy malnutrition in the community

a. *Health promotion*:
   - Nutritional care of pregnant mothers to prevent low birth weight
   - Nutritional care of lactating mothers to prevent subsequent malnutrition during infancy and childhood
   - Promotion of correct breastfeeding practices
   - Frequent feeds to a growing child
   - Promotion of health of the mother by family planning and spacing of births
   - Improvement in the living condition
   - Supplementary feeding programme for mothers and children (ICDS-scheme).
b. *Specific protection*:
   - Protein and energy rich diet for a growing child (i.e. diet containing milk, egg, fruits, etc.)
   - Immunization
   - Fortification of food.

c. *Early diagnosis and treatment of Protein Energy Malnutrition (PEM)*:
   - By maintenance of 'Road to Health' card
   - By early diagnosis and prompt treatment of infections
   - By periodical deworming.

d. *Disability limitation*:
   - Limiting the development of further disability by giving intensive treatment
   - Hospitalization if necessary
   - Follow-up.

e. *Rehabilitation*:
   Nutritional rehabilitation is purely mother oriented. The mother is educated to make simple modifications in the child's diet, with the locally available foods, without external supplement, within their economic constraints. This was formulated by Dr Bengoa. This has been modified in various countries and implemented. In India, National Institute of Nutrition (NIN) Hyderabad has recommended the following mixture:

Wheat	– 40 g
Roasted Bengal gram	– 16 g
Roasted groundnuts	– 10 g
Jaggery	– 20 g
Total	**– 86 g**

This mixture per day provides 11.3 g of proteins and 330 kcals of energy.

Vitamin Deficiency Diseases

Nutritional blindness: It is the blindness occurring due to malnutrition, mainly due to deficiency of vitamin A. It is common among children between 1 and 3 years. It is a permanent blindness and is totally preventable. It is one of the serious public health problem. Younger the child, more serious is the disorder, because an young child is not having sufficient vitamin A reserve in the body unlike adults. It is often associated with PEM.

Extent of the problem: Nutritional blindness is common among predominantly rice eating states in India like Andhra Pradesh, Karnataka, Tamil Nadu, Bihar, West Bengal, because rice is devoid of carotene. Incidence is less in North India.

Nearly 70,000 children below 3 years, are becoming permanently blind only due to vitamin A deficiency every year in India. It is predisposed by many social factors, such as poverty, illiteracy, ignorance, etc. Therefore, it is often called 'Social disease'.

Etiology
- Low dietary intake of vitamin A
- Infectious diseases which prevent absorption and utilization of vitamin A, aggravate the condition
- All causes of PEM are also the causes of nutritional blindness.

Clinical features: These are described under xerophthalmia.

Prevention and control of nutritional blindness (Xerophthalmia): This is now an integral part of primary health care. Nutritional blindness can be prevented by intervening at all the five levels, in the natural history of the disease, as follows:

Health promotion
- Nutritional care of the pregnant mother, to prevent low birth weight, (i.e. to prevent malnutrition at birth) by promoting the consumption of Green leafy vegetables or other vitamin A rich foods (Thus, measures are taken much before the child is born).
- Promotion of breast-feeding as long as possible.
- Proper weaning of young infants and feeding of growing children with fruits, carrots and vegetables.
- Health education (Nutrition education) of mothers about hazards of vitamin A deficiency among children and their easy prevention.

Specific protection
- Food fortification, i.e. addition of vitamin A to salt, sugar, tea, margarine, dried skimmed milk and Vanaspati (Dalda). This helps in covering the people of all the age groups including children.
- Administration of 5 mega doses of vitamin A concentrate, orally, to all children between 9 months and 3 years, under National Vitamin A Prophylaxis Program **(Table 16.30)**, which is a component of National Program for Prevention and Control of Blindness. However, it can be extended upto 5 years.

Thus, the child is 'almost immunized' against xerophthalmia. 2 lakhs IU = 110 mg of retinol palmitate in oil; 1 spoon of 2 ml capacity, holds 2 L IU of vitamin A, is supplied alongwith the bottle of vitamin A syrup.

Strategy
- Cent percent coverage of children below 3 years with 5 mega doses of vitamin A orally
- Elimination of blindness and other consequences of vitamin A deficiency.

Table 16.30 Vitamin A Prophylaxis-Schedule (under CSSM)

Dose No.	Age of child	Dose (orally)	Remarks
1.	At 9th month	1,00,000 IU	Along with measles vaccine
2.	At 18th month (1½ yr)	2,00,000 IU	With booster dose of DPT and OPV
3.	At 24th month (2 yr)	2,00,000 IU	Nil
4.	At 30th month (2½ yr)	2,00,000 IU	Nil
5.	At 36th month (3 yr)	2,00,000 IU	Nil

Source: Reference 6.

Early diagnosis and treatment of Vitamin A deficiency (Nutritional blindness)

- History of night blindness
- Clinical examination of eyes for the manifestations of xerophthalmia
- 'Rose-Bengal Dye' test. This consists of application of 1 percent of this dye to conjunctivae. Development of pink colored stain on conjunctiva, indicates conjunctival xerosis.

Treatment consists of oral administration of 2,00,000 IU of vitamin A concentrate soon after the diagnosis followed by another dose of 2,00,000 IU on the next day and third dose after 1 to 4 weeks (WHO). The dosage is same irrespective of age and sex, except among infants and women of the reproductive age group (15–45 yrs). Infants require 1,00,000 IU once in 3 to 6 months till 1 year of age and women (15–45 yrs) require 1,00,000 IU daily for 2 weeks.

Children suffering from acute respiratory infection, Diarrhea and Measles should be given prophylactic dose of vitamin A 2,00,000 IU orally as soon as the diagnosis is made.

Disability Limitation

Means limiting or prevention of further disability by giving intensive treatment with vitamin A injections, when the patient comes in the advanced stage of xerophthalmia (i.e. when there is involvement of cornea as xerosis, ulcer, keratomalacia, prolapse iris, etc.). The intensive treatment prevents the transition from impairment to handicap.

Disease →	Impairment →	Disability →	Handicap
Vitamin A deficiency →	Corneal xerosis (Abnormality of structure and function of cornea) →	Inability to see (Blurring of vision or blindness) →	Loss of job

Rehabilitation: This consists of training and retraining of a blind and handicapped person by the combined and co-ordinated use of medical (physical), vocational, social and psychological therapies to the highest level of functional ability. For example, schools for the blind, corneal grafting (corneoplasty), vocational training for earning, physical rehabilitation by the supply of walking sticks, etc.

Vitamin A concentrate oily solution: This is supplied as a flavored syrup in 100 ml bottle with a concentration of 1,00,000 IU per ml. The bottle is always supplied with a spoon of 2 ml capacity. This syrup does not require any storage measures like cold-chain. However, it should be stored in cool and dark place, protected from sun light.

Once the bottle is opened, it should be used within 6 to 8 weeks. The shelf life of the sealed bottle is one year. The price of the bottle is ₹ 25, i.e. 25 paise per ml. This is supplied free of cost to the community through Primary Health Center.

Vitamin A is also available in the following forms:

- *Capsules:* Each capsule contains 2,00,000 IU
- *Tablets:* Each sugar coated tablet contains 1,00,000 IU
- *Injectables:* Each ampoule of 1 ml equivalent to 1,00,000 IU to be given intramuscularly.

High-risk children for nutritional blindness:

- Low birth weight babies
- Newborns deprived of mother's milk (because they don't have sufficient reserve of vitamin A)
- Young children suffering from ARI, diarrhea and measles.

All such high-risk children should be given 2,00,000 IU of vitamin A orally, as soon as the diagnosis is made (1,00,000 IU for an infant) and the dose is repeated once in 3 to 4 months, till the infant completes one year and the other children up to 5 years of age.

Other vitamin deficiency diseases: Such as beriberi, pellagra, ariboflavinosis, scurvy, rickets and osteomalacia are explained under vitamins.

Mineral Deficiency Diseases

Nutritional anemia: It is a condition in which the hemoglobin content/level in the blood is lower than the normal, as a result of deficiency of one or more nutrients, specially iron.

Less frequent causes are deficiency of folic acid and/or vitamin B_{12}. It is often associated with malnutrition and chronic infections. The most vulnerable groups are infants, children and women specially during pregnancy.

Normal hemoglobin level in the blood is 14 g/dL = 100 percent.

WHO cut off criteria for anemia (in venous blood).

Adult man = 13 g/dL

Adult woman (nonpregnant) = 12 g/dL

Adult woman (pregnant) = 11g/dL

Child above 6 yrs = 12 g/dL

Child below 6 yrs = 11 g/dL.

Nutritional anemia is a health problem, social problem and an economic problem in our country.

Magnitude of the problem: Nutritional anemia is a global problem, more so in the developing countries. Globally about 3.6 billion people are suffering from this. In India, it is very high among nutritionally vulnerable group such as mothers and children. 20 percent of adult males, 40 percent of children, 55.8 percent of adolescent girls, 60 percent of adult females and 80 percent of pregnant mothers have iron deficiency anemia (NHFS-3).

The cut-off points are suggested by WHO to assess the magnitude of iron deficiency anemia are shown in **Table 16.31**.

Causes of Megaloblastic Anemia:

- Strict vegetarians, not taking even dairy products
- Tape worm anemia, which absorbs vitamin B_{12}

Table 16.31 Magnitude of iron deficiency anemia

Prevalence %	Public health problem
< 5	Not a problem
5–19.9	Low magnitude (mild)
20–39.9	Moderate magnitude (moderate)
40 and above	High magnitude (severe)

- Increased demand of folic acid, which occurs during pregnancy
- Malabsorption syndrome.

Causes of iron deficiency, and the detrimental effects of iron deficiency anemia and the recommended daily requirement of iron already explained (under minerals).

Clinical features of nutritional anemia (Iron deficiency): Since hemoglobin is necessary for oxygen transport and cell respiration, in nutritional (iron deficiency) anemia, every tissue cell suffers from lack of oxygen, resulting in dysfunction. Thus, there are clinical signs and symptoms related to every organ/system of the body. The common features are as follows:

General appearance—Pale, plumpy, person with poorly built and nourishment and easy fatiguability.

Head – Headache, giddiness
Face – Pale and puffy (edematous)
Eyes – Pale conjunctiva
Hairs – Dry, lusterless
Tongue – Pale, smooth tongue with atrophied papillae.
Abdomen – Anorexia, acidity, ascites may be present due to associated hypoproteinemia; dysphagia often present.
Thorax – Respiratory system—breathlessness (Exertional)
Cardiovascular system—soft systolic (hemic) murmur, best heard over the pulmonary area.
BP—lower than the normal
Pulse—rapid and weak
Feet – Edematous
Nails – Koilonychia (spoon shaped); brittle nails.

Edema of the face and feet with or without ascites indicates hypoproteinemia.

Prevention and control of nutritional anemia

- **Health promotion**
  - Adequate nutrition.
  - Nutrition education to improve dietary habits.
  - Health education specially to pregnant mothers about hazards of anemia and their prevention.
  - Periodical deworming specially among children and at least once during second trimester of pregnancy.
  - Nutritional supplementation (under ICDS scheme).
- **Specific protection**
  - Food fortification. Recent studies in National Institute of Nutrition, Hyderabad showed that simple addition of Ferric Ortho-phosphate to salt, when consumed over 12-18 months was found to reduce the prevalence of anemia.
  - National Nutritional Anemia Prophylaxis Program (NNAPP). This was launched by the Government of India, during the Fourth Five Year Plan, (1970) in order to prevent and control nutritional anemia among mothers and children (1–12 years).
  - Evaluation of the program was done in 1990 and found the prevalence rate of anemia to be surprisingly high (87%) inspite of the distribution of the Iron and Folic Acid (IFA) tablets among pregnant mothers and anemic children. Each adult tab then consisting of 60 mg of elemental iron and 500 mcg of folic acid and each pediatric tablet consisting of 20 mg of elemental iron and 100 mcg of folic acid.
  - The increased prevalence was due to poor quality of drugs, inadequate supply and poor compliance with the tablets. During 1991, the policy/program was revised and called 'National Nutritional Anemia Control Program' (NNACP). The elemental iron was increased from 60 mg to 100 mg per tablet in 1992.
- **New recommendations**
  - Infants between 6 and 12 months should also be included as beneficiaries for iron supplementation, under ICDS Scheme.
  - Liquid formulations to be prepared, each ml containing 20 mg of iron and 100 mcg of folic acid.
  - For children between 6 and 10 years, 30 mg of iron and 250 mcg of folic acid, and
  - For children between 11 and 18 years (adult dose) also to be included as beneficiaries for iron supplementation.

Beneficiaries are pregnant mothers, lactating mothers and children between 1 and 12 years.

Benefit is that Iron and Folic acid (IFA) tablets are distributed free of cost.

Eligibility criteria is all those beneficiaries, whose Hb level is between 10 and 12 g/dl. If the Hb level is less than 10 g/dl, such cases are referred to Medical Officer.

Dosage: If the pregnant mother has no visible signs of anemia, she is given one large IFA tablet containing 100 mg of elemental iron and 500 mcg of folic acid, during the last 100 days of pregnancy, to prevent anemia.

If the pregnant mother has visible signs of anemia but not severely anemic, she is given 2 large tablets of IFA daily to control anemia.

If she is severely anemic, she is admitted to hospital for intensive treatment and blood transfusion.

For anemic children (1–12 yrs) one small pediatric tablet of IFA containing 20 mg of elemental iron and 100 mcg of folic acid is given daily.

The tablets have to be consumed only after food.

Table 16.32 Grading and treatment of anemia

Grade (WHO)	Degree of anemia	Treatment
14–11 g	Normal	Nothing required
11–9 g	Mild	Oral iron therapy
9–7 g	Moderate	Parenteral iron therapy
< 7 g	Severe	Blood transfusion

- **Early diagnosis and treatment**
  - By history of headache, giddiness, fatigue, loss of appetite, etc.
  - By clinical signs
  - By laboratory investigations such as Hb percent, peripheral smear and stool examination for ova and cyst.

The grading of anemia recommended by WHO with its treatment is shown in **Table 16.32**.

Iron therapy should be followed by the treatment of the cause including underlying infection, infestation, bleeding piles, bleeding duodenal ulcer, etc.

- **Disability limitation:** This consists of limiting the development of further disability when the patient comes in the advanced stage of anemia by giving intensive treatment in the hospital by blood transfusion. If severe anemia is associated with cardiac failure (High output failure), packed cell transfusion is given under the umbrella of digoxin, lasix and potassium salts.
- **Rehabilitation:** A person with anemia will not become handicapped, if treatment is given correctly and completely.

Twelve by Twelve Initiative

It is an initiative launched by Federation of Obstetrics and Gynecology Society of India (FOGSI) Delhi, in collaboration with Government of India, WHO and UNICEF on 23rd April 2007 at All India Institute of Medical Sciences (AIIMS), New Delhi.

Meaning: By the year 2012, every child across the country should have at least 12 g percent Hb by 12 years of age.

Motive: Iron deficiency anemia is a global public health problem as harmful as the epidemics of infectious diseases. With a global population of 6.7 billion, about 3.6 billion people have iron deficiency and out of these about 2.0 billion are suffering from iron deficiency anemia. Children and women in reproductive age group are being hit hardest because of their vulnerability.

India continues to be one of the countries to have highest prevalence of anemia because of low dietary intake, poor availability of iron and chronic blood loss due to hookworm infestation and malaria. National Family Health Survey (NFHS) 3 estimates reveal the prevalence of anemia to be 70 to 80 percent in children, 65 to 75 percent in adolescent girls, 70 percent in pregnant women and 24 percent in adult men. Compared to the report of NFHS 2, there has been an increased trend.

Adolescents constitute 22 percent of our country's population. Adolescence being the phase of rapid growth, has an increased demand for iron requirement in both boys and girls, more so among girls because of menstruation. The adolescent girls constitute potential mothers. Anemia not only affects the present health status of adolescent girls but also has deleterious effects in future specially during pregnancy. The health consequences of anemia in children, adolescents and pregnant mothers are well documented.

Anemia has a serious impact on learning capacity, productivity and survival among children.

Maternal ill effects include reduced physical capacity and work performance, impaired immune response predisposing for infections, decrease in peripartum reserve, risk of cardiac failure and increased need for blood transfusions, thus anemia can result in negative reproductive consequences, endangering her life. Anemia during pregnancy is the result of uncared anemia during adolescence.

Fetal effects include low birth weight (LBW) baby who subsequently suffers from impaired psychomotor and cognitive function. Infants born to severely anemic mothers have a higher risk of irreversible brain damage, lower school achievement, a reduced physical and exercise tolerance and poor immune response.

Anemia during pregnancy puts the woman at three times greater risk of delivering LBW babies and nine times higher risk of perinatal mortality, thus contributing significantly for increased infant mortality rate (IMR) and maternal mortality rate (MMR). Thirty percent of maternal deaths are due to anemia.

The consequences of anemia extends over generations. Girls born underweight are at risk of producing premature infants themselves.

Thus, anemia is a silent epidemic. It is a critical health concern. However, it is a preventable condition. In order to reduce LBW, IMR and MMR there is a need to combat anemia during adolescences, a motive behind '12 by 12 initiative', so that women enter pregnancy and motherhood free of anemia and that newborns and infants are assured of good health. The IMR, MMR are reduced in a life cycle approach.

This initiative is an implementable, effective and sustainable nation building exercise with far reaching benefits in terms of safe motherhood and healthier future generations.

This initiative will contribute immensely to the achievement of the Millennium Development Goals 4 and 5 to reduce high rate of global child and maternal deaths by the year 2015.

Goals of 12 by 12 initiative

- To decrease the prevalence of anemia among adolescents to ensure healthy parenthood.

- To increase the awareness among adolescents regarding anemia and appropriate nutrition.

Objectives

- To determine the prevalence of anemia among children between 10 and 14 years of age.
- To create awareness about anemia among children.
- To provide the nutritional guidelines for the anemic children.
- To treat those detected to be anemic.
- To vaccinate all children against tetanus and all girls against rubella.
- To deworm all children and treat malaria if present.

Iodine deficiency disorders: Iodine deficiency disorders (IDDs) are the spectrum of disorders that occur due to deficiency of iodine and associated hypothyroidism, commencing from intrauterine life and extending through infancy, childhood, adolescence to adult life with serious implications **(Table 16.33)**. Till recently, iodine deficiency was equated with goiter only. But now it has become very clear that iodine deficiency not only results in goiter but also affects all stages of human growth and development resulting in varied manifestations, coined under the term 'Iodine Deficiency Disorders'. This term was introduced in 1983. The various disorders are abortions, premature births, growth failure, mental retardation, cretinism, myoxedema and neurological defects. Iodine deficiency is the most common cause of preventable mental retardation in the world today **(Fig. 16.7)**.

Extent of the problem

Global: About 190 million people are suffering from goiter and nearly 800 million people in developing countries are at risk.

Table 16.33 Spectrum of iodine deficiency disorders

Age group	Disorders
Fetus	Abortion, still births, congenital anomalies
Neonate	Neonatal cretinism—mental deficiency, Deaf mutism, spastic diplegia, squint, psychomotor defects, neonatal goiter, neonatal hypothyroidism
Child/Adolescent	Goiter, juvenile hypothyroidism, dwarfism, cretinism, impaired mental functions (low IQ), educational backwardness, personality problems
Adult	Goiter (Cosmetic effect and pressure effect) hypothyroidism, impaired mental functions myxedema

S-E Asia: In S-E Asia, 8 countries have significant IDD problems. These countries are India, Indonesia, Bangladesh, Bhutan, Burma, Nepal, Sri Lanka and Thailand. Out of these 8 countries, 102 million people have goiter, 277 millions are at risk, 1.5 millions are cretins and more than 35 millions are physically or mentally disabled.

India: In India, the major geographical focus is the sub-Himalayan region. It is estimated that about 55 million people are suffering from endemic goiter and about 150 million are at risk, about 2.2 millions are cretins and 6.6 million are having neurological deficits.

The sub-Himalayan region extending over 2400 km from Kashmir to Naga Hills, is called 'Himalaya Goiter Belt', which is the biggest goiter belt in the world.

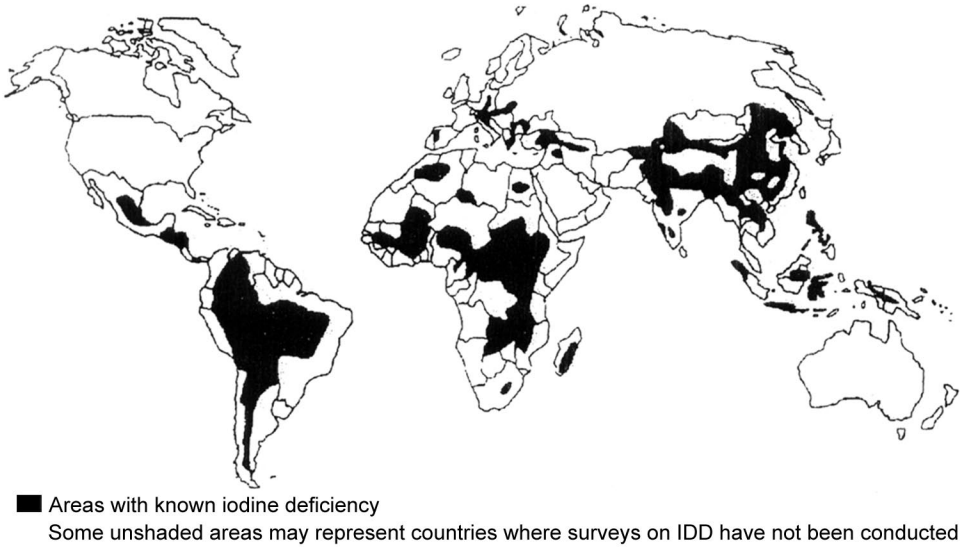


Fig. 16.7 Areas of the world where iodine deficiency is prevalent
Source: Public Health Nutrition Module, New Delhi

In addition, pockets of endemic goiter have been reported from almost all states of India. These are called 'Extra Himalayan' foci of endemic goiter. No state in India is said to be entirely free from goiter.

The prevalence of goiter in India is 7.3 percent of the total population. Endemic goiter is said to be present and considered as significant public health problem, when the prevalence of goiter (total goiter rate) exceeds 10 percent among school children, aged 6 to 11 years.

In fact with every passing hour, 10 children are born in the country without attaining optimum, physical growth and mental development due to neonatal hypothyroidism. This has been going unnoticed, as a 'Silent epidemic'.

The endemicity of goiter is graded as follows depending upon 'total goiter rate' (i.e. prevalence rate):

Goiter prevalence rate	-	Grade of endemicity
<10%	-	Not significant
10–20%	-	Mild endemicity
20–30%	-	Moderate endemicity
>30%	-	Severe endemicity.

The other indicators of iodine deficiency are prevalence of cretinism, prevalence of neonatal hypothyroidism and urinary iodine excretion.

Thus, it is seen that the problem is of greater magnitude than that of goiter alone. It is a national problem with grave socio-economic consequences, affecting the Human Resource Development. People become less vigorous and less productive in their work and domestic animals also suffer in the same way resulting in decreased production of wool, meat, eggs, etc. Abortions can also occur. Sterility can also occur.

Thus, IDD is not only a health problem, but also a social and economic problem.

Iodine—Sources, physiology, pathophysiology, daily requirement—explained under trace-elements.

Prevention and control of iodine deficiency disorders: There are four methods of iodine supplementation—namely iodized salt, iodized oil, iodized water and Lugol's iodine.

Iodized salt: This consist of incorporation of iodine as sodium or potassium iodide to the common edible salt. It is an example of fortification of salt. Edible salt is an ideal vehicle for iodine fortification because every-one consumes salt, thus easily distributable to entire population in an inexpensive way. More than all, the added iodine does not affect the appearance and taste of salt and is well accepted by the consumer. Since excess consumption of salt is not possible, it eliminates the danger of overdosage. Iodized salt should be added to the food after cooking to have the maximum benefit.

Therefore, iodization of salt is now the most widely used prophylactic public health measure against endemic goiter. In India, the level of iodization is fixed under the Prevention of Food Adulteration Act (PFA-Act). The iodine concentration in the salt should not be less than 30 ppm at the production point and not less than 15 ppm at the consumer level. Thus iodization of salt is the most economical, convenient, safe, feasible and effective means of mass prophylaxis in endemic areas.

There are three processes of iodization of salt:

- *Dry mixing:* This consists of mixing salt with potassium iodide.
- *Spray mixing:* This consists of spraying the aqueous solution of potassium iodate (KIO_3) on salt and then mixing in a blender.
- *Submersion process:* This consists of mixing the salt with a solution of potassium iodate in a tank and then drying.

Iodization: 50 kg of potassium iodate are added to 1,00,000 kgs of salt. This provides 50 ppm of KIO_3, which is equivalent to 30 ppm of iodine, because only 60 percent of KIO_3 contains elemental iodine at the production point. Since iodine is unstable, it comes to 15 ppm at the consumer level.

$$\frac{60}{100} \times 50 = 30 \text{ kg of elemental } I_2$$

Recently, NIN, Hyderabad has recommended 'Double fortification' of salt with KIO_3 and iron ('Two-in-one' salt). Community trials are going on. NIN has also recommend addition of stabilizers to increase the stability of salt such as calcium carbonate in iodized salt and sodium hexametaphosphate in double fortified salt. Stabilizers are found to be not hazardous.

Iodized oil: This consists of incorporation of iodine into vegetable oil (Poppy seed oil). NIN Hyderabad recently have successfully used sunflower oil for iodization. Most widely used is lipiodol.

One milliliter of lipiodol oil containing 480 mcg of iodine, given intramuscularly has proved to correct severe iodine deficiency for a period of over four years. The effective protection rate is 80 percent against neonatal hypothyroidism. A repeat injection may be required in 3 to 5 years. High cost of iodized oil is a limiting factor in its widespread use in India and lot of manpower to meet individual persons for giving injections.

Sodium iodate oral tablets or oral iodized oil has been found to have half of the effects of injectable oil, i.e. for about 2 years. Oral intake is not popular. Moreover, oral intake is costlier than injections.

The use of iodized oils preferred in those areas, where the problem is large and iodized salt is not available.

China has developed iodized walnut oil and iodized soybean oil for use in community programs.

Iodized water: This consists of incorporation of I_2 or KI or KIO_3 to drinking water in a concentration as to achieve a daily intake of 150 mcg of iodine. This method is practiced in Northern Thailand.

Lugol's iodine: Lugol's iodine solution can also be taken directly but the effect is considerably shorter than that of iodized oil. But the advantages are its easy availability and low cost. Repeated applications are necessary because of shorter duration of action.

Out of all the four methods, use of iodized salt is the most rational and feasible approach in our country.

Hazards of iodization: A mild increase in the incidence of thyrotoxicosis has now been described following iodized salt programs. An increase in lymphocytic thyroiditis (Hashimoto's disease) has also been reported.

Excess of Food Consumption

This results in the following conditions:
- Hypervitaminosis - A
- Hypervitaminosis - D
- Obesity
- Fluorosis.

Hypervitaminosis-A and D are explained under vitamins A and D respectively.
Obesity—explained under epidemiology of obesity.
Fluorosis—explained under trace elements, fluorine.

Food-borne Intoxications

These are grouped into two groups:
A. Due to naturally occurring toxins in the food grains.
   - Lathyrism
   - Epidemic dropsy
   - Endemic ascites
   - Toxic polyphenol

B. Due to toxins produced by the fungi in the food grains.
   - Aflatoxicosis
   - Ergotism

Lathyrism (Lathyriasis)

It is a neurodegenerative disorder, caused by the consumption of a pulse called 'lathyrus sativus' over a long period of time, clinically characterized by progressive, permanent, spastic paraplegia (upper motor neurone type of paralysis of both lower limbs), resulting in crippling deformity. This condition is also called 'Neurolathyrism'.

Extent of the problem: Sleeman in 1833, provided the first authentic record of an outbreak of lathyrism in India. Since then nearly 40 outbreaks have been described in India. During the last 3 decades, outbreaks of lathyrism have been recorded not only in India but also in Bangladesh, Nepal, China, Pakistan, Ethiopia, Canada and France.

In India, lathyrism is mainly reported from Satna and Rewa districts of Madhya Pradesh and to a lesser extent from Uttar Pradesh, Bihar and West Bengal. It is often reported from Gujarat, Maharashtra, Karnataka and Andhra Pradesh.

Lathyrus is traditionally considered as 'poor man's crop', being cultivated even in drought prone areas. It used to be given to landless agriculturist laborers by the landlords in lieu of wages. The pulse being cheap, having good taste and satiety value, thus victimizing the poor people. It is observed that diets containing over 30 percent of this dal, if consumed over a period of 2 to 6 months will result in neurolathyrism. But consumption in large quantities leads to the development of paralysis within about one month.

Agent factor: The pulse lathyrus sativus is commonly known as 'Kesari-Dal' (Theora dal, Lak dal, etc.). But the grains are not kesari in color. On the other hand, it is grayish in color, having characteristic triangular shape. It is often used to adulterate other pulses such as red-gram or Bengal-gram dal. Like other pulses, it is also a good source of protein, but it contains an excitotoxin and neurotoxin called 'β-Oxalyl Amino Alanine' (BOAA) an amino acid, responsible for the development of paralysis. It is water soluble. This property can be made use for removing the toxin, by soaking the pulse in hot water and discarding the soak water. The toxin is also referred to as Oxalyl Di-amino Proprionic Acid (ODAP), which was first isolated in 1963. The content of BOAA toxin in lathyrus sativus seeds varies from 0.2 to 1.0 g percent.

Host factors:

Age incidence: It is high in the age group of 15 to 45 yrs.

Sex incidence: It is high among men than among women.

Occupation: Incidence is high among agriculturist laborers as seen in Madhya Pradesh.

Environmental factors (socioeconomic factors): Poverty is the most important factor. This crop is a hardy crop, grows easily even in draught prone areas. Epidemics have occurred during famine.

Pathology and pathogenesis: BOAA is a neurotoxin (excitotoxin) which is capable of overstimulating the nerve cells of upper motor neurons followed by their destruction. It involves the pyramidal tract. It is an irreversible form of upper motor neuron disease. Pathologically there is loss of axis cylinders with gliosis of crossed pyramidal tracts in the lumbar and lumbosacral spinal cord resulting in paraplegia. Once a pathology, is a permanent pathology. It is reversible only in the early latent stage.

Latent period: Varies from 1 to 3 months, depending upon the amount of the pulse consumed. Thus it is directly proportional.

Clinical features: Acton (1922) described the clinical features of lathyrism, under the following stages.
- ***Latent stage:*** The person is apparently healthy. But he experiences weakness of lower limbs, gets pain in knee

and ankle joints while walking. So he tends to keep the joints bent while walking. On physical exertion, he exhibits an ungainly gait. Examination of nervous system shows involvement of upper motor neuron system such as exaggeration of knee jerks, ankle jerks, ankle clonus, and extensor plantar reflexes. Spasmodic muscular contractions of calf muscles is the earliest symptom.

- ***No stick stage:*** Patient walks with short, jerky, restricted and painful movements, but still can walk without the support of a walking stick. There is weakness in both the legs. Majority of the patients are found in this stage.
- ***One stick stage:*** This is characterized by increased tone and muscular rigidity in the legs resulting in slight flexion of the knee-joints and extension of the ankle joints and some amount of inversion of feet, resulting in crossing of gait while walking and there is a tendency to walk on toes, making the patient necessary to use a walking stick, to maintain the balance.
- ***Two stick stage:*** The symptoms are more severe. The gait is slow and clumsy. There is marked flexion of knees, extension of ankle joints and crossed (scissors) gait, so much so he requires 2 sticks (crutches) for support. He gets tired easily after walking for a short distance.
- ***Crawler stage:*** This is the final stage. Erect posture and walking becomes impossible, because the knee joints are completely flexed. So the patient crawls on his knees and palms. There is atrophy of muscles of the thighs and legs. There is spastic paralysis of both the legs (not flaccid paralysis). The person is crippled.

There is no treatment. Prevention is the only intervention. Rehabilitation is the alternative measure for the crippled people.

Prevention and control of lathyrism: There are five approaches:

a. ***Removal of toxin:*** The BOAA toxin can be removed by two methods:
   - *By steeping method:* Since the toxin is water soluble, the pulse, kesari dal, before cooking, is soaked in boiling water for 2 hours. The toxin steeps into the water. After 2 hours, the soak is drained off and the pulse is washed again with clean water. The water is drained and the pulse is dried in the sun. Later it is cooked. The disadvantage is that along with the toxin, water soluble vitamins and minerals are also lost. This method can be adopted at household level.
   - *By parboiling method:* This is an improved method of detoxicating the pulse. This can be done by 2 methods.
     i. Just like parboiling the rice, the pulse is soaked in luke warm water and then subjected to steam for 15 minutes.
     ii. Or the pulse is soaked in lime water overnight and next day it is washed and cooked.

   Parboiling is suitable for large scale operations.

b. ***Health education:*** The people in the areas where kesari dal is cultivated are educated about the hazards of consumption of kesari dal and methods of removal of toxin, before cooking.

c. ***Genetic approach:*** It is by cultivation of other pulses or other strains of lathyrus sativus with very low level of toxin (less than 0.1%). This does not require any drastic changes in the food habits of the people. Such strains of lathyrus sativus can be obtained from Indian Agricultural Research Institute, New Delhi.

d. ***Vitamin C prophylaxis:*** In the early stages, the damage can be repaired by daily administration of 500 to 1000 mg of ascorbic acid for about one week (as demonstrated in guineapigs and monkeys).

e. ***Legislation:*** This is a long-term measure. Under PFA-Act
   - Cultivation of the crop is banned
   - Use of any form of lathyrus sativus (whole, split or flour) is also banned
   - Adulteration of other pulses with kesari dals strictly prohibited

Among animals, consumption of lathyrus odoratus causes skeletal deformities. It is called 'Osteo-lathyrism'. The toxic product in the pulse is β-amino proprio-nitrile (BAPN).

Epidemic Dropsy (Argemone Poisoning)

This is a condition caused by the consumption of mustard oil adulterated (contaminated) with the oil of argemona-mexicana seeds (prickly-poppy seeds). This was first suggested by RL Sarkar in 1926.

The adulteration of mustard oil may be accidental or deliberate. Deliberate adulteration is profit oriented. The seeds of Argemona-mexicana grows wild in India. Usually epidemic dropsy occurs in communities that consume mustard oil as a cooking media. Thus it is related to dietary habits. Between 1975 and 1998, four epidemics of dropsy have been reported in Delhi. Govt. of India has stopped the sale of mustard oil from August 26, 1998.

Pathology and pathogenesis: Recently in 1941, Sri Mukherji isolated toxic substances called 'Sanguinarine' and 'Dihydro-sanguinarine' from argemone oil, the former being 2.5 times more toxic than latter. The toxin is absorbed from the gut into the circulation. The toxic alkaloid interferes with the carbo-hydrate metabolism resulting in the accumulation of pyruvic acid and lactic acid. There is dilatation, engorgement and increased permeability of capillaries, lowered blood viscosity, rise of hydrostatic pressure, hyperdynamic circulatory state, all features of toxic vasculites, leading to transudation of fluid into skin and sub-cutaneous tissue resulting in edema.

The toxic vasculites in the skin of legs leads to pedal edema, in the ciliary body and uveal tract of the eyes results in glaucoma and in the myocardium results in cardiac failure. There may be pleural, pericardial and peritoneal effusion also (Ascites). Similarly toxic vasculites in the kidneys results in renal failure.

The production of edema is facilitated by malnutrition, hypoproteinemia and anemia.

Clinical features: Incubation period is 1 to 2 weeks.

It is a syndrome, characterized by the sudden onset of non-inflammatory, bilateral, pitting edema of feet, associated with redness, pain and burning sensation in the overlying skin, often associated with nausea, vomiting and diarrhea. There is a tendency to develop cardiac insufficiency, renal failure and glaucoma. There may be pleural, pericardial and peritoneal effusion. Glaucoma can lead on to optic atrophy and blindness. Involvement of heart and kidney indicates poor prognosis.

This condition differs from beriberi, in that polyneuritis is less pronounced, gastrointestinal troubles are more frequent, glaucoma often occurs, infants are rarely attacked and it occurs only among those who use mustard oil as an article of diet.

Confirmation of the epidemic

- Large number of cases of pedal edema in the same family/community
- History of consumption of mustard oil
- Demonstration of argemone oil in the mustard oil
- Detection of sanguinarine in the serum or urine of the cases.

Detection of argemone oil (Sanguinarine) in mustard oil

- **Nitric acid test:** To the suspected sample of mustard oil in a test tube, equal amount of nitric acid (or dilute HCl) is added and shaken. Development of brown or orange-red color shows the evidence of argemone oil. The test is positive only when the level of argemone oil is more than 0.25 percent.
- **Paper chromatography test:** This is highly sensitive and highly specific test. It can detect argemone oil even if the concentration is as low as 0.0001 percent. But not very practical.
- **Ferric-chloride test:** Addition of ferric-chloride to the suspected sample of mustard oil gives orange-red precipitate. Highly specific test.
- **Spectrofluorophotometric method** using silica gel G: This test also helps in detecting sanguinarine in the serum and urine of the affected persons.
- **Cupric acetate test:** This is not very sensitive.

Detoxification of sanguinarine from edible oil

- The edible oil is shaken with phosphoric acid and activated Fuller's earth followed by filtration and neutralization of phosphoric acid with precipitated chalk. The oil thus purified shows negative to detection of argemone.
- Detoxification can also be done by shaking the oil with Fuller's earth only at 140°C.

Prevention and Control Measures

- Ensuring supply of pure mustard oil by the strict enforcement of Prevention of Food Adulteration Act
- Avoiding the use of mustard oil altogether when the disease is prevalent in the locality
- Extensive public awareness programs to be carried out including health education about argemone seeds and oil
- Testing of blood and urine for sanguinarine in suspected cases of dropsy should be done for confirmation
- All patients of epidemic dropsy should be monitored by various investigations including intraocular pressure recording
- All packed cooking oils should have a label 'ARGEMONE FREE', as is being done for HIV in the blood.

Separation of seeds: Specific gravity of mustard seeds is 1.133 and that of argemone seeds is 1.088. They can be separated by using salt solution. Specific gravity of salt is 1.10. Being heavier, mustard seeds sink in the solution. Another method is by air elutriation/air floatation.

Separation of toxin: Steam is passed through the oil for 30 minutes. The steam coming out is condensed and it contains about 95 percent of toxin.

Endemic Ascites

This is due to the accidental or deliberate contamination of the *millet panicum miliare* (locally known as Gondhali) with weed seeds of crotalaria (locally known as Jhunjhunia), which are known to contain pyrrolizidine toxic alkaloid, which are hepatotoxic.

It was reported from Central India (Madhya Pradesh) during 1973 and 1976 that a large number of Nagesia tribals developed ascites and jaundice, affecting the people of all the age group and both the sexes with a mortality of 40 percent. Studies showed that they subsist on the *millet panicum miliare* which were contaminated with crotalaria weed seeds.

Preventive measures

- Deweeding of Jhunjhunia plants
- Sieving of the millet in the houses to remove jhunjhunia seeds (seeds are smaller than the millet)
- Health education of the people about the disease.

Toxic Polyphenols

Deoiled cotton-seed flour is being recommended as a protein rich food for children in several developing countries including India. Cotton seeds are known to contain a toxic polyphenolic pigment called 'Gossypol' which binds lysine an essential amino-acid and prevents its release, thus impairing the nutritional quality of cotton seed protein. Gossypol also cause anorexia, diarrhea, hemolysis, hypoprothrombinemia, gastrointestinal hemorrhages and pulmonary edema. Maximum permissible limits of free gossypol is 600 ppm of total gossypol or 1.2 percent.

Aflatoxicosis

This is characterized by hepatitis, cirrhosis of liver and/or enteritis, caused by the ingestion of food-grains such as groundnuts, maize, jowar, etc. mainly ground-nuts, infested of

certain storage fungi such as Aspergillus flavus or Aspergilllus parasiticus. These fungi infest the above grains, when they are improperly stored under conditions of high humidity, i.e. moisture levels above 16 percent and temp between 11° and 37°C, they produce certain toxins, called 'aflatoxins' of which B_1 and G_1 are the most hepatotoxins, in addition to being carcinogenic. It is believed to be associated with childhood cirrhosis. Clinically, it is characterized by jaundice, rapidly developing ascites, often with bilateral pedal edema.

Recently (1975) there was a report of 400 cases including 100 deaths from Banaswada and Panchamahal districts of Rajasthan and Gujarat respectively.

Prevention and control

- Proper storage of food grains in dry containers. The moisture content should be kept below 10 percent
- Not to consume the food grains, if contaminated by fungi
- Health education to the local population about health hazards.

Ergotism

This is caused by the ingestion of food grains, such as bajra, rye, jowar and wheat infested by field ergot fungus called claviceps fusiformis or claviceps—purpurea, during the flowering stage. The fungus grows as a black-mass and the seeds become black and irregular. Clinically the condition is characterized by nausea, vomiting, giddiness, drowsiness in acute cases and painful cramps in the limbs and gangrene due to vasoconstriction of capillaries in chronic cases. The toxin is ergotamine.

Prevention and control

- **By removal:** When immersed in 20 percent salt water, the infected grains float, hence can be removed
- They can also be removed by air flotation or hand picking
- By health education.

Food Poisoning

It is an acute inflammatory disease of the gastrointestinal tract, caused by the ingestion of food contaminated with either toxin producing bacteriae or by their preformed toxins or chemical substances or other poisonous food substances. Clinically it is characterized by short incubation period, pain in the abdomen, vomiting and/or diarrhea, with or without fever.

Food poisoning differs from food borne diseases in that it is not transmitted by feco-oral route. It also differs from food intoxication in that there is neither toxic factor in the food grain nor there is contamination with fungus.

The epidemiological features of food poisoning are:

- History of ingestion of common food (as in marriages, dinner, hostels, etc.)
- A group of persons (ingesting common food) being affected simultaneously
- Similarity of signs and symptoms
- Short incubation period
- Absence of secondary cases.

Classification of Food Poisoning

They are broadly classified into two types:

1. Nonbacterial
2. Bacterial.

Non-bacterial food poisoning: These consist of the following types:

a. Mushroom poisoning
b. Solanine poisoning
c. Chemical poisoning.

- **Mushroom poisoning:** The two common poisonous mushrooms (fungi), which are eaten in mistake for edible mushrooms are amanita pantherina and amanita muscaria. Their poisonous effects are due to the presence of muscarine. Symptoms occur within a few minutes or hours. Abdominal pain followed by vomiting and diarrhea occur. Sometimes there may be sweating, twitchings, miosis, diplopia, muscular incoordination and convulsions, followed by coma. Atropine is the effective antidote. Amanita phalloides is highly poisonous fungi. It contains amanitine, which is cytotoxic and phallin, which is hemolytic. No antidote for this. Mortality is 50 to 90 percent. Both of these are destroyed by cooking. So the symptoms are produced only when they are improperly cooked or eaten raw.

  Other poisonous eatables are mussles and sea-foods.
- **Solanine poisoning:** Solanine is a toxic alkaloid present in the peelings of potato, specially in sprouts. Symptoms occur within a few hours. There will be fever, headache, pain abdomen, vomiting, diarrhea, weakness and depression. Patient usually recovers within a few days. Since the alkaloid is soluble in water, potatoes are boiled and peeled.
- **Chemical poisoning:** Inorganic chemical substances resulting in poisoning are pesticides, fertilizers, arsenic, zinc, mercury, etc.

Bacterial food poisoning: This is caused by the consumption of food contaminated with either toxin producing bacteriae or by their preformed toxins. Thus they are two types, namely:

a. Infection type
b. Toxin type.

Infection type: In this type, organisms enter the body through the food, multiply, produce toxin, cause pathology and result in clinical manifestations. Incubation period is more than 8 to 12 hours. The bacteriae which cause this type of food poisoning are *Salmonella* group, *Clostridium perfringens* and *Vibrio parahaemolyticus*.

Toxin type: In this type, there is already preformed toxin in the food. Therefore, the incubation period is shorter than that

of infection type. It is less than 8 to 12 hours. The bacteriae which result in this type of food poisoning are *Staphylococcus aureus*, *Clostridium botulinum* and *Bacillus cereus*.

Differentiation of bacterial food poisoning is shown in the **Table 16.34**.

Investigation of an Outbreak of Food Poisoning

- Collection of basic data such as location of the place where the affected people had taken the food
- Interrogation of all the participants
- Nature of the foods (type) eaten during the previous two days
- Time of onset of symptoms
- Nature of the symptoms in the order of occurrence
- Personal data such as total number of participants, number of persons affected, their names, age, sex, address, occupation and related information
- Number of deaths if any
- Assessment of environmental factors such as:
  - Inspection of kitchen
    a. To assess sanitation of kitchen and dining hall
    b. To know the nature of the storage of food grains
    c. To know the nature of the storage of cooked foods
    d. To know the presence of rodents
  - Interrogation and examination of food handlers and other employees regarding personal hygiene, habits and illness if any
- Laboratory investigations such as:
  - Vomitus and stools of the patients for culture in aerobic and anaerobic medias
  - Sample of suspected food for culture in both medias
  - Serological test of the blood of the affected persons for antibody titer
  - Culture of the stools and urine of the food handlers and kitchen employees
- Data is analyzed according to the descriptive methods of time, place and person distribution
- Food specific attack rates and case fatality rates are calculated
- Etiological hypothesis is formulated
- Case-control study is undertaken to establish the association between the disease and the particular food
- Prevention and control measures undertaken.

Prevention and Control

a. Taking care of food
   This consists of the following food-hygienic measures:
   - Proper storage of food grains
   - Proper cooking of food
   - Protection of cooked food from rodents, insects and bare-hands
   - Eating the food while hot
   - Discouraging canning of food
   - Refrigeration of remaining foods.

b. Taking care of food-handlers
   - They should maintain a high standard of personal hygiene
   - They are educated about the hazards of unguarded coughing and sneezing
   - They are educated to undergo periodical medical check-up
   - They must abstain from the duty, if they develop septic skin lesions, respiratory and intestinal symptoms
   - Carriers should remain absent for the duty till they are cured bacteriologically.

c. Taking care of environment
   - Kitchen and dining hall must be clean and dry
   - Utensils should be thoroughly washed with soap and hot water
   - Rodents and insects must be controlled.

Food-borne Diseases

These are the infectious diseases caused by the pathogens and transmitted through the contaminated food, which acts a vehicle of transmission. The list is shown in **Table 16.35**.

Assessment of Nutritional Status

The nutritional status of an individual is determined not only by the quality and quantity of the food intake but also by the physical health.

When the nutritional status of a 'group of persons' or a community is undertaken, it is called 'Nutrition Survey'.

A nutrition survey is conducted to determine the extent of nutritional problems/diseases in a community and their contributing factors, so that nutrition programs can be implemented for the prevention and control of the nutritional diseases.

When the nutritional status of a group of people or a community is assessed periodically, to monitor the success of a nutritional program, it is called 'Nutritional surveillance'.

The nutrition surveys could be longitudinal or cross sectional.

There are three methods of assessment of nutritional status:

- Direct assessment
- Indirect assessment
- Assessment of ecological factors.

Direct Methods of Assessment

This includes the following:

a. Clinical examination
b. Anthropometric examination
c. Biochemical examination
d. Biophysical examination.

Table 16.34 Differentiation of bacterial food poisoning

Type	Causative agent	Reservoir	Source/foods	Incubation period	Clinical features
a. Infection type • Salmonellosis	*S. gallinorum* *S. enteritidis* *S. typhimurium* *S. choleraesuis* *S. doublin* *S. abortus*	Poultry Pigs Rats	Milk, milk-products, egg, poultry, pork, food contaminated with urine of rats, human carriers	12 to 48 hours	Mainly diarrhea may be associated with blood, griping pain in the abdomen, usually associated with fever, (Gastric flu) vomiting may occur.
• *Clostridium welchi or perfringens*	*Clostridium perfringens anaerobic* spore forming organisms. There are 5 strains. Type C results in severe form. (i.e. Enteritis necroticans)	Dust and soil is the reservoir of spores	Reheating the stale cooked foods (meat, poultry, fish, etc.) prior to consumption is the critical factor. The spores germinate	12 to 24 hours	Moderate diarrhea associated with nagging abdominal pain and prostration. Not associated with fever and vomiting
• *Vibriopara-haemolyticus*	Gram negative, Non-agglutinating group of vibrio, halophylic (salt loving organism)	Sea-foods like Shell-fish, crabs, lobsters, shrimps, prawn, etc.	Improperly cooked sea-foods	12 to 18 hours	Profuse watery diarrhea, often containing blood and mucus, associated with pain abdomen, occasional vomiting with mild fever
b. Toxin type • *Staphylococcal type*	*Staph. aureus*	Animal—udder of the cattle. Human—cutaneous lesions like boil, carbuncle, whitlow, burns, etc. Nasal and Throat carriers	Milk, milk-products, salads, ice-cream, curds, etc.	1 to 6 hours	Vomiting is the main feature, vomiting is sudden, severe, violent, associated with pain abdomen without fever and diarrhea.
• *Bacillus-cereus* type	Bacillus-*cereus* Gram-positive, aerobic, spore forming motile bacilli, produces 2 types of enterotoxins: emetic form and enteric form	Food grains mainly cereals	Cereal based diet	8 to 12 hours	Emetic form results in vomiting. Enteric form results in diarrhea. Often pain abdomen.
• Botulism	*Clostridium botulinum* Strictly anaerobic, blocks the release of acetylcholine	Dust and soil	Canned food, smoked fish, pickled fish, Tinned vegetable food.	10 to 12 hours	Features are of parasympathetic paralysis. Blurring of vision, ptosis, dysphagia, diplopia, dysarthria, consti-pation. No vomiting or diarrhea. No fever. *Treatment:* Guanidine hydrochloride 25 to 40 mg/kg. Reverses the neuromuscular block.

Note: The food poisoning conditions, which are communicable diseases are Salmonellosis, Staphylococcal poisoning, *Clostridium perfringens* poisoning and vibrio-para-hemolyticus type

Table 16.35 List of food-borne diseases

Diseases	Causative agent	Vector or means of spread
Bacterial		
Anthrax	Bacillus anthracis	Contaminated meat
Cholera	Vibrioeltor	Contaminated food or water; house-flies.
Dysentry, bacillary	Shigella	Contaminated food or water; flies.
Typhoid	*Salmonella typhi*	Contaminated food or water, milk-and milk-products; flies.
Paratyphoid	*Salmonella paratyphi* A and B	Contaminated food or water, milk, milk-products, flies.
Streptococcosis, Staphylococcosis	*Streptococcus spp, Staphylococcus spp*	Food contaminated from humans sources.
Parasitic		
Amebiasis ascariasis	*Entameba histolytica, Ascaris lumbicoides*	Contaminated food, water, vegetables eaten raw.
Clonorchiasis diphyllobothriasis	Clonorchis simensis, Diphyllobothrium latum.	Improperly cooked fresh water fish.
Fasciolopsiasis	*Fasciolopsis buski*	Contaminated vegetables eaten raw.
Hydatidosis	*Echinococcus granulosus*	Contaminated food and water
Taeniasis	*Taenia saginata*	Infected beef
	Taenia solium	Infected pork
Trichinellosis	*Trichinella spiralis*	Infected pork
Trichuriasis	*Trichuris trichuria*	Contaminated food

Clinical examination: This consists of examination of an individual, clinically, from head to toe for the changes believed to be related to food consumption that can be seen or felt in the superficial tissues like hairs, eyes, skin, buccal mucosa, tongue, ears, nose, lips, teeth, gums, glands, nails, chest, abdomen and legs. Conglomeration of signs helps in making the diagnosis of a specific disease. If the signs are absent, the subject is declared nutritionally healthy.

Thus, clinical examination is the simplest, cheapest, very sound and most practical method of assessing the nutritional status.

In order to minimize the subjective errors, the surveyor is trained and is provided with a list of 'Standard signs', whereby he can record them appropriately.

Anthropometric examination: This consists of recording the following body measurements, which are although genetically determined, they are profoundly influenced by the nutrition.

- Weight
- Height
- Circumference of head
- Circumference of chest
- Circumference of mid-arm
- Thickness of the skin-fold.

The anthropometric measurements by themselves are of little value unless they are analyzed with reference to age.

Weight: This is the 'key' measurement. 'Weight for age' not only helps in assessing the current nutritional status but also the growth, specially among children, when recorded periodically and plotted in 'Road to Health' card.

Weight is employed in two ways:

- The current weight (in kg) of the child is compared with the expected standard weight and the deficiency in percentage is expressed in terms of degrees of malnutrition.
- The weight for age is also employed in Welcome's classification to assess PEM, as kwashiorkor, marasmus.

Weight is also employed in various other anthropometric methods such as Gomez classification, Waterlow's classification and Indian Academy of pediatric classification. (Explained under PEM).

A composite index of the nutritional status of adults is called the 'Body Mass Index' (BMI) or quetelet index. This is obtained by dividing the weight (in kg) of the individual by the height (in mtrs) squared.

$$\text{Quetelet Index} = \frac{\text{Weight (in kg)}}{\text{Height (in m}^2\text{)}}$$

An adult person is regarded nutritionally normal if his quetelet index is between 18.5 and 25. More than 25, it is obesity.

Persons having BMI value less than 18.5 are considered to be suffering from Chronic Energy Deficiency (CED) and are further classified as follows:

18.5 to 17—First degree CED
17 to 16—Second degree CED

< 16—Third degree CED (explained under epidemiology of obesity).

In a child (< 5 years) the ratio of wt/Ht^2 below 0.0015 is considered as malnutrition (Note: Ht is recorded in mtrs in adults and in cms in children).

Height: This is a linear dimension. It is a measure of skeletal elongation. Height for age gives an indication of duration of malnutrition.

For preschool children, below 3 years, 'Crown-heel' length is employed to avoid postural errors, by using Infantometer. Height is a stable measurement of growth as opposed to body weight. Whereas weight reflects the current health status of the child, height indicates the events in the past also.

Low height for age is also known as nutritional stunting or dwarfing. It reflects past or chronic malnutrition (i.e. duration of malnutrition). The cut-off point commonly taken for the diagnosis of stunting is 90 percent of United State National Center for Health Statistics (NCHS) height for age values. (Waterlow's Classification).

Indices used to assess the nutritional status of pre-school children are grouped into age dependent and age-independent indices.

Age dependent indices: These are 'Weight for Age' and 'Height for Age' (These indicators depend on age).

$$\text{Weight for age (under weight)} = \frac{\text{Actual weight} \times 100}{\text{Expected weight for that age}}$$

The expected weight is 50th percentile value of Harvard Standard and the cut-off point is 80 percent of 50th percentile value.

$$\text{Height for age (stunting)} = \frac{\text{Actual height} \times 100}{\text{Expected height for that age}}$$

The expected height is 50th percentile value of Harvard standard and the cut-off point is 95 percent of 50th percentile value.

Stunting is the sign of chronic malnutrition.

Age independent indices: These are:

- Weight for height
- Circumference of arm to height
- Circumference of arm to head-circumference
- Circumference of chest to head.

(These indicators do not depend on age).

Weight for height: This reflects current nutritional status or acute malnutrition. Only this indicator is more important and practical. Weight for height (wasting) reflects the nutritional deprivation of shorter duration.

$$\text{Weight for height (wasting)} = \frac{\text{Actual weight} \times 100}{\text{Expected weight for that height}}$$

Under field conditions, $\frac{\text{Wt}}{\text{Ht}^2}$ formula can be adopted (Quetelet index)

For adults, the height is recorded in meters and for children the height in cms and for both the weight is recorded in kg. The normal range is 18.5 to 25 to assess BMI and for children the cut-off point is 0.0015. Children with a ratio of less than this are considered to have PEM. A child less than 70 percent of the expected weight for that height is classed as 'severely wasted'.

Circumference of chest to head: Normally, at birth, the circumference of head is little more than that of the chest. Both become same by one year of age and crossing over takes after 1 year.

$$\frac{\text{Circumference of chest}}{\text{Circumference of head}} = \text{Ratio is < 1 at birth, 1 at 1 year and > 1 after 1 year.}$$

If the ratio of chest/head circumference is less than 1 in a preschool child, it indicates PEM.

The indicators of malnutrition among children is shown in **Table 16.36**.

Thickness of Skin-fold (Tissue Anthropometry)

This gives information about the sub-cutaneous reserve of calories in the body. Harpenden calipers is used for this. Measurement of a thickness of a skin-fold is recorded over triceps of left arm or infrascapular region. For a preschool child, 10 mm is taken as a cut-off point.

Circumference of mid-arm: This gives information about the muscle mass. Muscle wasting is a cardinal feature of PEM especially during early childhood. Mid-arm circumference above 13.5 cm means well nourished, between 13.5 and

Table 16.36 Indicators of malnutrition among children

Method	Name of index	Normal value	Severe malnou-rishment
$\frac{\text{Wt (kg)} \times 100}{\text{Ht (cm)}^{1.6}}$	Dugdale's	0.88–0.97	< 0.79
$\frac{\text{Wt (kg)} \times 100}{\text{Ht}^2\text{ (cm)}}$	Rao's	0.15–0.16	< 0.14
$\frac{\text{Wt (kg)}}{\text{Ht (cm)}^2}$	Quetelet's	0.0015–0.0016	< 0.0014
$\frac{\text{Mid-arm circumference (cm)}}{\text{Head circumference (cm)}}$	Kanawati	0.32–0.33	< 0.25
Mid-arm circumference between the ages of 1 and 5 years		> 13.5 cm	< 12.5 cm

Source: Bibliography no. 5, 9 and 13.

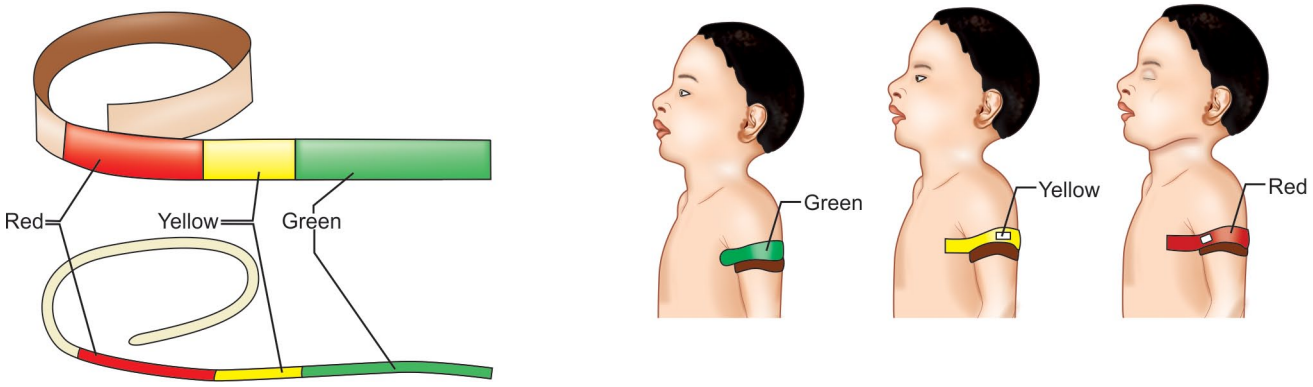


Fig. 16.8 Shakir's arm tapes (Green = Normal nutrition, Yellow = Moderate malnutrition, Red = Severe malnutrition)

12.5 cm means mild to moderate malnutrition and below 12.5 cm means severe malnutrition. The limitation is that a child between 1 and 4 years of age will have almost the constant measurement. Therefore, to make this an age-independent, it is compared against height and head circumference.

For a quick nutrition survey, a bangle with an internal diameter of 4 cm can be used. If it goes over the child's upper arm, it means the child is malnourished.

Shakir's arm tape can also be employed for quick nutrition survey **(Fig. 16.8)**.

Biochemical examination: Variations in the intake of nutrients in the diet are reflected by their concentration in the blood and urine. Thus, biochemical test helps to detect malnutrition much before the pathology has developed **(Table 16.37)**.

Biophysical examination: Cytological examination of buccal mucosa is done to study the cornified cells. Percentage of cornified cells increases with the degree of malnutrition. In healthy children, the normal percentage of cornified cells is 30 to 40 percent.

Indirect Method of Assessment

Since malnutrition influences morbidity and mortality rates, three indicators employed are:

- Age specific death rate among 1 to 4 yrs (Infant mortality rate and mortality in the age group of 1 to 4 yrs).
- Cause specific death rate among under-fives (i.e. due to PEM)
- Proportional mortality rate among under-fives due to PEM.

Assessment of Ecological Factors

Human malnutrition is always an ecological problem in that it is an end result of multiple overlapping and inter-acting factors in the community's physical, biological and cultural environment.

Table 16.37 Diagnosis of nutritional deficiency by biochemical test

Nutritional deficiency	Biochemical test
Proteins	Serum-albumin, urinary urea, urinary creatinine
Vitamin A	Serum-retinol
Vitamin D	Serum alkaline phosphatase
Ascorbic acid	Serum ascorbic acid
Thiamine	Urinary thiamine
Riboflavin	Urinary riboflavin
Iron	Hemoglobin, serum iron

The various influencing ecological factors are:

- Conditioning infections and infestations
- Cultural factors
- Socioeconomic factors
- Food production
- Food consumption
- Availability of health services.

1. *Conditioning infections and infestations:* Infections, acute or chronic, have a deleterious effects on the nutritional status specially among children.

   In fact there is a vicious interrelationship circle between infection and malnutrition, which is a known fact.

   Similarly associated infestation also affects the nutritional status.
2. *Cultural factors:* The different cultural factors which influence the nutritional status are food habits, customs, beliefs, traditions and attitudes. Family plays an important role and many times, the food habits pass from one generation to the other. The cultural factors make the individual to eat or not to eat a particular food item. These factors often affect the vulnerable groups.

Papaya is avoided during pregnancy because of the belief that it causes abortion. Mothers restrict diet during pregnancy thinking that if she eats more then baby will be big and the delivery would be difficult.

Disease oriented cultural factors are restricting certain food-item to treat the disease.

Religion has a powerful influence on the food habits of the people. Hindus do not eat beef and Muslims pork. Orthodox Hindus do not eat non-vegetarian food and also vegetarian items like onion and garlic. These are known as food taboos.

Cooking practices like draining away the rice-water at the end of cooking, peeling of vegetables, etc. also affect the nutritional status.

Child rearing practices such as premature weaning, bottle feeding, feeding artificial foods, etc. also affect. Habits like alcoholism has got a profound effect.

3. *Socioeconomic factors*: The important socioeconomic factors are income, education and the occupational status. These determine the quality of life, which in turn determines the nutritional status. Thus malnutrition is more among the poor.
4. *Food production:* Increased food production should lead to increased food consumption and better nutritional status. An average Indian has 0.6 hectare of land surface compared to 5.8 hectare per head in the developed countries.
5. *Food consumption:* It is obvious that the nutritional status of an individual is directly related to the quality and the quantity of the food eaten. Under eating results in PEM and over eating results in obesity.

The food consumption of an individual or a family can be assessed by the following steps:

- Diet survey
- Analysis of the data for the calculation of mean intake of foods, nutrients and calories.
- Comparison with the recommended allowances to know the deficiencies if any.

DIET SURVEY

Home visit is made by the investigator daily for 7 days, called 'one Dietary Cycle', the data is recorded in a specially designed proforma and the average for one day is taken.

The different methods of diet survey and their merits and demerits are as follows:

Oral Questionnaire Method

This is also called interview method or 24 hours dietary recall method.

The investigator will collect the information from the house-wife regarding the nature and quantity of foods eaten during the past 24 hours and makes necessary entries.

The advantage is that a large number of families can be covered in a short time. But it is not an accurate method. Nutritive values/energy values can be obtained directly for cooked foods (see Annexure of this chapter).

Questionnaire Method

In this method, the investigator will distribute the proformas containing questions regarding the total number of persons in that family, their age and sex, food items consumed daily, to the head of the family, with a request to fill them daily for one week. He collects those forms after one week. He will never interview them or discusses with them.

The disadvantage is that it cannot be used in those families, where the head of the family or house-wife is an illiterate.

Food Inventory or Log Book Method

In this method, the quantity of food present in the house at the beginning of the survey, is weighed and recorded. An account of the food-items purchased during one week study period should be kept by the head of the family and at the end of the week, the food items remaining unused is also weighed and recorded.

This gives information about the food items consumed during one week and the average is taken for one day.

The disadvantage is that it cannot be employed in those families, where the head of the family is illiterate. It requires co-operation from those families. Another disadvantage is that the house-wife may forget to record the purchase of the food brought or consumed. So the results may not be authentic.

Food List Method

In this method, the investigator will have a questionnaire containing a list of foods consumed by the family. The quantities of foods consumed, as stated by the housewife, are entered by the investigator. This method differs from the inventory method in that there is no measurement of the quantity of the food present in the house at the beginning, quantity purchased and the quantity remaining unused.

Weighment of Raw Foods

The investigator will weigh all the food-grains used for the day, just before cooking. Since this is practicable and if carried out properly, is a fairly accurate method and a reliable method.

The disadvantage is that often the house-wife may deliberately put the things out or in for weighing, which are likely (or not likely) to be cooked.

Weighment of Cooked Foods (Recipe Method)

In this method, the cooked food is weighed.

The left over cooked food is also weighed, so that the actual quantity of food consumed by the family members is calculated. Platewaste should also be recorded. This is also a fairly good method.

The disadvantage is that the head of the family or the house-wife may not allow the investigator to touch the cooked food. Thus there may not be co-operation.

Analysis of the Cooked Food

This involves the actual analysis of the composite sample of each cooked food-item, for the presence of various nutrients. About 10 percent by weight of the foods consumed by one individual can be taken as a sample. All the items are mixed and mashed into a fine paste in a grinding machine. Aliquots are used for the assay of vitamins, minerals, proteins, fats and carbohydrates. This is the most accurate method but it is time consuming, costly and is done in nutritional laboratories only.

Points to be noted while doing Diet Survey

- Foods used for feeding the children should be recorded separately
- Snacks consumed outside the house should be recorded.
- Foods given to neighborers or friends should be deducted from the total food purchased
- Absence of family members, during the period of survey should be recorded
- Guests partaking in the family meals must be noted
- Survey should not be made during occasions like marriage, birth-day ceremonies and religions celebrations.

Analysis of the data: The data so collected by diet-survey is analyzed for the following things.

- For the mean intake of foods in terms of cereals, pulses, vegetables, fruits, milk, meat, fish, eggs, oil, fat, sugar and jaggery
- For the mean intake of calories and nutrients in terms of proteins, fats, carbohydrates, vitamins and minerals, per dietary coefficient.

Since the family consists of several persons with different age groups and sex, the calculation of the diets consumed per head is difficult. In order to overcome this difficulty, the results are expressed terms of dietary coefficients (explained under energy requirements).

The nutritive value of the raw foods can be obtained from the Tables of food, published by Nutrition Expert Committee of ICMR (Indian Council of Medical Research).

Comparison: The data so obtained is compared with the recommended allowances to know the deficiencies if any so that they can be made-up.

6. *Availability of health services*: Health services like nutritional services, immunization services, family welfare services, educational services, etc. definitely improves the nutritional status of the community. Thus better the health services, better will be the nutritional status.

INDICATORS OF MALNUTRITION

Following indicators are used for surveillance of nutritional status and for assessment of nutritional programs:

- *Clinical indicators*:
  - Number of malnutrition cases admitted in the hospitals and health centers
  - Number of individuals with various deficiency disorders
  - Proportion of pregnant women during the last trimester with Hb level below 10 g/100 ml of blood
- *Anthropometric indicators*:
  - Percentage of newborns weighing less than 2500 g (incidence of LBW)
  - Weight and height standards of children up to 5 years (Quetelet index)
- *Statistical indicators*:
  - Infant mortality rate
  - Age specific mortality rate for the age group of 1 to 4 yrs
  - Proportional mortality rate for the age group of 1 to 4 yrs
- *Dietary indicators*:
  - Per capita intake of various food groups
  - Per capita intake of various nutrients.

NUTRITIONAL SURVEILLANCE

This means keeping a watch on the factors, which are related to nutritional status of a group of population.

The objectives are:

- To know the magnitude of nutritional problems in the community
- To find out the cause of the problems
- To assist the Government in formulating the nutritional policy

Table 16.38 Differences between growth monitoring and nutritional surveillance

Growth monitoring	Nutritional surveillance
• Oriented to individual child	• Oriented to group of individuals
• Done for all growing children	• Done for sample of all age groups
• Done monthly	• Done periodically
• Focuses to promote growth	• Focuses on the nutritional status
• Has educational approach	• Has interventional approach
• Mother is actively involved	• Trained worker is actively involved
• Intervention is by: – Supplementary feeding – Immunization – Vitamin A syp. – Deworming – Oral rehydration therapy	• Intervention is by: – Nutrition programs such as supplementary feeding

- To implement nutrition programs
- To evaluate the nutrition programs
- To prevent short-term food consumption crises.

Nutritional surveillance should not be confused with growth monitoring **(Table 16.38)**.

NATIONAL NUTRITION POLICY

This was adapted by Government of India in 1993. This has three parts—introduction, strategies and implementation.

Introduction

Malnutrition is widely prevalent in India and is one of the major causes of increased morbidity and mortality specially among young children and reduces the work capacity and productivity of the adults, thus interfering with the progress of the country.

The policy addresses itself to overcome the ecological factors such as inadequate food production, high prices of foods, poor purchasing power of the people and intra household discrimination against women, etc.

The objective of the policy is to define the problem, identify the vulnerable groups and to undertake preventive measures.

Strategies

There are two types: direct short-term and indirect long-term.

Direct Short-term Strategies

These are recommended for the vulnerable populations such as pregnant mothers, nursing mothers young children and adolescents. These are:

- To extend the ICDS network to cover all the uncovered blocks
- To extend the supplementary nutrition for all expectant mothers from first trimester up to 1 year after birth
- To bring the adolescent girls under the ambit of ICDS and give them IFA tablets and provide them training in home based skills including education on nutrition
- To trigger the behavior change in mothers in correct breast-feeding practices and in growth monitoring
- To fortify the salt with iron and folic acid
- To popularize low cost nutritious foods prepared out of locally available cheap foods
- To control the micro-nutrient malnutrition through extending and intensifying the vitamin A prophylaxis, IFA tabs supplementation and sale of iodized salt.

Indirect Long-term Strategies

- Food production, quality and availability:
  - By raising the food production, so as to ensure a per capita availability of 215 kg per year
  - By enforcing land ceiling laws and by carrying out tenurial reforms
  - By implementing PFA-Act strictly
  - By expanding the food distribution system
  - By supplying special ration to the landless laborers during the lean season
- Income generation and transfer:
  - By expanding employment opportunities to women
  - By revising the minimum wages act periodically and enforcing strictly
- Behavior change through communication and education:
  - By incorporating basic knowledge about health and nutrition in the school curricula
  - By carrying out IEC activities in the community on nutrition
- Monitoring and surveillance:
  - By monitoring the nutrition programs.
  - By nutritional surveillance.

Implementation

The policy should be implemented by the Department of Women and Child Welfare under the ministry of Human Resources Development.

This department should work in co-ordination with the Departments of Agriculture, Rural development, Health Education, Food and Civil supplies. For this a special working group/committee should be set up from personnel of these departments, under the chairmanship of the Secretary, Department of Women and Child Welfare.

A National Nutrition Council should be constituted in the Planning commission, with the Prime Minister as its President for the co-ordination. Its members should include Union Ministers, a few State Ministers, representatives of NGOs and grass-root level workers. This Council will be the

highest forum for policy making, coordination, review and direction at the national level.

At the state level, there should be State Nutrition Council under the chairmanship of Chief Minister. A state co-ordination committee should also be set-up.

National Programs on Nutrition

These are discussed under National Health Programs.

ANNEXURE

Approximate calorific value of some cooked preparations:

Preparation	Quantity for one serving	Calories (kcal)
1. Cereal		
Rice	1 cup	170
Phulka	1 No.	80
Paratha	1 No.	150
Puri	1 No.	100
Bread	2 slices	170
Poha	1 cup	270
Upma	1cup	270
Idli	2 Nos.	150
Dosa	1 No.	125
Kichidi	1 cup	200
Wheat porridge	1 cup	220
Semolina porridge	1 cup	220
Cereal flakes with milk (corn/wheat/rice)	1 cup	220
2. Pulse		
Plain dhal	½ cup	100
Sambar	1 cup	110
3. Vegetable		
With gravy	1 cup	170
Sambar	1 cup	150
4. Non-vegetarian		
Boiled egg	1 No.	90
Omelette	1 No.	160
Fried egg	1 No.	160
Mutton curry	¾ cup	260
Chicken curry	¾ cup	240
Fish fried	2 big pieces	220
Fish cutlet	2 Nos.	190
Prawn curry	¾ cup	220
Keema kofta curry	¾ cup (6 small koftas)	240
5. Savoury snacks		
Bajji or pakora	8 Nos.	280
Besan ka pura	1 No.	220

Contd…

Contd…

Preparation	Quantity for one serving	Calories (kcal)
Chat (Dahi-pakori)	5 pieces	220
Cheese balls	2 Nos.	250
Dahi vada	2 Nos.	180
Vada	2 Nos.	140
Masala vada	2 Nos.	150
Masala dosa	1 No.	200
Pea-kachori	2 Nos.	380
Potato bonda	2 Nos.	200
Sago vada	2 Nos.	210
Samosa	1 No.	200
Sandwiches (butter–2 tsp)	2 Nos.	200
Vegetable puff	1 No.	170
Pizza (Cheese and tomato)	1 slice	200
6. Chutneys		
Coconut/ground/til	2 tbsp	120
Tomato	1 tbsp	10
Tamarind (with jaggery)	1 tbsp	60
7. Sweets and Desserts		
Besan barfi	2 pieces	400
Chikki	2 pieces	290
Fruit cake	1 piece	270
Rice puttu	½ cup	280
Sandesh	2 Nos.	14
Double ka meetha	½ cup	280
Halwa (kesari)	½ cup	320
Jelly/jam	1 tsp	20
Custard (aramel)	½ cup	160
Srikhand	½ cup	380
Milk chocolate	25 g	140
Ice-cream	½ cup	200
8. Beverages		
Tea (2 tsp sugar+50 ml toned milk)	1 cup	75
Coffee (2 tsp sugar+10 ml toned milk)	1 cup	110
Cow's milk (2 tsp sugar)	1 cup	180
Buffalo's milk (2 tsp sugar)	1 cup	320
Lassi (2 tsp sugar)	1 glass (200 ml)	110
Squash	1 glass (200 ml)	75
Syrups (Sherbat)	1 glass (200 ml)	200
Cold drinks	1 bottle (200 ml)	150
Fresh lime juice	1 glass (200 ml)	60

Contd…

Contd…

Preparation	Quantity for one serving	Calories (kcal)
9. Nuts		
Almonds	10 Nos.	85
Cashewnuts	10 Nos.	95
Coconut (fresh)	¼	130
Coconut (dry)	¼	140
Peanuts	50 Nos.	90
10. Fresh fruits		
Apple	1 medium	65
Banana	1 medium	90
Grapes	30 Nos.	70
Guava	1 medium	50
Jackfruit	4 pieces	90
Mango	1 medium	180
Mosambi/orange	1 medium	40
Papaya	1 piece	80
Pineapple	1 piece	50
Sapota	1 medium	80
Custard apple	1 medium	130
Watermelon/muskmelon	1 slice	15
11. Salads		
Beetroot	1 medium	30
Carrot	1 medium	20
Cucumber	1 medium	15
Onion	1 medium	25
Radish	1 medium	10
Tomato	1 medium	10

Source: Prasad KR, Rangaswamy. Clinical Evaluation of Some Anthropometric Indices of Nutritional Status. Arch Child Health, 1975;17(4).

BIBLIOGRAPHY

1. Alleyne, et al. Protein Energy Malnutrition. Edward Arnold London, 1977.
2. Gopalan C, Ramashastry BV, Balasubramanyan, Narasinga Rao BS, Deasthale YG, Pant KG. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad (ICMR), 1989.
3. Hiremath DA, Lalitha D Hiremath. Essentials of Community Medicine. A Practical Approach. Jaypee Brothers Medical Publishers, 1st edn, 2004.
4. ICMR. Nutrient Requirement and Recommended Dietary Allowances for Indians. New Delhi, 1990.
5. Jelliffe DB. Assessment of Nutritional Status of Community. WHO Monograph No 53, 1966.
6. National CSSM Programme. Programme Interventions. MCH Division, Ministry of Health and Family Welfare Services. Govt of India, New Delhi, 1994.
7. Nutrition Foundation of India (NFI) Bulletin, 2010;31(1).
8. Park K. Park's Textbook of Preventive and Social Medicine, 18th edn, 2005.
9. Prabhakar GN. Short Textbook of Preventive and Social Medicine. Jaypee Brothers Medical Publishers, 1st edn, 2002.
10. Prasad KR, Rangaswamy. Clinical Evaluation of Some Anthropometric Indices of Nutritional Status. Arch Child Health, 1975;17(4).
11. Waterlow JC. Classification and Definition of Protein Calorie Malnutrition. Br Med J. 1972;3:5826.
12. Waterlow JC. Classification and Definition of Protein Energy Malnutrition. WHO Monograph No 62, 1976.
13. WHO Iodine and Health; Elminating Iodine Deficiency Disorders Safely through Salt Iodization. A statement by WHO, 1994.
14. WHO Tech Rep Ser No 672, 1982.

SECTION 4

Occupational Health

- Ergonomics
- Occupational Hazards
- Pneumoconioses
- Lead Poisoning
- Occupational Cancers
- Occupational Dermatoses
- Accidents in Industries
- Offensive Trades
- Sickness Absenteeism
- Prevention and Control of Occupational Hazards
- Legislation
- Social Security

CHAPTER 17

Occupational Health

INTRODUCTION

Working population constitutes the major portion of the community. They determine the progress and development of the country. In other words, their health status is considered as a sensitive indicator for the development of the country.

Just like home, the place of work is also an important environment for an earning person. Such a person spends nearly 6 to 8 hours a day in the working place till the retirement for about 3 decades. Not only the worker should be healthy but also the working environment should be healthy, safe and free from harmful agents. It is becoming more complicated as man is becoming more ingenious because of industrialization and urbanization. So a worker in all occupations needs special health care delivery.

Industrial health is different from occupational health. Industrial health deals with workers in industries and mines, whereas occupational health is concerned with man in any occupation. So it is with reference to all types of employment such as industries, mines, agriculture, forestry, service trades, offices, schools, colleges, mercantile and commercial enterprises, etc. Thus, industrial health is a component of occupational health.

According to Joint ILO/WHO Committee occupational medicine is defined as that branch of community medicine, which deals with the study of health promotion, health protection and maintenance of highest degree of physical, mental and social well-being of workers in all occupations. Thus, occupational health/medicine is application of preventive medicine in all places of employment. But industrial workers are given special attention by the Government, because they work in hazardous environment and are exposed to special risks. If the working environment is healthy, it is not only beneficial for the worker (employee) but also for the employer. There will be mutual benefit for both because there will be increased efficiency, increased production and decreased accidents. The subject envisages health, safety and welfare of all workers.

Bernardino Ramazzini (1633-1714) of Italy was the first person to stress the importance of taking occupational history of a patient. He wrote on occupational diseases. He is considered as 'Father of Occupational Health'.

BURDEN OF OCCUPATIONAL DISEASES

There are 100 million occupational injuries causing 0.1 million deaths in the world according to WHO. In India, it is estimated that 17 million (17% of global burden) occupational nonfatal injuries and 45,000 fatal injuries occur each year. Out of 11 million cases of occupational diseases in the world, 1.9 million cases (17%) are contributed by India and out of 0.7 million deaths in the world 0.12 million (17%) is contributed by India.

Aims

- To increase the efficiency
- To increase the production
- To decrease the accidents.

Objectives

- To promote the health of the workers
- To maintain the highest degree of physical, mental and social well-being of the workers
- To prevent the diseases by elimination of factors which are inimical to their health.

ERGONOMICS

It is a new concept in occupational health. It is concerned with human engineering. It is derived from Greek words, '*Ergon*' means work and '*Nomos*' means law. It simply means 'fitting the job to the worker'. That means placing the worker in an environment (job), which is adopted to his physiological and psychological capacity.

The main object of ergonomics is to achieve the best mutual adjustment between the man and the machine, which are complimentary to each other, so that there is increased efficiency, increased production and decreased accidents in the industry.

This term was coined in a conference at Stockholm in 1961, conducted by International Ergonomics Association. Ergonomics has made a significant contribution in reducing the industrial accidents and in overall health and efficiency of the workers.

The health of the worker is influenced by three factors, namely occupational (working) environment, domestic environment and social security and welfare measures.

Working (Occupational) Environment

It is the environmental conditions prevailing in the working place, which have a bearing or influence on the health of the worker, by three types of interactions. In other words there are three types of working environment **(Fig. 17.1)**.

First one, 'man with machine': The interaction between man and machine (mechanical). In almost all the industries, the machines are driven by power. Poor installation of machines, the unguarded, protruding moving parts, poor maintenance, etc. result in accidents. Working for long hours result in fatigue, discomfort and decreased efficiency.

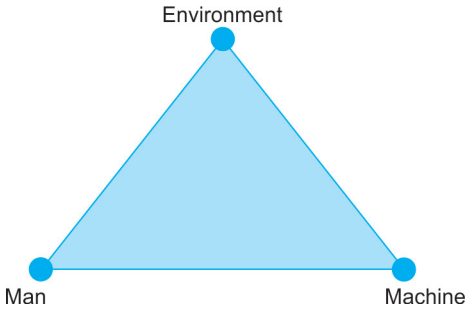


Fig. 17.1 Working environment

Second one, 'man with environment': The interaction between the worker and his external environment such as physical, chemical and biological agents, which have an influence on the health of the workers.

Third one, 'man with man': The interaction (the relation) between the worker and his co-workers and the employer. This depends upon many psychosocial factors like nature of the work, service conditions, job satisfaction, payment, welfare conditions, incentives, union activities, etc. which have an influence on the safety and welfare of the workers. This constitutes psychosocial environment.

- *Domestic environment:* Working environment and domestic environment are complimentary to each other. The disturbances, the stress, the strain and such others occurring at working place, disturbs his sleep. Similarly, the stress and strain, worries such others occurring at home disturbs his work. Such things when continued over a long period, results in serious physical and mental illness, ultimately decreases the efficiency, production and increases the accidents.
- *Social security and welfare measures:* This consists of provision of minimum income and such other amenities to the worker during the time of crisis such as accident, major illness or retirement, as a security measure. They also contribute to health or happiness of the workers.

All the factors related to workers operate simultaneously on human health and are interlinked. Thus, occupational health represents a dynamic equilibrium between the workers and the occupational environment.

OCCUPATIONAL HAZARDS

An industrial worker is exposed to the following five types of hazards (Physical, chemical, biological, mechanical and psychosocial hazards), depending upon the nature of the occupation.

Physical Hazards

These are the hazards occurring due to following physical agents:

- *Heat:* The effects are heat syncope, heat cramps, heat exhaustion, heat stroke, heat hyperpyrexia, prickly heat, burns, etc.
- *Cold:* Frost bite, Reynaud's disease, erythromelalgia, erythrocyanosis, chilblains, trench-foot, gangrene, etc. All because of cutaneous vasoconstriction.

Note: Heat syncope—It is fainting attack due to pooling of blood in lower limbs.
Heat cramps: It is painful and spasmodic contractions of muscles due to loss of sodium and chloride.
Heat exhaustion: It means loss of salt leading on to circulatory failure.
Heat hyperpyrexia: It is characterized by failure in heat regulating mechanism without the features of heat stroke. Temperature is about 106°F. It may proceed to heat stroke.
Heat stroke: There will be failure in the heat regulating mechanism, resulting in high temperature of the body, delirium, convulsions, partial or total loss of consciousness. Skin is dry and hot. Death may occur due to hyperpotassemia, cause of which is not known, probably due to release of potassium from RBCs, which are injured by heat. Treatment is by rapid cooling in ice-water bath.

- *Light:* Effects occur either due to inadequate light or excessive light.
  Inadequate light: Headache, eye strain, eye fatigue (visual fatigue). Chronic effect is 'Miner's nystagmus'.
  Excessive light: Bright light results in glaring, visual fatigue, blurring of vision, discomfort and accidents.
- *Radiation:*
  1. *Ionizing radiation:* X-rays, radio-active isotopes like cobalt 60, phosphorus 32.
     i. *Acute effects:* Acute radiation syndrome .
     ii. *Chronic effects:*
     - *Somatic effects:* Leukemia, aplastic anemia, cancer, tumor induction, pancytopenia.
     - *Genetic effects:* Stillbirths, congenital defects, neonatal deaths, sex chromosome aneuploidy, sterility.
  2. *Nonionizing radiation:*
     i. *Ultraviolet radiation:*
     - *On the skin:* Darkening of the skin, thickening of the skin, erythema, cancer of the skin.
     - *On the eyes (Ex: Welding):* Photophobia, conjunctivitis, keratitis, corneal ulcer, blindness (Welder's flash), snow blindness.

     ii. *Infrared radiation:* Cataract
     iii. *Microwaves:* Microwave sickness
     iv. *Laser radiations:* Thermal burns, cataract, retinal burns.
- *Atmospheric pressure:*
  i. *High atmospheric pressure (as in mines):* Caisson disease (compressed air illness), syncope, aches and pains in joints, air embolism, cardio-respiratory distress, paralysis.
  ii. *Low atmospheric pressure (as in high attitudes):* Deafness (due to blocking of Eustachian tubes), pain in the ears, rupture of eardrums, expansion of gasses in the sinuses and body cavities, headache, pulmonary edema, dyspnea, etc.
- *Electricity:* Electric shock, burns, ventricular flutter.
- *Noise:*
  – *Auditory effects:* Deafness (temporary or permanent), tinnitus (buzzing in the ears) degeneration of cochlea and eighth nerve.
  – *Nonauditory effects:* Fatigue, irritability, nervousness, interference with speech and communication, annoyance, increased intracranial tension, hypertension, peptic ulcer, higher environmental stress.
- *Vibration (working with pneumatic tools like drills and hammers):* Numbness, white fingers, injuries.

Chemical Hazards

These result from irritants, inhalants, ingestants and allergens.

- *Irritants (Such as dyes, acids and alkalis):* Occupational dermatoses, e.g. dermatitis, folliculitis, eczema, ulcerations, cancer.
- *Inhalants:* Dusts, fumes and gases.
  Dusts: Pneumoconioses.
  Fumes: Metal fume fever (This chemical intoxication results from inhalation of fumes of molten metals like arsenic, antimony, beryllium, cadmium, cobalt, lead, zinc, etc.)
  Gasses:
  Asphyxiating gasses: CO, SO_2, Cl_2, H_2S, methyl isocyanide gas, etc.
  Anesthetic gasses: Ether, chloroform, trichloroethylene.
- *Ingestants:* Toxic hazards occurring from the metals like lead, arsenic, mercury, cadmium, manganese, chromium, etc.
- *Allergens:* Allergic rhinitis, bronchitis, asthma, dermatitis, urticaria, etc.

Biological Hazards

These are from the animals and soil. These are common in agricultural industry.

- *From the animals:* They are called 'Zoonotic diseases'.
  Ex: Anthrax, bovine tuberculosis, salmonellosis, Japanese encephalitis, rabies, plague, Kyasanur forest disease, etc.
- *From the soil:* Tetanus, ankylostomiasis, gas-gangrene, malignant edema, anthrax, aspergillosis, coccidioidomycosis, mycetoma.

Mechanical Hazards

These are mainly accidents.

Psychosocial Hazards

These are due to failure of the worker to develop a healthy relationship with his co-workers, employers, management, supervisors, etc. They are divided into two groups.

- *Psychological (Behavioral) changes:* Such as hostility, aggressiveness, anxiety, depression, frustration, tardiness, alcoholism, drug addiction, sickness absenteeism, etc.
- *Psychosomatic ill health:* Such as neurosis, fatigue, propensity to peptic ulcer, hypertension, asthma, etc.

Other Hazards

- *Occupational cancers:* Cancers of the skin, lungs, bladder and blood forming organs (i.e. Leukemia).
- *Occupational dermatoses:* Dermatitis, eczema, folliculitis, urticaria, ulcers, etc.

PNEUMOCONIOSES

(Pneumons = lungs; Konia = dust; Pneumoconiosis is singular).

These are also known as dust diseases.

Pneumoconioses are a group of lung diseases occurring out of the specific occupation, caused by inhalation of insoluble dust, over a prolonged period of exposure.

Pathologically it is characterized by fibrosis of the lung parenchyma followed by its complications. Once a pathology, it is usually progressive, permanent, pulmonary pathology.

Clinically, it is characterized by persistent cough, progressive breathlessness, gradually cripples the person by reducing the working capacity due to fibrosis of the lungs followed by the features of complications such as tuberculosis, emphysema, chronic obstructive pulmonary disease (COPD), pulmonary hypertension, cor pulmonale and even carcinoma in some cases.

There is no treatment or cure for pneumoconioses. Prevention is the only intervention. Therefore, it is essential to prevent these diseases from arising.

Factors influencing pneumoconioses are:

- *Concentration of the dust in the air:* Higher the concentration, greater the health hazards. The permissible limit is 200 mcg (m) per cu meter of air.
- *Composition of the dust:* More complicated the composition of the dust, greater the health hazard.
- *Size of the dust particles:* This is the most important determining factor. Smaller the size of the dust particle, greater the tissue reaction.
  - Particles more than 10 μ, settle down on the ground and become soil dust.
  - Between 10 and 5 m, the particles are caught in the upper respiratory passage.
  - Between 5 and 3 m, they are caught in mid respiratory passage.
  - Between 3 and 0.5 m, they reach the alveoli and cause tissue reaction (fibrosis). They are most dangerous.
  - Less than 0.1 m, they are harmless because of Brownian movements they exhibit and they are absorbed.
- *Duration of exposure:* Longer the duration of exposure to the dust, greater the health hazard. Nearly 10 to 15 years of exposure is necessary for the development of tissue reaction. However, there are cases on record in which extensive fibrosis has occurred within 2 years following exposure to high concentration of dust.
- *Individual susceptibility (Health status):* Better the health and nutritional status, lesser the chances of development of pneumoconiosis early.

The common pneumoconioses, their causative agents and the industries of the occurrence are as described in **Table 17.1**.

Silicosis

It is an age old occupational disease. It is the commonest, major and the most serious of all the pneumoconioses. It was first reported in India, in 1947, from Kolar Gold Mines (Fields; KGF) of Karnataka state, described by Kaplan and Burden. Eversince its occurrence has been uncovered from other

Table 17.1 Common pneumoconioses, their causative agents and the industries of the occurrence

Dusts	Disease	Industries
Inorganic (Mineral) dusts		
Silica	Silicosis	Sand stone industry, stone quarrying and dressing, granite industry, pottery and ceramic industry, gold, silver, mica and steel industry
Asbestos	Asbestosis	Asbestos cement factory, fireproof textiles, brake lining gaskets
Iron	Siderosis	Iron ores and mines, iron and steel industries
Coal dust	Anthracosis	Coal mines
Aluminum	Aluminosis	Aluminum industries
Barium	Baritosis	Photography, printing, barium diagnostic works
Beryllium	Berylliosis	Beryllium mining, manufacture of alloys
Stone	Lithosis	Stone industries
Organic (Vegetable) dusts		
Cotton dust	Byssinosis	Textile industries
Sugar cane dust (Bagasse)	Bagassosis	Cane sugar factories, paper and card board factories
Tobacco dust	Tobaccosis	Tobacco factories (*Beedi*, Cigar, Cigarette)
Mouldy hay (Grain dust)	Farmer's lung	Agricultural industry

industries also. Its prevalence is 34 percent in mica mines and 15 percent in ceramic and pottery industries.

Importance

Silicon contributes to about 28 percent of earth's crust. Silicon being very reactive, does not remain in the elemental form but combines with oxygen alone to form silicon dioxide (SiO_2, i.e. free silica), which constitutes 12 percent of earth's crust or with oxygen and other elements to form silicates, e.g. asbestos (i.e. Combined silica). Silica and silicates constitute the bulk of most kinds of rocks, clay and sands. The other form, i.e. crystalline silica is known to be carcinogenic.

The term 'Silicosis' is reserved for the lung disorder caused by inhalation of free silica, which is an untreatable, progressive, pulmonary disease and is the commonest and most widespread of all pneumoconioses. Exposure to large amount of silica can pass unnoticed because silica is odorless, nonirritant, insoluble and inorganic. It does not cause any immediate noticeable effect and hence is confused with ordinary dust. Chronic exposure predisposes to tuberculosis, which is still a major public health problem.

Pathology and Pathogenesis

Inhalation of free silica (i.e. SiO_2) over prolonged period, causes major fibrogenic damage in the lungs. Dust particles between 0.5 and 3μ in diameter are most dangerous, because they reach the alveoli. Thus, the most important biological characteristic of free silica dust is fibrogenicity.

The free silica particles in the alveoli are phagocytosed by the macrophages in which they exert cytotoxic effect. Eventually, macrophages undergo autolysis and death. While dying, the macrophages release fibrogenic factor (i.e. macrophase fibrogenic factor; MFF), which causes fibrogenic reaction in the pulmonary interstitium, viz the fibroblasts proliferate resulting in the deposition of collagen and formation of fibrosis. Later there is hyalinization of collagen. Thus, first there is cytotoxic reaction followed by fibrogenic reaction.

The essential pathology is the typical 'nodular fibrosis' in the lungs, each nodule varying from 3 to 4 mm in diameter, hard, grayish, more frequent in the apex and posterior border of the lungs (Fibrosis is diffuse, basal in location and peribronchial in asbestosis). As the pathology progresses, contiguous, adjacent nodules may fuse to form 'massive conglomerate fibrosis' (i.e. progressive massive fibrosis). This conglomeration is precipitated by associated infection such as tuberculosis. Thus, silicotics are prone to develop pulmonary tuberculosis, a condition called 'Silico-tuberculosis'.

But in recent years there is doubt whether silicotics really develop tuberculosis, because their sputum is negative for AF bacilli and contacts do not develop tuberculosis (Sputum is negative for AFB because the silicotic fibrosis prevents the discharge of *Tubercle bacilli* in the sputum). Thus, many cases of tuberculosis remain undiagnosed during life but observed in postmortem studies. Only radiologically it is similar to pulmonary tuberculosis.

X-ray chest shows 'Snow storm' appearance of the lung fields (Ball of wool appearance).

Radiological changes occur in four stages as follows:

- *Latent stage (Radiologic latency):* In the initial stage, there is reticulation of lung fields due to thickening of perivascular and intercommunicating lymphatics. This latent stage lasts till the nodules reach the optimum size.
- *Early stage:* Once the nodules reach the optimum size, they look like 'Lace' plus there is enlargement of hilar opacity. The silicotic nodules are 2 to 5 mm in diameter, homogenous in density and usually bilaterally symmetrical.
- *Late stage:* There is coalescence of the nodules, giving rise to 'snow-storm' appearance in the lung fields.
- *Complicated stage:* Large opacities with cavities indicates silicosis with tuberculosis (Silico-tuberculosis).

Incubation Period

This varies from few months to few years, depending upon the concentration of the dust, composition of the dust, size of the dust, period of exposure and susceptibility of the individual.

Clinical Features

These are almost same in all types of pneumoconioses. The person will have chronic cough, progressive, exertional dyspnea, loss of weight and emphysema. Occasionally productive cough is associated with hemoptysis. Symptoms resemble chronic bronchitis. Chest pain and hemoptysis indicates the possibility of complication like tuberculosis.

Diagnosis

Features of chronic bronchitis, history of exposure to silica dust, X-ray chest showing 'snow-storm' appearance.

Complications

Tuberculosis, chronic obstructive pulmonary disease, (COPD), emphysema, pulmonary hypertension, cor pulmonale, Coplan's syndrome (i.e. Silicosis with rheumatoid arthritis).

Management

There is no treatment for silicosis. Once a pathology is a permanent pathology. The fibrotic changes cannot be reversed. Treatment is given for the complications of the disease. Research is going on to find out treatment for silicosis.

Silicosis is a notifiable disease under the Factories Act, 1948 and the Mines Act, 1952.

Anthracosis (Coal Workers' Pneumoconiosis)

This is due to the inhalation of coal dust over a long period of time. It is also called 'Coal workers' pneumoconiosis (CWP)' or Miners' black lung.

Pathology

The coal dust particles accumulate just before the bronchioles open into the alveoli. The aggregation of coal dust is known as 'Coal macule', which look like nodular opacities (or reticulation) in the X-ray of chest.

Pathogenesis

The disease occurs in two stages or phases:

a. *First phase:* This is called 'Simple pneumoconiosis.' This stage is characterized by little ventilatory impairment. It requires about 10 to 12 years of exposure for its development (i.e. the period between the date of exposure and initiation of fibrosis). The atrophy of bronchial smooth muscles and dilatation of bronchioles, gives rise to focal emphysema.

b. *Second phase:* This is characterized by 'progressive massive fibrosis (PMF)'. This leads to pulmonary hypertension and cor pulmonale. There is severe respiratory disability followed by congestive cardiac failure and premature death.

Once simple pneumoconiosis occurs in a coal worker, a progressive massive fibrosis may develop out of it, even without further exposure to it. Predisposing factors are tuberculosis, smoking, nonspecific respiratory infections and autoimmunity.

The other health hazards, other than anthracosis, for which coal-mine workers are exposed to are:

i. 'Beat-elbow' or 'beat-knee', as a result of their peculiar posture during work, followed by 'bursitis', which subsequently becomes the seat of 'septic cellulitis.'

ii. 'Miner's nystagmus' because of poor lighting in the mines.

X-ray chest shows multiple, nodular densities or reticulation (i.e. Black-lung).

Anthracosis is notifiable under Indian Mines Act (1952) and compensable under Workmen's Compensation Act (1959).

Asbestosis

Asbestos is a commercial name given to fibrous, mineral silicate, i.e. silica combined with oxygen and other elements like calcium, magnesium, iron, sodium or aluminum. Asbestosis is a pneumoconiosis resulting from inhalation of asbestos dust over a long period of time.

Asbestos is used in the manufacture of asbestos cement, sheets, pipes, gaskets, fire-proof textiles, etc. Exposure to this dust occurs in mining, milling and in the manufacture of asbestos products.

Asbestos is of two types, namely:

1. Serpentine or chrysolite (white asbestos) type (i.e. hydrated magnesium silicate)
2. Amphibole type (hydrated silicate of iron, calcium and sodium).

The latter type occurs in different forms like crocidolite (or blue form) and amosite (or brown form). The blue form is more hazardous. However, 90 percent of world's production of asbestos is of the serpentine variety, a safer one.

Like other mineral dust, asbestos is also insoluble in the lungs. It results in the following types of reactions in the lungs:

- *Fibrosis:* There is fine, interstitial, diffuse fibrosis, around the terminal bronchioles, involving the walls of air spaces, tissue reaction being mainly due to mechanical irritation, usually in the lower half of the lungs (in contrast to silicosis in which fibrosis is nodular in character and in the upper part of the lung). Pleura is thickened. Fibrosis is followed by bronchiectasis and emphysema.

X-ray chest shows 'ground-glass' appearance of lower two-thirds of the lungs and heart shows 'shaggy' appearance (i.e. without clear-cut cardiac margins). Sputum shows 'asbestos bodies' (asbestos fibers coated with fibrin). Shaggy radiological characteristic appearance is due to thickening of the pleura.

Pathology may progress evenafter cessation of exposure to asbestos dust.

- *Pleural calcification:* Calcified pleural plaques are seen, usually bilateral.
- *Neoplasms:* Common malignant lesion is bronchogenic carcinoma. Less common is malignant mesothelioma of pleura or peritoneum, often associated with effusion or ascites respectively. Smoking is an additional synergistic factor in the development of bronchogenic carcinoma and not mesothelioma. Thus, asbestos predisposes to cancers of lung, pleura and peritoneum.
- *Asbestos corns of the skin:* This is not due to inhalation of asbestos dust but due to local effect on the skin of the hands. Spicules of asbestos penetrate the skin and result in corns. It requires excision. It occurs among those who are bagging the fiber.

Clinical Features

These are the same type as in any other pneumoconiosis.

Byssinosis

This is due to inhalation of cotton-dust over a long period of time. Therefore, it is common among those workers who are working in textile industries. Some industrial scientists believe that the cause is 'Aerobacter cloacae' which contaminates

the cotton fibers in hot and humid climates. It affects 7 to 8 percent of textile workers.

Acute symptoms are tightness in the chest and altered respiratory function, within hours after beginning the exposure, specially on Mondays or after holidays. With continued exposure over several years, irreversible impair-ment may develop, manifested by chronic cough, progressive dyspnea, later leading on to emphysema.

No characteristic X-ray changes are seen in the lungs. 'Mill fever' which resembles metal fume fever also occurs as a result of exposure to cotton dust.

Bagassosis

This is due to inhalation of cane-sugar dust (bagasse). Cane-sugar dust is utilized in the manufacture of paper, cardboard and rayon. Therefore, this condition is seen not only in sugar factories but also in paper, cardboard and rayon factories.

Bagassosis was first reported from Calcutta, in 1955, by Ganguly and Pal, in a card-board industry.

The bagasse, after extraction of juice from cane-sugar, is baled when it remains moist. The storage of such bales in hot environment for long time predisposes for the growth certain fungi called *Thermoactinomyces sacchari*. When the bales are broken for use in the industries, the fungus enters the respiratory tract of workers and sets the disease process.

Incubation period is 2 to 4 months.

Clinical features are the same as in other pneumoconiosis. X-ray of the chest shows 'mottling' appearance in lung fields. If treated early and prevented from further exposure to the dust, there will be resolution of the lungs.

Farmer's Lung

This is a chronic disease of lungs, due to inhalation of mouldy hay or grain dust, in the agricultural fields.

During winter season, the grain-dust with a moisture content of over 30 percent, bacteriae grow rapidly and produce heat of about 45°C. The heat encourages the growth of certain thermophilic actinomycete fungi of which Microspora (Micropolyspora) faeni is the main cause of Farmer's lung.

This condition is considered to be an allergic (hypersensitivity) reaction to the inhalation of antigen (dust) with the development of antibodies.

The clinical features are the same as that of bronchial asthma (Eosinophilia) (Allergic bronchitis). First acute attacks are noticed. Repeated attacks cause pulmonary fibrosis and lung damage (cor pulmonale).

X-ray chest shows 'fine nodular density'.

Since agricultural industry is the major industry in our country, this is one of the major public health problems of our country.

Different pneumoconioses and their radiological changes are depicted in **Table 17.2**.

Table 17.2 Different pneumoconioses and radiological changes

Pneumoconiosis	Radiological changes in chest X-ray
Silicosis	'Snow-storm' appearance (upper part of lungs)
Anthracosis	'Black-lung' (multiple nodular opacities)
Asbestosis	'Ground-glass' appearance (lower part of lungs) and 'Shaggy' appearance of heart
Byssinosis	No characteristic changes
Bagassosis	'Mottling' appearance
Farmer's lung	'Fine nodular opacity'

Table 17.3 Different conditions in prevention of pneumoconioses and their contradictions

Conditions	Disqualifying job
Color blindness	Railway engine or motor driver
Hernia	Lifting of heavy objects
Respiratory illness	Dusty atmosphere
Skin disease	Handling of dyes, acids and alkalies

Prevention of Control of Pneumoconioses

Health promotion: By the following measures:

A. *Preplacement examination (Pre-employment examination):* This consists of thorough examination of the individual before giving the job. This includes not only thorough physical examinations but also routine investigations including X-ray of the chest. Then suitable job is given depending upon the physical and mental abilities, i.e. 'Fitting the job to the worker' (i.e. placing the right person in the right job). This is called ergonomics. The object is to increase the efficiency, increase the industrial production and decrease the accidents.

   The different conditions and their contradictory jobs are discussed in **Table 17.3**.

B. *Health education:* Employees at a risk of pneumoconioses are educated about the hazards of dust inhalation over long period. They are also educated about the hazards of smoking as a precipitating factor and prevention of those hazards.

C. *Provision of healthy physical environment:* Improvement in the sanitation such as cleanliness, adequate ventilation and good house-keeping (wet mopping of floors and walls) are mandatory in the industries.

D. *Control of dust:* This includes:
   a. Prevention of formation of dust at the point of origin by water sprays, e.g. wet drilling of rock. Similarly oil or steam can also be used. Thus, 'wet method' is useful in the control of dust.

b. *Prevention of escape of dust into the atmosphere:* If it is not possible to prevent the formation of dust completely, at least the escape of dust into the atmosphere can be prevented by special enclosures or cabinets or hood for the machinery at the point of origin of dust. Such enclosures are usually combined with exhaust ventilation. The dust is drawn into the hood and conveyed through ducts into collecting units.

   Keeping moisture content below 20 percent and spraying 2 percent propionic acid (fungicide) controls bagassosis.

   Use of safer type of asbestos like chrysolite (white form) and amosite (brown form) reduces hazards of asbestosis.

c. *Removal of dust:* Dust can also be removed by special ventilatory arrangements.

Specific protection: The workers should protect themselves by using 'face-masks'. Other protective devices are respirators and gas masks.

Early diagnosis and treatment: The workers should undergo periodical medical examinations including X-ray of chest, so that the cases of respiratory diseases can be detected early and removed from the offending occupation and are given some other job. If detected before the formation of fibrosis of the lungs and changed the job, resolution of the lungs can occur, except in asbestosis and anthracosis.

Disability limitation: This consists of limiting the further disability of the worker by detecting even the slightest degree of disability and immediately assigning some other suitable job.

Rehabilitation: This is required for those workers, who have become handicapped due to the development of fibrosis of the lungs. They require physical, psychological, social and vocational rehabilitation **(Table 17.4)**.

Mass Sociogenic Illness

Mass sociogenic illness (MSI) in an industry, is a phenomenon in which a group of people have an access of illness behavior, without a detectable medical basis, but with an apparent physiological basis.

The symptoms are burning sensation over the face, weakness of the limbs, noises in the ears and heaviness of the head. It may lead on to psychological disorder.

The likely causative factors are poor ventilation causing a mild excess of CO_2 concentration as well as a mild heat load, overlaid on a background of work stress.

Carbon dioxide concentration at low levels (500 ppm) is associated with nonspecific symptoms, at higher concentration (6000 to 10,000 ppm) is an important potentiating factor and at very high concentration (30,000 ppm) results in frank poisoning.

Table 17.4 Differences between preplacement and periodical examination

Preplacement examination	Periodical examination
This is done before placing the worker to the job.	This is done after placing the worker to the job.
This is done only once.	This is done periodically.
This is called ergonomics.	This is for early diagnosis and treatment of health hazards.
This is done to assess the physical and psychological capacity of the individual.	This is done to assess the physical and pathological aspects in the individual.
Helps to detect 'high-risk' group.	Helps to detect the group who are going to develop high-risk.
The objective is to increase the efficiency, to increase the production and to decrease the accidents.	The objective is to protect the individual from further complications.
This is primary level of prevention (Health promotion)	This is secondary level of prevention (Early diagnosis and treatment).

MSI are often diagnosed by exclusion of chemical and physical factors.

Such illness requires social healing rather than a medical curative technique. The overall approach is important.

LEAD POISONING (PLUMBISM)

It is the most common toxic metal poisoning occurring in the industries, as a silent epidemic, because of its wide usage. It is widely used because of its properties like low boiling point, easy mixibility with other metals to form alloys, easily oxidized and anti-corrosive.

Most dangerous (toxic) lead compounds are lead arsenate, lead carbonate and lead oxide. Lead sulfide is least toxic.

Sources of Lead

There are two sources, occupational and nonoccupational:

- *Occupational type of plumbism:* It is common in the following industries:
  - Mines of lead ores
  - Industries of glass, paint and storage batteries
  - Printing and potteries
  - Plumbing works (pipe fitting).
- *Nonoccupational sources:* The greatest source is gasoline (leaded petrol). Being a heavy metal, lead is not burnt in the engine and comes out in solid form. Thousands of tonnes of lead is exhausted from automobiles every year. Thus, lead is present abundantly in the environment.

Thus, from the environment lead poisoning can occur by inhalation of dust and fumes and also by ingestion through contaminated food and water.
(Lead is added to petrol for raising octane rating.)

The other nonoccupational type of lead poisoning can occur through drinking water conveyed through lead pipes or through drinking wine contaminated with lead because the lid of the bottle is made up of lead,

- Through eating fruits sprayed with insecticides containing lead.
- Among children, it can occur through the habits of pica (eating mud), chewing lead-paint by nibbling of toys coating with lead paint, chewing on window sills, keeping lead-pencils in the mouth, etc.
- Through contaminated hands also, lead ingestion can occur.

Absorption, Storage and Elimination

Lead poisoning occurs mainly by inhalation and often by ingestion. It can also occur by absorption through the skin. Only organic compounds such as alkyl lead (Tetraethyl lead) can penetrate the skin.

Normal adult ingests about 0.2 to 0.3 mg of lead per day largely from food and beverages. Ninety percent of ingested lead is excreted in the feces. Only 10 percent is absorbed. But regular intake can increase the amount of lead in the body. Lead is mainly stored in the bones and to some extent in the liver and kidneys. It is a cumulative poison. Unabsorbed lead is excreted in the stools and absorbed lead is excreted in the urine.

Lead exerts its toxic action by combining with 'SH' group of certain enzymes involved in porphyrin synthesis in RBCs and suppresses it. It also suppresses carbohydrate metabolism.

Clinical Features of Plumbism

The features are different in inorganic and organic type of lead poisoning. Normal blood level of lead is 25 mcg per 100 ml. Toxic features appear when the level exceeds 70 mcg per 100 ml.

Inorganic Lead Poisoning

This is characterized by involvement of mainly alimentary system. But lead can affect almost every system of the body. No other disease is having signs and symptoms related to each of the alphabet.

These are:

- Anemia, anorexia, arthralgia, amenorrhea
- Blue (or black) line on the gums (known as Burton's or Burtonian line, due to deposition of lead sulfide granules in the gums, 1 mm from the gingival margin, more in the upper jaw, specially over the incisors. Lead combines with hydrogen sulfide and forms lead sulfide).
- Colicy abdomen (cramps)
- Diarrhea
- Encephalopathy
- Fatigue
- Giddiness, growth failure among children
- Headache
- Insomnia, irritability
- Joint pains
- Kidney damage (Fanconi syndrome) (Chronic nephritis)
- Lassitude
- Myalgia, mental retardation
- Nausea, nervousness
- Oliguria
- Paralysis (Lead palsy: Wrist drop due to paralysis of extensor muscles of hand, i.e. Teleky's sign.)
- Pallor, pica
- Seizures, sterility
- Tremors
- Vertigo, vomiting
- Weakness.

Organic Lead Poisoning

This is characterized by the involvement of central nervous system characterized by insomnia, headache, mental confusion, irritability, nervousness, anxiety, convulsions, delirium, coma and death.

Other Epidemiological Features

- Occupational inorganic lead poisoning is common among adults and nonoccupational organic lead poisoning is common among young children.
- Children suffering from pica, are at a risk of plumbism.
- Chronic respiratory and intestinal infections predispose to plumbism.
- Pregnancy increases susceptibility to plumbism. Not only the pregnant mother but also the fetus is at risk of 'Small for date' (intrauterine growth retardation) and mental retardation.
- Predisposing personal factors are alcoholism, lack of personal hygiene, nail biting and wearing work uniform outside the factory.
- Children with plumbism will develop growth failure, progressive mental retardation, low I-Q, aggressive behavior, lack of concentration, etc.

Diagnosis (Table 17.5)

- History of occupational exposure to lead.
- Clinical symptomatology.

Table 17.5 Diagnosis of lead poisoning

Material	Normal level	Dangerous level
Blood lead	25–40 mcg per 100 ml	> 70 mcg per 100 ml
Urinary lead	0.2–0.8 mg per liter	> 0.8 mg per liter
Urinary amino levulinic acid (ALA)	6 mg per liter	60 mg per liter
Urinary coproporphyrin*	<150 mcg per liter	>250 mcg per liter

*In plumbism, coproporphyrin is excreted in the urine because lead combines with Sulfhydryl (SH) group of the enzymes concerned with the synthesis of RBCs, releasing coproporphyrin.

- Laboratory investigations, such as:
  - *Hemoglobin percentage:* This is done to know the severity of anemia. Pallor is out of proportion to anemia.
  - *Peripheral blood smear:* Shows 'microcytic—hypochromic' picture and 'Basophilic Stippling' of RBCs.
  - RBC count is decreased.
  - Reticulocyte count is increased.
  - Blood level of lead and
  - Urinary level of lead, coproporphyrin and aminolevulinic acid.

Management

- Prevention of further exposure to lead absorption by change of job.
- Saline purge helps in the removal of unabsorbed lead from gut.
- Promotion of lead excretion in the urine from the soft tissues by giving chelating agents such as Ca-EDTA (Calcium Ethylene Diamine Tetra-Acetate) and d-penicillamine.

Prevention and Control

Health Promotion

- Preplacement examination to rule out the presence of contraindications if any such as pallor, blue line of gums, etc.
- Improvement in the sanitation: Good house-keeping (i.e. wet mopping of floors), ventilation and cleanliness is mandatory in the industries.
- Control of dust (explained under pneumoconioses).
- Use of unleaded petrol for automobiles.
- Health education of employees about maintenance of high standard of personal hygiene for plumbers and for those working with paints, to change the work-uniform after leaving the factory. All employees are educated about the risks involved.
- Substitution of lead compounds by less toxic materials wherever possible, e.g. toxic lead oxide is substituted with titanium dioxide.

Specific Protection

- By use of gloves among painters
- By use of respirators and masks for those exposed to dust and fumes.

Early Diagnosis and Treatment

Plumbism can be diagnosed early by periodical examination of 'at-risk' group of people and when detected, they are treated with chelating agents like Ca-EDTA and d-penicillamine.

Disability Limitation

When the patients (employees) come in the advanced stage, development of further disability can be prevented by giving aggressive treatment followed by change of the job.

Rehabilitation

This is given for those who have developed wrist drop (lead palsy) or neurological deficits following lead encephalopathy.

Plumbism is a notifiable disease under Indian Factories Act 1948 and a Compensatable disease under Workmen's Compensation Act, 1959.

Prevention of Plumbism among Children

- By health education of parents.
- By avoiding the use of materials (like toys and cribs) painted with lead paints.
- By periodical screening of those children living in old houses.
- Community awareness with regard to pica reduction may be an important preventive measure.

Metal Fume Fever (Brass Founder's Ague)

This is a temporary malady resulting from inhalation of heavy concentrations of fresh metallic oxide fumes of mainly zinc and magnesium, which are generated when these metals are burnt and molten. Other metallic oxides also initiate this syndrome. The condition develops some hours after the exposure and resembles the typical sensitization reaction to foreign proteins.

The usual features are rise in body temperature with sweating, chills, dryness of throat, cough, tightness of chest, breathlessness, malaise, and leukocytosis.

Complete recovery occurs in 12 to 24 hours, when the person is away from the molten metal fumes.

Persons exposed to this develop temporary immunity to this condition. Metal fume fever does not lead to any permanent damage. Since this condition resembles that of respiratory infection, it is often mistaken.

This condition often occurs in galvanizing operations and in welding.

This respiratory hazard can be prevented by the use of air masks or respirators or by proper ventilation of the work-place.

OCCUPATIONAL CANCERS

They are also called as 'Industrial cancers'. These constitute another important health problem in the industries because many types of chemicals are employed in the industries, which act as carcinogens. The most common types of occupational cancers are those of skin, lungs, bladder and blood forming organs (like bone marrow).

Agent Factors

These are mainly chemical carcinogens, both organic and inorganic. Organic chemical carcinogens mainly result in lung cancer and inorganic ones mainly result in skin cancer.

Environmental Factors

Physical environment like heat and radiation also result in industrial cancers.

Influencing Factors

The factors influencing the development of industrial cancers are potency (intensity) of the carcinogen, duration of exposure, degree of personal hygiene and availability of preventive measures.

The different types of occupational cancers, their carcinogens and 'at risk' group in the industries are followed in **Table 17.6**.

Table 17.6 Types of occupational cancers, their carcinogens and related industries

Type of cancer	Carcinogen	'At risk' group in the industry
Skin cancer*	Anthracene, coal-tar, soot, pitch, oils and dyes, acids, U-V rays, X-rays.	Farmers, sheperds, fisherman, road-builders oil refiners, dye-stuff makers, radiology department staff, tar distillers, coke-oven workers.
Lung cancer	Arsenic, asbestos, beryllium, chromium, uranium, tobacco, coal tar, nickel.	Asbestos factory, uranium-mines, nickel-refineries, gas industry, tobacco industry.
Bladder cancer #	β-naphthylamine, benzidine, auramine, aromatic amines, para-amino diphenyl, hemotoxins.	Aniline industry, rubber industry, electric cable industry.
Leukemia	Ionizing radiations (X-rays and gamma rays), radioactive isotopes	Radiology department, atomic energy research station

Note: 'Dhoti-cancer' as described by Khanolkar is not an industrial cancer but caused by mechanical irritation (friction) of dhoti over the skin of waist.
*Occupational skin cancers also include Mule spinner's cancer and Chimney sweeper's cancer (cancer of scrotum).
Cancer of the bladder resulting from the infestation of Schistosoma hematobium (a biological agent) is not an industrial cancer.

Features of Occupational Cancers

- They occur in those sites, where the action of carcinogens is constant, most intense and prolonged.
- They appear after a prolonged exposure of about 10 to 15 years.
- They can occur even after cessation of exposure as in asbestos industry.
- The average age incidence of occupational cancers is much earlier than that for cancers in general.
- It is more among men than among women.
- The localization of the tumor is remarkably constant in any one occupation.
- Maintenance of high standard of personal hygiene is very important in the prevention of occupational cancers.

Prevention of Industrial Cancers

By five levels of prevention.

Health Promotion

- *Preplacement examination:* This consists of examination of the individual for assessing his physical and psychological capacity, so as to place him in a suitable job (Fitting the job to the worker). This is called 'Ergonomics', e.g. person with skin disease is not placed in handling acids, alkalies and dyes.
- *Sanitation in the working environment:* Good housekeeping, ventilation and the cleanliness are mandatory in the industries.

- *Health education:* The workers are educated on the following points:
  - To change their attitude towards cancer.
  - To know the 'Danger signals' of cancers (Cancer education)
  - To know the hazards of smoking as an aggravating factor in the dusty environment.
  - To maintain high standard of personal hygiene.
- Control of dust in asbestos industry.

Specific Protection

- Primordial prevention consists of elimination or avoidance of carcinogens in the industry. This also consists of discouraging the workers from adopting harmful lifestyle such as smoking.
- By the use of protective devices such as:
  Masks in the asbestos industry, lead apron, lead gloves and dark spectacles in radiology department. Use of barrier creams in dyeing section of the industry.
- Safety of the worker by wearing 'Pocket dosimeter' for personal monitoring of the radiation dose received.
- Safety of the machine by proper installation and maintenance of X-ray machine, use of efficient fitters so that unwarranted radiations are excluded. They are operated on high kilo-voltage with fast films, so that exposure is reduced to minimum dose.

Early Diagnosis and Treatment

This is done by 'Periodical examinations' of at-risk group of industrial workers, specially in the cancer clinics to detect lesions of early and curable stage. The periodical examinations should be continued even after cessation of exposure to carcinogen. This screening procedure consists of thorough physical examination followed by procedures like blood examination, urine examination, X-ray of chest, cytology, endoscopy and even biopsy.

Treatment is given by chemotherapy, surgery, radiotherapy, hormonal therapy or immunotherapy depending upon the type.

Disability Limitation

This consists of limiting the development of further disability by giving intensive treatment, when the patients come in the advanced stage.

Rehabilitation

This is given for those who have become handicapped following major surgery such as amputation, lobectomy, etc. They are rehabilitated physically, socially, psycho-logically and vocationally.

OCCUPATIONAL DERMATOSES

These are the diseases of the skin arising out of the occupation or during the course of employment. These are dermatitis, eczema, folliculitis, urticaria, ulcers and even cancer of the skin.

The occupational dermatoses account for 40 to 70 percent of all occupational diseases, depending upon the nature of the occupation. The incidence has been increasing every year due to industrialization and thus constitutes one of the major public health problems in industrial areas.

The occurrence of dermatoses depends upon the nature of the causative agent and the duration of exposure.

The agent factors are grouped under the following groups:

- Physical agents—such as heat, radiation
- Chemical agents (Irritants)—acids, alkalies, dyes, solvents, grease, tar, pitch and minerals like arsenic, chromium.

A primary cutaneous irritant is an agent which causes dermatitis by direct action on the normal skin at the site of contact, if it is permitted to act in sufficient intensity and/or sufficient length of time. It acts by dissolving keratin, by dissolving fat, by dehydrating the tissue, by precipitating the proteins by oxidation/reduction and by keratogenic action.

- *Biological agents:* Such as viruses, bacteriae, fungi and certain parasites.
- *Plant products:* Such as leaves, fruits, flowers, vegetables, plants like parthenium, poison ivy, etc.
- *Sensitizing agents:* These act as allergens such as photodeveloping materials, formalin, synthetic resins, insecticides, fungicides, etc.

Irritants and sensitizers constitute the important agent factors.

Host Factors

Age: It is more among young adults than older group of persons.

Sex: It is more among men than among women because women take better care of their skin.

The factors which influence the development of dermatoses are as follows:

Age: Dermatoses are common among young adults than elderly people.

Sex: It is more among men than among women.

Habits: Alcoholism predisposes to dermatoses.

Nature of the skin: Fair skin is more susceptible than dark skin.

Allergic diathesis, hyperhidrosis predispose to dermatoses.

Season: Incidence is higher in summer season than in winter season because of sparsity of clothes and excessive sweating.

Personal hygiene: Lack of personal hygiene also predisposes.

Other skin lesions: Presence of other skin lesions impairs the resistance and predisposes for dermatoses.

Prevention

Health Promotion Measures

- Preplacement examination is done for the workers and those suffering from cutaneous disorders, should be kept away from those jobs involving a skin hazard.
- Health education of all those who are 'at risk' of dermatoses, about maintenance of personal hygiene, frequent washing of hands, keeping the machines clean, changing the clothes everyday. They must also be educated about the correct methods of handling paints, greases, irritants, etc.

Specific Protection

- By avoidance of allergens
- By providing protective clothing, long leather gloves, aprons, boots and application of barrier creams to the hands.

Early Diagnosis and Prompt Treatment

- Periodical examinations are done almost daily among those who are handling acids, alkalies, dyes, etc.
- 'Patch test' is done in the event of dermatoses due to allergens. However, negative test does not rule out the diagnosis.
- The affected person is removed from that job and is placed in another situation till the dermatosis heals up.
- Treatment should be prompt with saline wash of the affected part, $KMnO_4$ compresses, application of ointments and antibiotics if there is secondary infection of skin lesions.

OCCUPATIONAL HEALTH IN AGRICULTURAL INDUSTRY

Agriculture (farming) is the major most and largest industry in our country because 80 percent of our population live in the rural areas and their main occupation is agriculture. Not only it is largest industry but also the oldest of the industries. Yet, 'occupational health in agriculture' is rather a new concept.

Agricultural occupation includes all activities connected with ploughing the soil, growing crops, harvesting, processing of crops, breeding, raising and caring for animals including poultry and tending gardens and nurseries. It also includes handling of machines, tools, insecticides, pesticides, etc.

Agricultural occupation differs from other occupation in that:

- The workers work in the open fields
- They are exposed to the vagaries of the nature, like sun's heat, rainfall, winter, etc.
- There are no 'labor laws' in practice
- The workers are so remotely dispersed in rural areas that the health services may not reach them.

The health hazards of agricultural occupation is grouped into six groups, namely physical, chemical, biological, mechanical, social and miscellaneous hazards.

1. *Physical hazards:* These are due to the extremes of the climate conditions (vagaries of the nature). The important physical environment are heat, cold and radiations.

   Humidity and other climate conditions impose additional stress upon the workers.

   Effects of temperature are heat syncope, heat exhaustion, heat cramps and heat stroke.

   Effect of radiation are dermatoses, eczema, epithelioma (cancer), etc.
2. *Chemical hazards:* These are the toxic hazards, due to the extensive use of chemicals in agricultural activities, in the form of fertilizers, insecticides, pesticides, etc. Most of them are organophosphorus compounds, which have been found to be 'ubiquitous' in soil, water, food-grains, fruits, vegetables, etc. so much so a recent study has shown a correlation between the use of pesticides and occurrence of orthopedic limb deformities, for example, 'Andigodu syndrome' in a place called Andigodu, near Shimoga, in Karnataka state, characterized by multiple orthopedic deformities. It has been attributed to the consumption of fish and crabs, collected from the rice fields, sprayed with DDT (and/or parathion).

   Often these chemicals can result in acute poisoning. Some of the chemicals act as irritants and allergens. Some act as potential carcinogens also.
3. *Biological hazards:* These occur because of their close contact with plants, animals and soil.
   a. *From the plants:* They get allergic/contact dermatitis, and Farmer's lung from the dusts of grain or mouldy hay.
   b. *From the animals:* They are at the risk of certain zoonotic diseases such as tetanus, anthrax, brucellosis, salmonellosis, leptospirosis, bovine tuberculosis, Japanese encephalitis, rabies, etc.
   c. *From the soil:* They are at the risk of tetanus, ankylostomiasis, gas-gangrene, malignant edema, aspergillosis, coccidiodomycosis, mycetoma, etc.
4. *Mechanical hazards:* These are mainly accidents resulting in the agricultural fields from the use of farming tools, overturning of tractors, work load, etc.
5. *Social hazards:* These occur mainly due to poverty, illiteracy, poor standard of living, lack of knowledge,

ignorance, over-crowding, traditional culture, blind beliefs, etc. all predisposing for the prevalence of many communicable diseases.

6. *Miscellaneous hazards:* These include, snake-bites, scorpion bites, bull-gore injuries and other traumatic injuries.

Prevention and Control of Agricultural Hazards

1. *Health promotion:* This consists of mainly healthful living, (good housing), cleanliness in and around the house, maintenance of personal hygiene, training in the use of agricultural equipment, education on the hazards of open air defecation, walking barefoot, etc.
2. *Specific protection:* This consists of avoiding allergens, immunization against tetanus, protection from the hazards of fertilizers and pesticides, etc.
3. *Early diagnosis and treatment:* This consists of periodical examinations for the detection of contact dermatitis, Farmer's lung, etc. Emphasis is laid on provision of first aid treatment and primary health care services. Cases beyond competency, should be referred to nearest primary health center or *taluka* hospital.

HAZARDS DUE TO INDUSTRIALIZATION AND URBANIZATION

Undoubtedly, industrialization is the basis for the progress and socio-economic development of a country. But at the same time, it results in the following health hazards, which are grouped as—physical, psychological, social and miscellaneous hazards.

Physical (Environmental) Hazards

These are:

- *Housing (Living):* Because of the migration of the population for the sake of employment in the industries, slums will come up like mushrooms. There will be poor standard of living, over-crowding, lack of sanitation, improper drainage system, etc. all predisposing for the prevalence of many communicable diseases, often resulting in epidemics.
- *Environmental pollution:* This consists of air pollution, water pollution, soil pollution because, of discharge and emission of industrial waste, dust, smoke, fumes, etc.
- *Vector problems:* Collections of water, in and around the industries and residential areas, become the potential breeding places for the mosquitoes.

Psychological Hazards

Due to migration of the population, altered living conditions, food, failure of adjustment, etc. leads to mental illness, behavioral disorders, neurosis, psychoses, etc.

Social Hazards

These are alcoholism, drug abuse, gambling, prostitution, divorces, broken-homes and anti-social activities like theft, murder, rape, juvenile delinquency and such other crimes.

Miscellaneous Hazards

- A nuisance to the people by noise, smoke and smell.
- Particular health hazards due to particular industry, (such as pneumoconioses)
- Accidents not only in the industries but also outside, due to vehicular traffic, congestion, increased tempo of life (such as stress, strain, lifestyle, etc.)
- Malnutrition, sexually transmitted infections, etc.

ACCIDENTS IN INDUSTRIES

Accidents are common in many industries, more so in mines, quarries and construction works. Nearly 92 percent result in temporary disablement, 5 to 6 percent in permanent disability and about 2 to 3 percent are fatal. It is estimated that nearly 3 million mandays are lost yearly in India because of accidents. The accident rate is estimated to be 0.14 per 1000 workers per year. Every year about 7000 workers are dying from industrial accidents. To the worker, the loss is in terms of his wages apart from his sufferings. To the industry (or employer), the loss is in terms of decreased production, provision of medical care and compensation. To the nation, it affects the progress.

Factors—Responsible for Accidents

- Explosions, roof collapses
- Inundation of mines with water
- Landslides with boulder-falls
- Unprotected or unmarked pits
- Ill-designed tools and machinery without safety devices
- Absence of fencing or guarding for the moving parts of the machinery
- Emission of flying slivers and sparks.

Causes

Causes of industrial accidents are grouped into two groups—human and environmental.

Human Factors

These are responsible for 85 percent of all industrial accidents. They are grouped further into physical, physiological and psychological factors, as follows:

- *Physical factors:* Such as hearing defects, visual defects, etc. not meeting the job requirements.
- *Physiological factors:*
  - *Age:* Young and recently recruited workers are frequently the victims of accidents.
  - *Sex:* It is 5 times more common among men than among women.
  - *Time:* Accidents occur more frequently at the end than at the beginning of the shift.
  - *Experience:* Lesser the experience, more the accidents. Thus, it is more among the inexperienced employees.
  - *Duration of work:* Longer the duration of work, more the accidents.
- *Psychological factors:* These are carelessness, overconfidence, lack of concentration in the work, ignorance, emotional stress and accident proneness.

Accident proneness: About 75 percent of all industrial accidents occur to the same 25 percent of workers. They are referred to as 'accident prone'. They suffer from a subconscious desire to seek out hazardous activities and deliberately avoid taking precautions or using protective devices.

Environmental Factors

These are poor lighting, noise, humidity, unsafe or unguarded machines with protruded moving parts, etc. Unsafe machines attribute to nearly 20 percent of all industrial accidents.

Prevention

- Adequate pre-placement examination of the workers for their physical and psychological fitness and fitting the job to the worker.
- Health education of the workers about the hazards they are exposed to and their protection against those hazards.
- Ensuring safe environment specially with reference to lighting.
- Adequate training of the workers.
- Proper installation and maintenance of the machines.
- Machineries must be safe, in that they must be fitted with 'built in safety device', so that the machine should stop immediately and automatically when any part of the operator's body or clothes is about to be entangled in its moving part or revolving part.
- Establishment of safety department in the industries.
- First-aid facilities should be made available in the industries. Ambulance is kept ready all the 24 hours for immediate transportation of severely injured persons to the nearest hospital.
- Disabled and handicapped workers are rehabilitated and placed in some other job of the industry.

OFFENSIVE TRADES AND OCCUPATIONS

Some trades and occupations apart from being injurious to the health of the workers and surrounding population, they are of nuisance and offensive value to the special senses of sight, smell, hearing and touch, an account of material or processes employed. The effect on health may be direct, indirect, immediate or late. The ill effects are due to:

- Effulvia, dust, noise or obnoxious smell coming out of the manufacturing plant
- Offensive sight
- Effluent which on accumulation breeds insects like mosquitoes and flies, pollutes water sources, causes dampness of soil, etc.

Common offensive trades are keeping of animals, slaughtering of animals, boiling of blood and bones, scraping of gut, melting of fat and tallow, fellmongering, paper mills, oil mills, rice mills, etc.

Keeping of Animals

Such as cattle, horses, pigs, sheep, etc. often create nuisance of smell and promotes breeding of flies, mosquitoes and other insects, only when they are kept in over crowded, ill-ventilated and badly drained localities that the emanations (excreta) become a source of nuisance.

This offense is prevented by proper construction of cowsheds and stables.

Slaughtering of Animals

Slaughter houses constitute a source of a very serious nuisance arising from the storage of decomposed carcasses, garbage, putrefaction of the offal and continuous flow of blood, urine and fecal matter.

For proper sanitary control, all slaughtering should be done in public slaughter house (abattoir). It should be built with concrete and brick and well protected against rodents. In the construction of slaughter houses, the following points (criteriae) should be fulfilled:

- It should be at least 100 feet away from any dwelling house and it should be open to the outside air.
- It should always be above the ground level.
- It should have abundant water supply.

- The floor should be of an impermeable material with a proper slope and a channel.
- Walls should be of sufficient height and should be covered with impervious material. Corners should be rounded off and there should not be any cracks on the floor.
- Dogs and rats should not be allowed in and around the slaughter house an account of the danger of the trichina and *Echinococcus* infections.
- The employees must be clean and wear clean outer clothes.
- Persons suffering from communicable disease should not be allowed to handle any meat or meat-products.
- Butchers who handle carcasses should wash their hands in some disinfectant solution and all instruments used must be sterilized.
- All refuse, blood, manure and garbage are to be placed in vessels with close fitting covers, immediately after slaughtering, to prevent vultures and birds reaching them. Skin, fat, etc. should be removed from the slaughter house as soon as possible.

Blood Boiling and Drying

The blood collected from slaughter houses is utilized for making blood albumin, manufacturing red pigment, preparing blood manure and refining sugar. Blood is usually boiled by mixing with sulfuric acid and then dried. During this process, it gives off very sickly smell.

Bone Boiling and Crushing

This is done to prepare phosphate manures for agricultural purposes. It produces nuisance by smell.

Gut Scraping

This is done for the manufacture of catgut, sausage skin, etc. This causes nuisance by sight, smell and flies.

Fat and Tallow Melting (Soap Making)

The fat obtained from butchers is usually decomposed and is used for manufacturing candles, soaps, leather dressings and preparations for lubricating the machinery. In the manufacture of soap, fat is boiled with an alkali, called 'lye' and while boiling gives off offensive smell.

Fellmongering

Fellmongering means processing the fresh or old skin for the leather dresser. First the skin is beaten to get rid of the dirt, then soaked in water tank. Hair is removed by painting the inner side of the skins with a solution of slaked lime and sodium sulfide, which acts as depilitatory and within 24 hours, the hairs are easily removed.

Tanning

This process is very offensive. The process consists of soaking the hides in strong solution of nut-galls, reinforced by a solution containing tannin. By the process of tanning, the putrescible hides are converted into non-putrescible material, known as 'leather'. Tanning creates nuisance of smell. Therefore, the tanneries should be located on the outskirts of the town.

Paper Mills

Paper is prepared from substances like cotton, linen-rags, waste paper, straw, bamboo, espartograss, bagasse (cane sugar waste), etc. These basic materials are converted into pulp by boiling with caustic alkali. Nuisance is caused chiefly by alkali waste during boiling.

Oil Mills

Cause nuisance by smell.

Rice Mills

In the preparation of parboiled rice, nuisance is created by smell.

SICKNESS ABSENTEEISM

It means remaining absent from the work by the industrial worker due to certified sickness or injury, but not due to pregnancy or confinement (delivery).

Sickness absenteeism is an important health problem in the industry. It results in staggering of the work and seriously impedes the production and progress of the industry. Thus, absenteeism is an useful index (indicator) to assess the health status of the industry and the health status of the workers.

Absenteeism is expressed in two ways:

- Number of days remaining absent per person per year.
- Percentage of workers remaining absent per year (Sickness absenteeism rate).

$$\text{SAR} = \frac{\text{No. of workers remaining absent during a year}}{\text{Total no. of workers}} \times 100$$

Extent of the Problem

Incidence of SAR is 15 to 20 percent in our country and is on the increase. In terms of number of days, it is 8 to 10/days/

person/year. Higher the SAR, poorer the health status of the workers and industry. A certain amount of sickness absenteeism is inevitable. Beyond 7 percent, it is a matter of concern for employers.

Causes (Factors Influencing)

1. *Medical causes:* This is the main cause of sickness absenteeism. About 10 percent of the days lost were found to be due to the accidents in the industry.
2. *Economic causes:* Since the worker is entitled to 'Sickness benefit' (Sick leave with pay), he/she tends to avail this benefit of cash (7/12 of daily wage) by declaring himself/herself unfit for work, of course, it is being certified by the Insurance Medical Officer. Worker gets this benefit for 56 days in a year.
3. *Host factors:*
   a. *Age:* Sickness absenteeism increases as the age advances.
   b. *Sex:* Women workers have frequent absences and men have longer absences. Since the majority of women workers are married and have children, it is undoubtedly due to their home responsibilities.
   c. *Marital status:* Sickness absenteeism is more among married workers than among unmarried workers.
   d. *Season:* Sickness absenteeism is more in winter season than in other seasons because of frequent respiratory diseases.
   e. *Social factors:* Such as wedding ceremonies, festivals, construction work, agricultural work and such other occasions compel workers to seek leave on medical grounds.
   f. *Other causes:* Habits like alcoholism, drug-abuse, etc. predispose to sickness absenteeism. Malingering or escapism is another factor. Whenever the worker wants to escape from the stressful situation or whenever the relation with the co-workers or management is not good, applies leave.

Preventive Measures (Reduction Measures)

- Preplacement examination of the workers for contraindications in order to fit the job to the worker (Ergonomics).
- Elimination of stressful conditions.
- Proper supervision by the foreman.
- Provision of treatment facilities.
- Good factory management including recreational activities and incentives.
- Healthy relation between the management and the employees.

WOMEN IN INDUSTRY

The employment of women creates certain health problems associated with their normal physiologic process of pregnancy, menstruation, lactation, menopause and other problems related to their strength, ability to work and home responsibilities.

Menstruation and Dysmenorrhea

These are often used as excuse for absenteeism. In fact women engaged in sedentary work have a higher incidence of dysmenorrhea than those engaged in more active occupations. Lost time (absenteeism) due to dysmenorrhea can be greatly reduced by certain types of exercises, education, provision of a place for rest and simple first-aid treatment.

Statements have been made that exposure to toxic chemicals, heavy muscular work, vibrations may aggravate the menstrual and other gynecological conditions, but proof of this is lacking, and it appears that the ability of women to perform mental and muscular works is not altered by the menstrual cycle.

Pregnancy

This problem is more among women of younger age group. There is no sound data available to determine whether the employment of women during pregnancy affects the course of the pregnancy, diseases of pregnancy, incidence of spontaneous abortions or infant death rate. But some studies have indicated that women who worked late in pregnancy had a higher incidence of premature infants than those who ceased to work by 28th week. Health authorities, in general, believe that it is safe for pregnant women to continue work at least during the first six months of pregnancy and usually longer if their health permits and if the character or nature of the work is suitable.

The recommendations concerning the employment of pregnant women are as follows:

- They should not be employed on work which requires heavy lifting, good balance, constant standing, constant moving or in fact any prolonged posture because of the increased venous pressure in the legs.
- They should not be exposed to dangerous concentrations of toxic chemical substances like lead, carbon monoxide, mercury, carbon tetrachloride, etc. or to ionizing radiations since such an exposure may exert a harmful effect on the course of pregnancy or on the fetus.
- They should not work for more than 48 hours per week and preferably not more than 40 hours.

- They should cease work 6 weeks before delivery and should not return to work at least for 6 months in order to practice exclusive breastfeeding. They should apply all types of leaves at their credit during postpartum period, for 6 months, in the interest of welfare of the child.
- They should be encouraged to report to the medical department with the understanding that their employment will be continued if their health permits. When they are assured of continued employment if their health permits, they can be placed in areas free from harmful conditions, if their regular work is not suitable.

Menopause

The problems associated with the menopausal changes do not appear to be important in most industries. Many women suffer no ill effects. However, the character (nature) of their work should be reviewed, since it is stated that heavy lifting or straining may aggravate certain gynecological conditions which occur during this period.

Ability of Women to Work

Women are especially capable at jobs requiring manual dexterity and fine coordination. But properly trained women are capable of performing almost all types of work except those involving excessive muscular work. Women have less physical strength and lower maximum pulmonary ventilation rate and maximum cardiac output. Therefore, they cannot lift or hold heavy weights, their grip is not strong and their capacity to perform hard work to the point of exhaustion is less than men.

Since their height, weight and size of the hands are smaller, they should be properly placed in the job suitable to their physical fitness.

Just because they are physically less strong than men, it does not mean that the onset of fatigue is rapid among them. If at all there is rapid onset of fatigue, it is probably due to the fact that they spend some hours of work in the domestic duties also, in addition to those spent in the industry.

In addition, women in industry are also at the risk of all occupational hazards, depending upon the industry they are working.

They also enjoy the same benefits, as men enjoy.

HEALTH STATUS OF INDUSTRY

This depends upon the collective health of its employees. It cannot be precisely measured. But the following are some of its indirect indicators:

- *Occupational mortality:* Higher the mortality rate of workers in an industry, poorer is the health status. However, the mortality depends upon the nature of the occupation, age and sex structure/composition of the workers. So the mortality rates of different occupations cannot be compared. Therefore, for purposes of comparison the mortality rates has to be standardized for age and sex. The index that is commonly used is 'Standardized mortality ratio' (SMR). It is the ratio of actual mortality experience of a given occupational group to its standardized mortality experience. It is expressed as percentage.
- *Sickness absenteeism rate:* Already explained.
- *Production figures:* Higher the production, the profits and the percent bonus paid, better is the health status of the industry.

PREVENTION AND CONTROL OF OCCUPATIONAL HAZARDS

Primary Prevention

- Health promotion
- Specific protection.

Health Promotion of Workers

The workers should have a state of positive health. The different measures recommended are:

a. *Pre-placement examination:* It is the examination of the worker before employing in the occupation, to assess his physical and psychological fitness so that right person is placed in right job (i.e. Ergonomics), thereby there will be increased efficiency, increased production and decreased accidents.

b. *Provision of healthy physical environment:* Many factors in the workers' environment contribute to promotion of their health and efficiency. These are building construction, lighting, ventilation, temperature, humidity, noise, vibration, cleanliness, machine safety, process control, monitoring, substitution, etc. These are all engineering measures.
   - *Building:* Building should be structurally safe to withstand the stress and strain of the machineries. There should be protection from solar radiation and conducted heat and noise. It should be away from the residential areas.

     Inside the building, there should not be overcrowding nor the area be congested with machines. On an average, a space of 400 cu ft should be provided per worker.
   - *Lighting:* There should be sufficient light in the factory (natural, artificial or both), so as to enable the workers to see the things clearly. There should not be any glare. Excessive brightness should also be avoided.

Defective illumination predisposes for accidents and nystagmus in the mines. Therefore to obtain uniform light from the sun, the workshops are constructed to face north and south. The walls must be periodically white washed, which not only keeps the room bright, but also helps proper diffusion of light. Indirect illumination reflecting from the ceiling is best. When artificial lights are used, fluorescent lighting is suitable.

- *Ventilation:* There must be proper ventilation of the working place. If natural ventilation is not adequate, arrangements should be made for artificial ventilation. The ventilatory openings (doors and windows) should be in the proportion of 5 sq feet for each worker. Exhaust system of ventilation is preferred specially in those rooms, where dust is generated. Good ventilation minimizes the occurrence of pneumoconiosis. The Indian Factories Act has prescribed a minimum of 500 cu ft of air space for each worker.
- *Thermal comfort:* 'Comfort-zone' is the one wherein the worker feels comfortable for doing the work. The criteria of comfort zone are:
  - Corrected Effective Temperature (CET) to be between 77 to 80°F, (25–27°C).
  - Relative humidity between 30 to 65 percent.
  - Dry Kata reading 6 and above.
  - Wet Kata reading 20 and above.
  - Predicted 4-hour sweat rate (P_4SR) is 1–3L (Av 2.5L). P_4SR is applicable only in that situation where sweating occurs. It is the rate at which the person sweats. It is a good index of heat stress.
- *Control of dust:* There must be measures:
  - To prevent/to reduce the formation of dust by wet method, oiling, etc.
  - To prevent the escape of dust by hoods, enclosures, to trap the dust.
  - To remove the dust by exhaust ventilation, suction fans, etc.
  - To control the dust by wet-mopping of the floors.
- *Good house-keeping:* This refers to general cleanliness of the factory premises. The floor is regularly cleaned by wet-mopping or vacuum cleaning. It also consists of regular white washing and painting of the industry. The premises should be clean and tidy. Good house-keeping is a fundamental requirement for heath promotion and prevention and control of occupational hazards.
- *Water supply:* There must be provision for providing protected water supply to the workers in the industry. It is one of the basic requirements. Installation of drinking water fountains, at convenient points, should be encouraged. Quantity of water to be provided should be about 5 liters per head per day. Sufficient water supply is mandatory.
- *Latrines and urinals:* There must be one latrine for 25 workers and one urinal for 50 workers as recommended. They must be of sanitary type, separate for men and women, located in a convenient place. Garbage and waste disposal should be so as to avoid breeding of flies and vermin.
- *Disposal of swage:* Large industries should have their own sewage treatment plant. The sewage to be disposed into the river water only after treatment. If necessary, re-circulation can be done.

c. *Machine safety and process control:* Accidents are common among those, who are working with unguarded, improperly installed, carelessly operated or defective machineries. Following precautionary measures should be taken:
   - Standard machinery and equipment to be used.
   - They are so placed as to leave sufficient space all around.
   - Machinery should be fitted with a 'built-in' safety device.
   - The dangerous parts of the machine (such as cutting part, revolving part) must be fenced or provided with a suitable guard.
   - Installation of the machines should be proper.
   - Machines to be cleaned periodically.
   - All electrical connections should be properly earthed.
   - The manufacturing process should be so controlled so as to expose the worker to the least amount of noxious substances, e.g. providing filters to the X-ray machine.
   - Mechanization of the plant is another aspect to protect the workers from dangers, i.e. Using machines to do the work instead of worker doing it, e.g. dermatitis can be prevented if hand mixing is replaced by mechanical device, long-forceps is used to handle radioactive substances, acids are conveyed through pipes, etc.
   - Substitution of harmful substances by less harmful substances to be done wherever possible **(Table 17.7)**.

d. *Health education:* This is also an important health promotive measure. This envisages at both the levels in the industries—the worker and the management.

To the worker, ideally it should start before he/she is employed. Worker is educated about the risks involved

Table 17.7 Harmful and harmless substances

Harmful substances	Harmless substances
• Yellow (white) phosphorus	Phosphorus sesquisulfide (prevents 'Phossy' jaw)
• Lead paints	Zinc or iron paints
• Mercury salts	Silver salts
• Benzene	Acetone
• Sandstone	Carborundum

and the measures to be taken for self-protection. They are also educated about personal hygiene and also the importance of maintaining a healthy social relationship with the co-workers and the management.

e. *Safety education and training:* All workers are given safety education by the Welfare Officer (Safety Officer) and the Factory Physician (Industrial Medical Officer) about the dangers of the machine and the materials they are handling and their self-protection.

Workers are also given education on first-aid. They must also be given 'Job training,' which in turn promotes their health.

f. *Working hours:* 8 hours a day with a break for 1 hour during lunch hours, for 6 days in a week and 1 day preferably Sunday to be holiday.

g. *Other health promotional activities:* These are the following welfare services:
   - Recreational, play and cultural activities
   - Provision of quarters, lunch rooms and retiring rooms
   - Incentives and reward for initiative, craftsmanship and the like
   - Family welfare advice and services
   - Crèches for the children of employed mothers, insurance facilities against loss of job, illness and disablement.

h. *Environmental monitoring:* Monitoring specially with reference to thermal conditions, lighting, ventilation, dust concentration, etc. by periodical survey goes a longway in reducing occupational hazards.

i. *Notification:* National laws and regulations require the notification of cases of occupational diseases. They are to be notified to the Chief-Inspector of Factories, who makes an epidemiological enquiry and gets compensation. The main purpose of notification in industry is to initiate measures for protection of the workers by investigating the working conditions and to prevent such recurrences.

Specific Protection

When it is not possible or practical to control the environment in which a person works, personal protective measure become necessary which are as follows:

a. *Personal protective equipment (protective devices):*
   - Head protection—is by wearing helmet of correct size. It should not be heavy and made up of non-combustible material and nonconductor of heat and electricity.
   - Eyes protection—is by suitable protective goggles, heat treated lenses, eye-shields, visors, etc. Such equipment are needed for workers engaged in welding works, furnace work, etc.
   - Ear protection—is by using ear-plugs, ear-muffs, etc, by those who are working in intensive noise room.
   - Skin protection—is by using:
     - Protective clothes against chemicals, asbestos suit against heat, lead apron against radiation, etc.
     - Protective ointments such as barrier creams against carcinogens
     - Personal cleanliness by daily bath and frequent washing of hands with soap.
   - Leg protection—is by using safety shoes, gum boots.
   - Respiratory protection—is by using gas masks and respirators in cases of emergency and not recommended for continuous use.

   Respirators are of three types, namely:
   - Mechanical respirators, which filter the impurities of the air
     - Chemical respirators, canister masks
     - Air respirators or Horse-masks.

b. *Personal health habits:*
   - Smoking and alcoholism must always be avoided.
   - Nutrition must be adequate.
   - Food should never be taken in the work-room, but only in the place meant for it.
   - Moderate exercise like early morning walk keeps the worker healthy, active and energetic.

c. *Immunization:* The workers should protect themselves against communicable diseases such as cholera, tetanus, typhoid, hepatitis B, and also against rabies among workers in the veterinary hospitals.

Secondary Prevention

It is by early diagnosis and treatment.

- *Early diagnosis:* It is done by periodical medical examinations, including certain laboratory investigations and radiological examinations. This is a very important procedure because many occupational diseases develop slowly, over a long period of time (years). So this procedure helps to detect the disease early, specially pneumoconioses, dermatoses or cancers. The frequency of examination depends upon the type of industry.
- *Prompt treatment:* As soon as the diagnosis is made, the worker is shifted (from further exposure of the risk) to a safer job and treated promptly to prevent the development of disability.
- *Personal monitoring:* This is specially important among those who are exposed to radiation hazards, by wearing 'Dosimeter' on shirt collar, which gives an information about the cumulative dose of the radiation the worker has received.

Tertiary Prevention

It is by disability limitation and rehabilitation.

- *Disability limitation:* This consists of limiting the development of further disability which occurs usually among

the chronic patients and middle aged persons, by giving intensive treatment and aid (if necessary) to enable the worker to continue working effectively till retirement.
- *Rehabilitation:* Careful attention must be given to those workers who become physically handicapped during the course of their employment, either by accident or injury. Such persons are rehabilitated and given a suitable job, so that his/her psychological trauma is countered and becomes an useful person to himself, to the family and country.

LEGISLATION

In order to safeguard the health, safety and welfare of the industrial workers, laws have been framed in every country. The important factory laws in India are:
- Indian Factories Act, 1948
- Employees' State Insurance Act, 1948
- Workmens' Compensation Act, 1923
- Mines Act
- Tea Plantations Act
- Minimum Wages Act, 1948
- Maternity Benefit Act
- Dock Laborers' Act
- Industrial Dispute Act
- Employees' Provident Fund Act, 1952
- Family Pension and Deposit Linked Insurance Fund Act.

These Acts lay down certain standards which the employer must comply for the health, safety and welfare of the employees.

Indian Factories Act, 1948

The Original Act was passed on July 1, 1881. The IFA was revised and amended seven times, the latest being IFA 1987. The Act has 9 chapters:

Chapter I: Preliminary: Scope and definition.

Section 1: Scope: The Act extends to whole of India, except Jammu and Kashmir.

Section 2: Definitions.
- Child—an individual who has not completed 15th year.
- Adolescent—an individual who has completed 15th year but not 18th year.
- Young person—an individual who is either a child or an adolescent.
- Adult—an individual who has completed 18th year.
- Power—means an energy transmitted mechanically and is not generated by human agency.
- Factory—is an establishment employing 10 or more workers where power is used and 20 or more persons where power is not used.
- Worker—means a person employed, whether for wages or not, in any manufacturing process.

Chapter II: The inspecting staff.

Section 8: Inspectors: The State Government may appoint Chief Inspectors and Additional Inspectors of factories. Every District Magistrate shall be an Inspector for his district.

Section 9: Powers: An Inspector can enter any factory, within his local limits and make an examination of premises, machineries or records which he may consider necessary.

Section 10: Certifying Surgeons: The state government may appoint qualified medical practitioners to be certifying surgeons.

Chapter III: Health: This chapter deals with the provision of sanitary environment for the protection and promotion of health of the workers.

Section 11: Cleanliness

Section 12: Disposal of refuse

Section 13: Ventilation and Temperature

Section 14: Dust and fumes

Section 15: Artificial humidification

Section 16: Over-crowding

Section 17: Lighting

Section 18: Drinking water

Section 19: Latrines and urinals

Section 20: Spittoons.

Chapter IV: Safety: This chapter prescribes precautions to be taken for safety of the workers against accidents and injuries. These include casing (fencing) of the machinery, devices for cutting off the power, hoists and lifts, cranes and other lifting devices, protection of the eyes and precautions against dangerous fumes, explosive and inflammable material. The Act says nonemployment of persons on dangerous machines and no worker shall be required to lift or carry loads, which are likely to cause injury. The Act also advices appointment of one 'Safety officer' for a factory involving 1000 or more workers.

Chapter V: Welfare measures: These are:
- Facilities for washing, drying and storing the clothes.
- Facilities for rest and recreation.
- Canteen if there are more than 250 workers.
- Crèches, for the children of women workers, if there are more women workers.
- First aid appliances, at the rate of 1 box for every 150 workers.
- A Welfare Officer, if there are more than 500 workers.

Chapter VI: Working hours
- *Weekly hours:* Not more than 48 hours in a week. Not more than 60 hours including over-time.
- *Weekly holiday:* One day in a week, preferably on Sunday.

- *Daily hours:* Not more than 9 hours, with half an hour rest, after five hours of continuous work.
- *Women:* No women shall be allowed to work between 7 pm and 6 am.

Chapter VII: Employment of young persons
- No child, who has not completed his 14th year, shall be allowed to work in any factory.
- Adolescents (between 15 and 18 years) should be duly certified by the 'Certifying Surgeons' regarding their physical fitness for work.
- Certificate is valid only for 12 months, after which it is to be renewed.
- Adolescent employee should work only between 6 am to 7 pm.

Chapter VIII: Annual leave with wages: Act lays down that besides weekly holidays and general holidays, every worker is entitled to leave with wages, after 12 months of continuous service at the rate of 1 day for every 20 days of work and the leave can be accumulated up to 30 days.

Chapter IX: Special provisions:
- *Section 88:* Certain accidents, including death or serious injuries, should be notified by the manager to District Magistrate and Police. Enquiry is done in every fatal accident.
- *Section 89:* Act gives a schedule of notifiable diseases and occurrence of such a disease, to be notified to Chief Factory Inspector and Certifying Surgeon by the manager. IFA 1976 amendment includes byssinosis, asbestosis, occupational dermatitis and noise induced hearing loss, to the list of other notifiable diseases.

Employees' State Insurance ACT, 1948

ESI Act was passed in 1949 and amended in 1975, 1984 and 1989. This is an important measure of social security and health insurance in India. The Act provides benefits in Cash and Kind, to the industrial workers, in case of sickness, maternity and employment injury, thereby removing the economic fear and physical fear.

Scope

The ESI Act extends to whole of India. It applies to all factories (establishments) employing less than 20 members and power is being used or more than 20 members and power is not used. The amendment made in 1975, includes the following establishments also:
- Hotels and restaurants
- Cinemas and theaters
- Road transport establishments
- Newspaper establishments
- Shops.

With effect from 1.04.2004, the Act covers all employees, manual, clerical, supervisory and technicals getting ₹ 7500/- per month. The provisions of the Act can be extended to any other agricultural or commercial establishment.

ESI Act is named so because of the following reasons. It is called 'Employees' because it is meant for the employees. It is called 'State' because the State Government takes upon itself the responsibility of intervening and providing remedial measures in the event the worker meets with a crisis. It is called 'Insurance' because the workers have to pay a small percentage (varying from 1 to 2.5%) of their wages as premium, whether they get immediate benefit or not.

Administration

The administration of ESI Scheme under the Act is entrusted to an autonomous body, called 'ESI Corporation', which meets at least twice a year. The body consists of the following members:
- Chairman: The Union Minister of Labor.
- Vice-chairman: Secretary to Government of India—Ministry of Labor.
- Five representatives of Central Government.
- One representative from each State Government.
- One representative for all Union Territories.
- Five representatives of employees.
- Five representatives of employers.
- Two representatives from medical profession.
- Three members of parliament.

A 'Standing Committee' is constituted from the mem-bers of the ESI Corporation, which acts as an 'Executive body' for day to day administration. This body meets four times in a year. It has a strength of about 16, headed by Director General of Corporation, who is the Chief Executive Officer and is assisted by four principal Officers. They are:
- Insurance Commissioner
- Medical Commissioner
- Financial Commissioner
- Actuary.

Matters relating to medical benefits to the employees are decided by a body called 'Medical Benefit Council', which is headed by Director General of Health Services, who is the Chairman of the council. Thus, the council consists of:
- Director General of Health Services, as Chairman
- Deputy Director General of Health Services
- Medical Commissioner of ESI-Corporation
- One member from each state
- Three representatives of employees
- Three representatives of employers
- Few members of medical profession (one must be a woman).

ESI Corporation—makes policies
Standing Committee—executes the policies
Medical Benefit Council—is an advisory body to advise on the organization of medical relief.

For day-to-day administration, the ESI Corporation has set up 21-State-wise Regional Offices and 15 Sub-Regional Offices. Under the Regional Offices, there are several local offices to receive the claims of insured persons and to pay them cash benefits. There are Inspection Officers throughout the country to inspect factories regarding the benefits given to the workers and also the correct payment of their contributions.

Finance

The different sources of finance to run the scheme are:

- Contribution by the employees—1.75 percent of their wages
- Contribution by the employers—4.75 percent the wages of their workers
- State Government—contributes 1/8 total cost of medical care
- ESI-Corporation—contributes 7/8 of total cost of medical care
- Government of India—contributes 2/3 of administrative expenditure.

(Employees getting daily wages of below ₹ 15/- are exempted from payment of contribution).

Benefits to Employees

Following benefits are provided to the employees under the ESI Scheme. First five benefits are in cash and 6th one in kind:

- Sickness benefit
- Maternity benefit
- Disablement benefit
- Dependent benefit
- Funeral benefit
- Medical benefit
- Rehabilitation benefit.

All these benefits are provided to only those employees whose wages do not exceed ₹ 7500/- per month.

Sickness Benefit

It is a benefit given to the insured worker in cash during the period of sickness, when he/she is unable to attend to the work, provided the sickness is duly certified by the Insurance Medical Officer. The benefit consists of 50 percent of the average daily wage, for a maximum period of 91 days, in any continuous period of 365 days. This is called 'Ordinary Sickness Benefit'. This benefit covers only short-term illness.

Employees suffering from long-term illnesses, the benefit of cash is extended beyond 91 days. It is called 'Extended Sickness Benefit'. The benefit is payable up to 309 days, provided the insured person has put in two years of continuous service. This is with effect from 1.1.2000.

Thirty-four diseases are entitled under extended sickness benefit. They are grouped as follows:

A. Infectious diseases
   1. Tuberculosis
   2. Leprosy
   3. Chronic empyema
   4. AIDS

B. Neoplasms
   5. Malignant diseases

C. Endocrine, nutritional and metabolic disorders
   6. Diabetes with complications like retinopathy, nephropathy and diabetic foot.

D. Disorders of the nervous system
   7. Monoplegia
   8. Hemiplegia
   9. Paraplegia
   10. Hemiparesis
   11. Intracranial space occupying lesions (Brain tumor)
   12. Spinal cord compression
   13. Parkinson's disease
   14. Neuromuscular dystrophy
   15. Immature cataract
   16. Detachment of retina
   17. Glaucoma

E. Diseases of the cardiovascular system
   18. Coronary artery disease
   19. Congestive heart failure
   20. Cardiac valvular diseases with failure
   21. Cardiomyopathies
   22. Heart disease with surgical intervention

F. Chest diseases
   23. Bronchiectasis
   24. Interstitial lung disease
   25. Chronic obstructive pulmonary diseases (COPD) with congestive heart failure (Cor pulmonale)

G. Diseases of the digestive system
   26. Cirrhosis of liver with ascites

H. Orthopedic diseases
   27. Dislocation of the vertebra/prolapse of intervertebral disk
   28. Nonunion or delayed union of the fracture
   29. Post-traumatic surgical amputation of lower extremity
   30. Compound fracture with chronic osteomyelitis

I. Psychosis
   31. Schizophrenia, depression, dementia, depressive psychosis

J. Others
   32. More than 20 percent burns with infection/complication.
   33. Chronic renal failure.
   34. Reynaud's disease/Burger's disease.

During the period of sickness, the insured person is protected from dismissal or discharge from the service by the

employer. The benefit is available, irrespective of whether the diseases occur on account of occupational factors or not.

Maternity Benefit

It goes without saying that this cash benefit is available for only insured women workers. The duration of benefit for miscarriage, and for premature birth is 6 weeks, for sickness arising out of pregnancy is 30 days and for confinement it is 12 weeks (6 weeks before delivery and 6 weeks after delivery). The benefit is allowed at full wages.

Disablement Benefit

This cash benefit besides free medical treatment, is for those disabled workers, provided the disability has arisen from the occupation or has occurred as a result of injury in the course of employment. The disability may be temporary or permanent. In case of temporary disability, the cash benefit is 85 percent of the wages as long as the temporary disablement lasts. In case of total permanent disability, the pension is given at full rate throughout the life. In case of partial permanent disability, a portion of it is given as life pension.

Dependent's Benefit

This cash benefit goes to the dependents of the insured worker, who dies as a result of employment injury. The payment is given periodically. The children and widow get the pension, at the rate of 40 percent more than the Standard Benefit Rate. The minimum benefit to the dependents is ₹ 14/- per day with effect from 1.1.1990. The legitimate or adopted children are paid till they attain 18 years of age. The benefit is withdrawn if the daughter marries earlier. The widow gets the benefit life-long or until she gets remarried.

Funeral Benefit

This is an immediate cash benefit, not exceeding ₹ 2500/- given to the eldest surviving family member, in the event of death of the insured worker, irrespective of the cause of death, towards the expenses on the funeral ceremony.

Medical Benefit

Unlike all other benefits, this is a benefit in kind and not in cash. This consists of three types of medical care to the insured persons:

a. 'Full medical care', which includes hospitalization, free of cost, not only to the insured persons but also to the members of the family in case of sickness, employment injury and maternity.

   The nature of the medical care provided are out-patient care, in-patient care, supply of drugs, services of the specialists, pathological and radiological investigations, antenatal, natal and postnatal care, family welfare services, immunization services, emergency service, ambulance services and health-education services. In complicated cases, the patients are sent even outside the state at the expense of the ESI corporation.

b. Restricted medical care—or limited medical care. This consists of only out-patient care.

c. Expanded medical care—this consists of full medical care short of hospitalization.

The medical care is provided either directly or indirectly.

Direct pattern: This is provided through the agency of ESI hospitals and dispensaries, where the medical and paramedical persons are working full time, appointed directly by the ESI corporation. They are established in those areas, where the number of family units are more than 1000.

In areas, where the number of family units are less than 750, part-time ESI dispensaries are established. If the residential concentration of employees is scattered over a long distance, mobile dispensaries are established.

Indirect pattern: This is also called as 'Panel system' of medical care because the care is provided indirectly through a panel of private medical practitioners, appointed as 'Insurance Medical Practitioners', at the rate of 1 per 750 family units, in those areas where the families of workers are scattered in place. They are paid a fixed honorarium of ₹ 17.50 per family unit, whether the family unit requires the services or not. The remuneration is paid quarterly.

Miscellaneous Medical Benefits

- Free supply of artificial limbs, spectacles, hearing-aids, hand driven cycles, walking callipers, surgical boots, dentures, spinal braces and the like to those workers, who are disabled due to employment injury
- Preventive inoculations
- Free contraceptives and cash incentives for undergoing sterilization
- Training in *yoga* exercises.

Cost of Medical Benefit

This has been increasing steadily. The per capita cost of medical benefit was ₹ 23.79 during 1961-62, ₹ 67.53 during 1973-74, and ₹ 905 during 2001-02.

Rehabilitation Benefit

On monthly payment of ₹ 10, the insured persons and his family members continue to get medical treatment after permanent disablement or retirement.

ESI Scheme by March 31, 2003, had covered 78 lakhs employees including 14 lakhs women. The total number of beneficiaries were around 253 lakhs. The total number of beds available are nearly 27000. There are about 700 ESI hospitals, 350 specialist centers and about 1500 hospitals functioning in the country. The Doctor: Population ratio under the scheme is 1:585 as against the national average of 1:2148.

Benefits to Employers

- Exemption from the applicability of Workmen's Compensation Act, 1923.
- Exemption from Maternity Benefit Act, 1961.
- Exemption from payment of medical allowance to employees and their dependants or arranging for their medical care.
- Rebate under the Income Tax Act on contribution deposited in the ESI Account.
- Healthy work-force.

As on 31.03.2003, about 2.54 lakh employers were covered under the scheme.

Workmen's Compensation Act, 1923

This Act deals with the compensation to be given by the employer, to the worker when he/she dies or gets disabled as a result of the occupational injury or disease. This is applicable to only those areas where ESI Scheme is not working. The decision of the amount of compensation is given by the labor courts. It is not functioning well because of the illiteracy and ignorance of the labor population and indifference on the part of the employers.

SOCIAL SECURITY

It is the security or the guarantee that the society (State) furnishes through appropriate organizations to its members during the time of crises (risks) such as loss of working or earning capacity, due to sickness, invalidity, maternity, old-age and death.

Social security is essential because, those who are not secured in this way, may cause social harm for fulfilling their own needs. If the number of insecured individuals goes on increasing not only the social pathology increases but also the entire community development lags behind. Thus, social security is the basis of social welfare.

The first social security Act was enacted in Germany in the year 1881 for the industrial workers. Today, Sweden is the only country where the entire population is under social security schemes.

Social security includes social insurance and social assistance.

Social Insurance

This provides income security (Cash-benefits).

Social Security for Industrial Workers

The different legislations providing social security/insurance for industrial workers in India, are ESI Act, 1948, Workmen's Compensation Act, 1923, Central Maternity Benefit Act, 1961 and Family Pension Scheme 1971.

Social Security for Civil Servants

The employees of the Central and State Government have pension, gratuity, provident fund and family pension schemes.

The Central Government Health Scheme in Delhi provides Comprehensive medical care to all categories of Central Government employees. This scheme has been extended to other cities also.

Social Security for General Public

The risks of death, accident and fire are covered by Insurance Schemes, for example: Life Insurance Corporation of India, Public Provident Fund Scheme, etc.

Social Assistance

This is not insurance. Therefore, there is no contribution system. It entitles persons like unemployed, disabled, old, widows, orphans, handicapped, etc. The fund is from the general revenues. There is hardly any legislation in India today.

The main features of a comprehensive plan for social security are the following:

- Coverage of the whole population
- Coverage of all principal contingencies
- Adequate medical and allied services
- Benefits—adequate to replace lost earnings
- Contributions—specifically by the employer, employee and State Government
- Administration by tripartite organization.

Difference between Social Insurance and Social Assistance (Table 17.8)

The relation among social insurance, social assistance and social defence is shown in **Figure 17.2**.

Table 17.8 Difference between social insurance and social assistance

Social insurance	Social assistance
There is contribution not only by the employees but also employers and the organization	There is no contribution system.
Members receive the benefit of cash not by sympathy but by a matter of right	The members receive the benefit of cash or kind by sympathy or charity.
Members do not develop inferiority complex	Members develop inferiority complex.
Members are actively involved in economic planning for their future	Members are not actively involved in their economic planning.
It is suitable to the workers, who can contribute	It is suitable to the workers, who cannot contribute.
Members may not become permanently dependent on the scheme	Members may become permanently dependent on the scheme.
There are many legislations	There is hardly any legislation.
Beneficiaries (members) are industrial workers, employees of the State and Central Government, other publics, who can contribute money	Beneficiaries (members) are unemployed, widows, orphans, handicapped, old age people, etc. who cannot contribute money.
Examples: ESI Scheme, Public Provident Fund Scheme, LIC of India, Group Insurance Scheme, Medicare	Ex: Unemployment allowance, Sanjay Gandhi Niradhar Yojna, Savithri Bai Phule Dattak Palak Yojna, Workmen's Compensation Act, 1923.

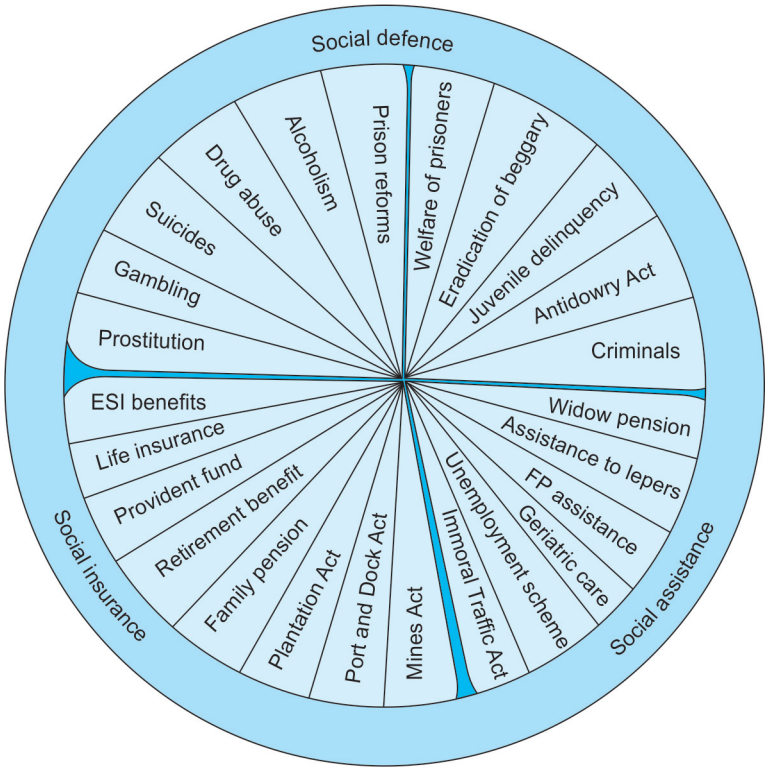


Fig. 17.2 Showing relation between social insurance, social assistance and social defence

BIBLIOGRAPHY

1. Donald Hunter. The Diseases of Occupation, 1962.
2. ICMR Bulletin. Silicosis, New Delhi Vol 29 (9), 1999.
3. ICMR. A Review of Occupational Health Research in India, New Delhi, 1955.
4. International Labour Office. Occupational Health and Safety. Encyclopedia. Geneva Vol I and II, 1972.
5. Johnson Se, Miller RT. Occupational Diseases and Industrial Medicine. WB Saunders and Co, London, 1960.
6. Lanza AJ. Pneumoconiosis, 1963.
7. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.
8. WHO Chronicle No. 30, 318, 1976.
9. WHO Chronicle No. 7, 279, 1960.
10. WHO Health Hazards of Human Environment, Geneva, 1962.
11. WHO Tech Rep Ser No. 246, 1962.
12. WHO Tech Rep Ser No. 571, 1975.

SECTION 5

Epidemiology

- Principles and Practice of Epidemiology
- Epidemiology of Infectious Diseases
- Epidemiology of Communicable Diseases
- Epidemiology of Noncommunicable Diseases

CHAPTER 18

Principles and Practice of Epidemiology

EPIDEMIOLOGY

Epi- among, upon; Demos = people, population; Logos = science, study

Definition

Epidemiology has been defined as, 'The study of distribution and determinants of health related states or events in specified populations and application of this study to the control of health problems' (John M Last, 1988).

The meaning of 'Key' words need to be explained.

Events

The health related events are all the conditions of the spectrum of health such as disease, injury, disability and death.

These events are with reference to the human population (epidemiology is also studied among animals).

Distribution

This refers to the pattern of occurrence of disease in the community with reference to time, place and person. This part of the study is known as, 'Descriptive epidemiology'. This helps to study the trend of the disease over the years (decades), geographical areas and over different population groups. This study also helps to know the magnitude of the problem, gives a clue about the etiology, mode of transmission of the disease and also helps to formulate etiological hypothesis.

Determinants

This refers to the etiological or risk factors related to particular disease. This study helps to test the etiological hypothesis formulated by descriptive study. This aspect of epidemiology dealing with testing the hypothesis is known as 'Analytical epidemiology.'

Another important related term is disease frequency.

Disease Frequency

This means measuring the magnitude or extent of the health related event or health problem in the community, in terms of morbidity rates such as incidence and prevalence and also in mortality rates. These are expressed in terms of rate, ratio and proportion. This helps to compare with that of other countries or other groups of population in the same country (Morbidity means sickness and Mortality means deaths).

OBJECTIVES OF EPIDEMIOLOGY

- To know the distribution of the disease in the community
- To know the magnitude of the problem
- To identify the etiological and risk factors in the development of disease

- To plan for the implementation of prevention and control measures
- To eliminate or eradicate the disease
- To evaluate the control measures
- Ultimate objective is to promote the health and well-being of the people.

EPIDEMIOLOGICAL APPROACH

It is an approach to achieve the above objectives by collecting the data by asking the following questions and analyzing the data systematically:

- What is the event? (Nature of the disease)
- When did the disease occur? (Time distribution of the disease)
- Where did the disease occur? (Place distribution of the disease)
- Who are the persons affected? (Person distribution of the disease)
- What is the extent of the problem? (Magnitude)
- Why did it occur? (Etiology)
- What is to be done to reduce the problem? (Control measures)
- How can it be prevented in future? (Preventive measures)

SCOPE OF EPIDEMIOLOGY

The scopes of epidemiology are shown in **Flow chart 18.1**.

Measurements in Epidemiology

The magnitude of the health problem in the community is measured in terms of diseases (morbidity) and deaths (mortality). It is expressed in terms of rates, ratios and proportions, which are called 'Basic tools' in epidemiology.

Rate

It measures the occurrence of an event (disease or death) in a given population, during a given period of time, usually one year, e.g. death rate, birth rate, growth rate, accident rate, etc. Usually it is expressed per 1000 mid year population (MYP). Death rate is the rate at which the people are dying in a given area, during a given period of time, per 1000 MYP.

$$\text{Death Rate} = \frac{\text{No. of deaths in a given area, in one year}}{\text{Mid-year population}} \times 1000$$

MYP = Population as on 1st of July

In case of accident rate, a better denominator would be number of accidents per 1000 vehicles or per million vehicle miles.

Another example, out of 500 juveniles in a juvenile home, 200 are found to be delinquents.

$$\text{Delinquent rate} = \frac{200}{500} \times 1000 = 400 \text{ per } 1000 = 40\%$$

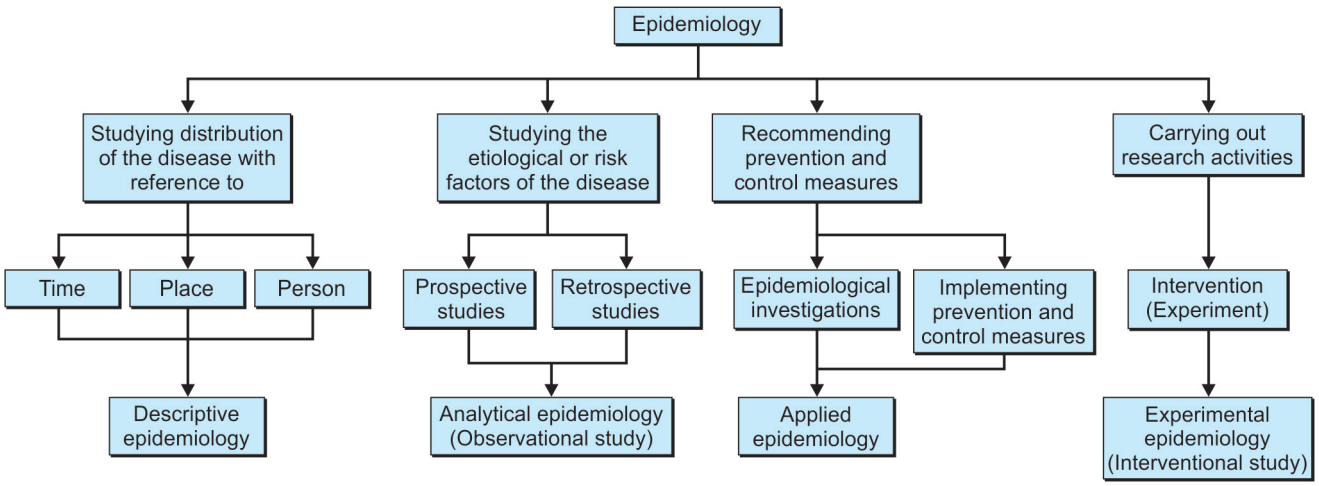
Ratio

This expresses a relation between the two quantities. The numerator is not a component of the denominator. It is expressed as x/y or x : y.

In the above example, the juvenile delinquency ratio is 200: 300, i.e. 2 : 3.

Similarly, Doctor: Population ratio, Sex ratio, (Female: Males), etc.

Flow chart 18.1 The various scopes of epidemiology



Proportion

This also expresses relation between two quantities, but here the numerator is always included in the denominator. It is expressed as percentage. In the above example:
The proportion of juvenile delinquents.

$$= \frac{\text{No. of delinquents}}{\text{Total no. of juveniles}} \times 100$$

$$= \frac{200}{500} \times 100 = 40\%$$

MEASUREMENT OF MORBIDITY

This means determining the quantum of disease in the community (i.e. disease load).

When the survey is carried out over a period of time (minimum one year) it is called longitudinal survey or incidence survey, which helps to find out the occurrence of NEW cases, of a specified disease. When the survey is carried out at a given point of time or a particular period, it is called cross sectional or horizontal or prevalence survey, which helps to find out the existence of both OLD and NEW cases in total, of a specified disease. Thus, morbidity is measured and expressed in two ways—incidence and prevalence rates.

(Incidence is obtained from longitudinal studies and prevalence from cross-sectional studies).

Incidence

It is the occurrence of only NEW (fresh) cases of a specified disease in a given area, during a given period of time (minimum one year). It is expressed for 1000 population at risk.

$$\text{Incidence rate} = \frac{\text{No. of new cases of a specified disease in a given area during a given period of time}}{\text{Population at risk during that period}} \times 1{,}000$$

For example, if 200 new cases of tuberculosis occur in a population of 1,00,000 in a year, the incidence rate would be:

$$\text{IR} = \frac{200}{1{,}00{,}000} \times 1{,}000 = 2 \text{ per } 1{,}000 \text{ or } 2 \text{ per millie}$$

Since a person can suffer from the same disease for more than once during the same period, e.g. suffering from diarrhea 2 times in a year, he would contribute to two spells of sickness.

$$\text{Incidence rate} = \frac{\text{No. of spells of sickness occurring in a defined period}}{\text{Population at risk}} \times 1{,}000$$

Incidence study refers to new cases and acute conditions. It is not influenced by the duration of the disease.

Related Terms

Attack rate, secondary attack rate, hospital admission rate.

Attack Rate

This is the rate at which the disease is spreading and attacking the people in the community (i.e. extent of the epidemic). This incidence is expressed in percentage and not per 1000. This indicator is employed, with reference to acute diseases specially when there is an epidemic. (It is the percentage of the population at risk, getting the disease).

$$\text{Attack rate (AR)} = \frac{\text{No. of new cases occurring during given period}}{\text{Total population at risk during the same period}} \times 100$$

Secondary Attack Rate

Secondary attack rate (SAR) is the percentage of exposed persons, developing the disease following exposure to a primary case, within the range of incubation period.

$$\text{SAR} = \frac{\text{No. of exposed persons developing the disease}}{\text{Total no. of exposed/susceptible persons}} \times 100$$

The primary case is excluded from both the numerator and the denominator.

For example, if in a family of 6 persons consisting of 2 parents (already immune) and 4 children, susceptible to chickenpox, one child develops chickenpox and after sometime 2 children develop among three.

$$\text{The SAR} = \frac{2}{3} \times 100 = 66\%$$

Hospital Admission Rate

It is the percentage of the population being admitted to the hospital during a given period of time (e.g. Admission for poisoning). Here, the incidence rate is derived from the number of events and not the number of persons.

The incidence rates are the usual method whereby disease frequency in different populations is compared. Before making such comparisons the rates are usually standardized, to allow for the differing age/sex structure of populations. Unstandardized rates are referred to as CRUDE rates.

Prevalence

It refers to the existence of all cases (both old and new) of a specified disease at a given point (point prevalence) or a given period of time (period prevalence), in a given population. The point of time may be hour, day or week. The period of time may be months or years. Period prevalence is the sum of point prevalence, at the beginning of the specified period and the incidence during that period **(Fig. 18.1)**.

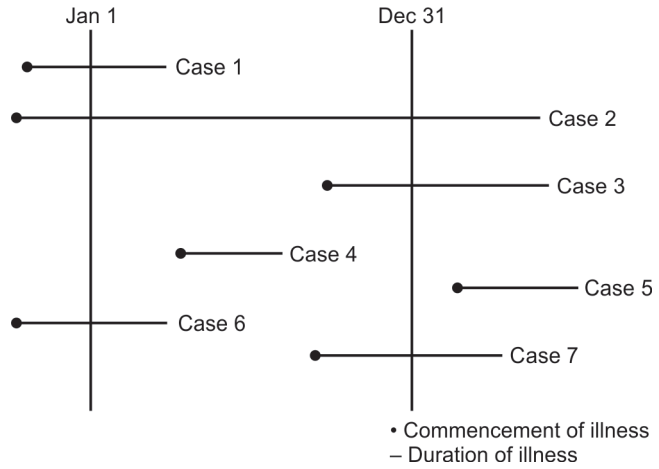
Prevalence is expressed as the proportion of or percentage of the population affected by a specified disease.

$$\text{Prevalence rate} = \frac{\text{No. of all current cases (Old + New)}}{\text{Total population}} \times 100$$

When the term 'Prevalence rate' is used, without any further qualification, it is taken to mean 'Point prevalence.'

$$\text{Point prevalence} = \frac{\text{No. of all current (Old + New) of a specified disease, existing at given point of time}}{\text{Total population}} \times 100$$

For example, four percent prevalence rate of tuberculosis indicates, that at any given point of time, four percent of the people in the community are known to be suffering from tuberculosis.



Incidence of the disease during the year
= cases 3, 4 and 7.
Point prevalence on January 1
= cases 1, 2 and 6.
Point prevalence on December 31
= cases 2, 3 and 7.
Period prevalence during the year (Jan-Dec)
= cases 1, 2, 3, 4, 6 and 7.

Fig. 18.1 Terms incidence and prevalence

$$\text{Period prevalence} = \frac{\text{No. of all current cases (Old + New) of a specified disease, existing at a given period of time}}{\text{Estimated mid year population at risk}} \times 100$$

Prevalence gives total case load and is useful for planning of community services related to the disease.

Prevalence of a disease is mainly influenced by incidence (I) and mean duration (D) of that illness. The relationship can be expressed by the formula as:

$$P = I \times D$$

The equation also shows that longer the duration of the disease (e.g. tuberculosis) greater the prevalence and shorter the duration of the disease (as in measles, rabies) lower the prevalence. Thus, prevalence is not only influenced by the duration of illness but also by the number of new cases (incidence) occurring.

Differences between Incidence and Prevalence (Table 18.1)

Table 18.1 Differences between incidence and prevalence

Incidence	Prevalence
Refers to occurrence of new cases only in a given area, during a given year.	Refers to existence of both old and new cases in a given area, during a given period/point of time.
Incidence rate is expressed per 1,000 population at risk	Prevalence rate is expressed per 100 population at risk
Estimated from longitudinal studies.	Estimated from cross-sectional studies.
Estimation requires exact knowledge of time of onset of disease.	Such knowledge is not required.
Refers to acute cases having short incubation period.	Refers to chronic cases having long incubation period
Ex: Rabies, measles, Act GE, etc.	Ex: Tuberculosis, leprosy, etc.
Not influenced by duration of illness.	Influenced by not only duration of illness but also by incidence of illness. $P = I \times D$
Related terms are attack rate and secondary attack rate.	Related terms are point prevalence and period prevalence
Incidence rate is an ideal measure to study the etiology of a disease	Prevalence is not an ideal measure to study the etiology of a disease
Incidence rate is more useful in formulation and testing the etiological hypothesis	Prevalence rate is useful to know the magnitude of the problem
Incidence rate helps to evaluate the control measures	Prevalence rate helps for health planning.

Prevalence Rate

Increased by	Decreased by
• Longer duration of the disease	• Shorter duration of the disease
• Prolongation of life of the patients without care.	• Improved cure rate of the disease.
• Increase in number of new cases (i.e. increased incidence)	• Decrease in number of new cases (i.e. decreased incidence)
• Immigration of new cases	• Emigration of new cases.
• Emigration of healthy people.	• Immigration of healthy people.
• Immigration of susceptible people.	• Emigration of susceptible people.
• Better reporting of cases.	• Under reporting of cases.

MEASUREMENT OF MORTALITY

The commonly used indicators are:
a. Crude death rate
b. Specific death rate
c. Case fatality rate
d. Proportional mortality rate
e. Survival rate
f. Standardized death rate.

Crude Death Rate

Definition

Crude death rate (CDR) is the number of deaths from all causes, per 1,000 estimated mid year population in one year, in a given place.

Formula

$$\text{CDR} = \frac{\text{No. of deaths from all causes during a given year}}{\text{Mid-year population}} \times 1{,}000$$

Higher the death rate, it means poorer is the health status of the population. Thus, it is an indirect way of assessing the health status of a country. It is called 'Crude' because it does not specify the age group of deaths, or sex groups of deaths nor the cause of deaths. If these are specified in the death rate, then it is called 'specific death rate.'

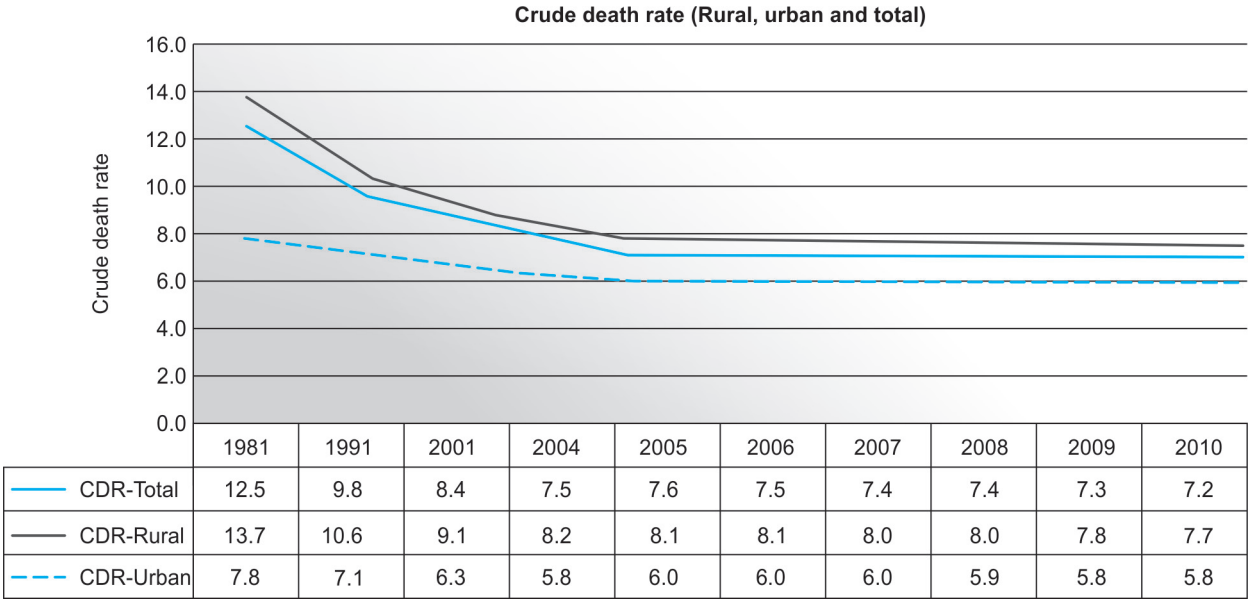
In India, CDR is now 7.4/1000 MYP (2011). It has been declining since 1981 as shown in **Fig. 18.2**.

Specific Death Rate

This is the death rate in which the cause or the group is specified. Accordingly, there are cause specific death rate, group specific death rate, period specific death rate.

Cause Specific Death Rate

Cause specific death rate, i.e. deaths from diabetes, tuberculosis, cancer, etc.



	1981	1991	2001	2004	2005	2006	2007	2008	2009	2010
CDR-Total	12.5	9.8	8.4	7.5	7.6	7.5	7.4	7.4	7.3	7.2
CDR-Rural	13.7	10.6	9.1	8.2	8.1	8.1	8.0	8.0	7.8	7.7
CDR-Urban	7.8	7.1	6.3	5.8	6.0	6.0	6.0	5.9	5.8	5.8

Fig. 18.2 Declining death rate (*Source:* GOI MOHFW. Family Welfare Statistics in India. 2011.)

$$\text{Specific death rate due to particular disease (diabetes)} = \frac{\text{No. of deaths due to diabetes during a year}}{\text{Mid-year population}} \times 1{,}000$$

Group Specific Death Rate

It is the death rate in a specified group. The groups could be of different age, sex, race, occupation, social class, etc.

$$\text{Age specific death rate} = \frac{\text{No. of deaths in a particular age group}}{\text{Mid-year population (MYP) of that age group}} \times 1{,}000$$

Age specific death rate is very high among infants and very old people. It is lowest in the age group of 10 to 19 years. Infant mortality is exceptional age group specific death rate, because it is not estimated per 1,000 mid year population of infants but estimated per 1,000 live births.

$$\text{Infant mortality rate (IMR)} = \frac{\text{No. of deaths occurring among children below 1 year of age}}{\text{Total number of live-births during the year}} \times 1{,}000$$

In India, IMR is 47.57/1000 livebirths (2010). Like IMR, under 5 mortality rate is also estimated per 1000 livebirths. However 1 to 4 years child mortality rate is estimated per 1000 population of 1 to 4 years of age group.

Sex Specific Death Rate

This can be estimated for males and females separately.

$$\text{Specific death rate for females} = \frac{\text{No. of deaths among women during a year}}{\text{Mid year population of females}} \times 1{,}000$$

Maternal mortality rate (MMR) is an example of age-sex, specific death rate. It consists of deaths only among women of reproductive age (15-49 years), who can become pregnant. Since MYP of women of this age group is unknown, the denominator used is the total number of livebirths in the year. Thus, MMR is estimated per 1,000 livebirths.

Period Specific Death Rate

Period specific death rate, i.e. specific death rate occurring during a particular month or week.

$$\text{Period specific death rate for March} = \frac{\text{No. of deaths in March}}{\text{Mid-year population}} \times 1{,}000$$

Since the crude death rates are calculated for one year period, it has to be devided by 12 to calculate monthly mortality rate and to be devided by 52 to calculate weekly mortality rate. In order to make it comparable with annual death rate, it has to be multiplied by 12 and 52 respectively.

Thus, the specific death rate helps to find out 'At-risk' group to adopt preventive and control measures.

Case Fatality Rate

Case fatality rate (CFR) is the percentage of particular cases dying.

$$\text{CFR} = \frac{\text{No. of deaths due to particular disease (Measles)}}{\text{Total no. of cases of that particular disease (Measles)}} \times 100$$

CFR represents the killing power of a disease. It is typically used in acute infectious diseases like measles, rabies, food poisoning, etc. because it is closely related to virulence of the organisms. Rabies has 100 percent CFR.

Proportional Mortality Rate

Proportional mortality rate (PMR) is the proportion or percentage of deaths due to particular cause out of all the total deaths. It measures the disease burden in the community.

$$\text{PMR} = \frac{\text{No. of deaths due to particular cause (MI)}}{\text{Total no. of deaths from all causes}} \times 100$$

PMR draws attention to focus reduction measures. Ex: 40 percent IMR in India is due to prematurity.

Similarly, the age proportional mortality rates are:

$$\text{Under 5, proportional mortality rate} = \frac{\text{No. of deaths below 5 years age group in the given year}}{\text{Total no. of deaths during the same year}} \times 100$$

$$\text{Proportional mortality rate for aged 50 years and above} = \frac{\text{No. of deaths of persons aged 50 and above}}{\text{Total no. of deaths in all the age groups during that year}} \times 100$$

PMR is employed when population data is not available. Higher the Under-5 PMR, poorer is the health status and higher the PMR for aged 50 years and above, better is the health status of that country.

Survival Rate

Survival rate is the percentage of the treated patients remaining alive at the end of 5 years of observation. It is the yardstick for

Differences between Case Fatality Rate and Crude Death Rate (Table 18.2)

Table 18.2 Differences between CFR and CDR

Case fatality rate (CFR)	Crude death rate (CDR)
It is the percentage of the cases dying.	It is the number of deaths per 1000 mid year population, in a given area, during a given period.
Period during which cases are dying is not taken into consideration.	Period considered is usually one year.
Numerator is the number of deaths due to specific illness.	Numerator is the number of deaths due to all causes.
Denominator is the total number of the cases of specific illness.	Denominator is the total mid year population, including both sick and healthy persons.
$\text{CFR} = \frac{\text{No. of deaths due to specific disease}}{\text{Total no. of cases of that specific disease}} \times 100$	$\text{CDR} = \frac{\text{No. of deaths from all causes during of given year}}{\text{MYP of the area}} \times 1{,}000$
It depends upon factors like age, sex, treatment taken etc.	It does not depend upon such factors.
It reflects the killing power of the disease.	It reflects the health status of that area.
This can be compared with that of other diseases.	This cannot be compared with other diseases.

assessing the standards of therapy. The survival period starts from the date of treatment. This is helpful in cancer studies.

$$\text{Survival rate} = \frac{\text{Total no. of patients alive at the end of 5 years of observation}}{\text{Total no. of deaths in all the age groups during that year}} \times 100$$

Standardized Death Rate (Adjusted Death Rate)

Suppose the death rate of two countries have to be compared, crude death rate is not the right indicator because different countries have different age composition with different mortality rates. For example, a developing country has more of younger population with a higher mortality rate than a developed country with lesser younger population with lower mortality rate. The rates are comparable only if the age group of the population is comparable.

Therefore, the age is standardized (or corrected) so that the confounding effect of age is removed in the entire population thereby the death rate can be compared directly. Thus, standardization or adjustment can be made not only for age but also for sex, race, etc. The death rates corrected for age-sex distribution of population is called 'Standardized death rate'.

There are two methods of standardization—direct and indirect methods. If age specific death rates of places are available, direct method can be used; otherwise indirect method. Both the methods begin by choosing a 'Standard population' and not the age structures of the population. A standard population is defined as one for which the numbers in each age and sex group are known. It is usual to use the national population as the standard. Usually, one lakh or even one million population is taken as the standard for standardization.

Direct Standardization

This can be applied only if the number of the deaths of various age/sex groups of the population of a place is known. With that data, the expected deaths can be estimated in the respective age groups of the standard population. From the total number of expected deaths of the standard population, the standardized death rate can be estimated per 1000 population by dividing by one lakh (or one million) depending upon the standard population.

Steps of direct standardization (Table 18.3)

- Data of the mid year population of the different age groups of the study area (population) is collected.
- Number of deaths occurring in the respective age group is also collected.
- Standard population of the country is chosen.
- Age specific death rate of the study population, whose crude death rate is to be standardized, is calculated.
- 'Expected' number of deaths in the standard population of each age group is estimated.
- Total number of expected deaths is calculated by adding all expected deaths.
- Standardized age adjusted death rate is calculated by dividing the total expected deaths by the total standard population and estimated per 1000 population.

Indirect Standardization

This method is applied when the number of deaths of various age/sex groups is unknown or not available in the study population. Under such circumstances, the age specific death

Table 18.3 Calculation of standardized death rate for city X (Direct method)

Age group in years	Mid year population of city X (study population)	No. of deaths in study population	Age specific death rate of study population	Standard population (National 1985)	Expected death in standard population
<1	5,000	130	$\frac{130 \times 1,000}{5,000}$		$\frac{130 \times 2,500}{5,000}$
			= 26	2,500	= 65
1–4	7,000	70	10	9,500	95
5–14	5,000	30	06	18,000	108
15–19	6,000	36	06	10,000	60
20–24	8,000	64	08	9,000	72
25–34	7,000	42	06	14,500	87
35–44	10,000	80	08	12,500	12.5
45–54	8,000	96	12	11,500	92.0
55–64	9,000	126	14	6,500	108.0
>65	6,000	108	09	6,000	
Total	**71,000**	**782**		**1,00,000**	**699.5**

Table 18.4 Calculation of standardized death rate (Indirect method)

Age group in years	Mid year population of city X (study population)	No. of deaths during the year	Standard population (1985)	Specific death rate in standard population	Estimated number of deaths in study population
<1	5,000	130	2,500	$\frac{130 \times 1,000}{2,500} = 52.0$	$\frac{52 \times 5,000}{1,000} = 260.0$
1–4	7,000	70	9,500	07.4	51.8
5–14	5,000	30	18,000	01.7	08.5
15–19	6,000	36	10,000	03.6	21.6
20–24	8,000	64	9,000	07.1	56.8
25–34	7,000	42	14,500	02.9	20.3
35–44	10,000	80	12,500	06.4	64.0
45–54	8,000	96	11,500	08.3	66.4
55–64	9,000	126	6,500	19.4	174.6
>65	6,000	108	6,000	18.0	108.0
Total	**71,000**	**782**	**1,00,000**	**–**	**832.0**

rate of the national standard population is obtained from the census records and the number of deaths in the study population of that area is obtained, by multiplying the MYP of the study area and the age specific death rate of the standard population. Then the index death rate of study population (area) and the standardizing factor (i.e. correction factor) are employed to calculate standardized death rate of the study population, as shown in the **Table 18.4**.

Direct method

$$\text{Crude death rate} = \frac{\text{Total no. of deaths}}{\text{MYP}} = \frac{782}{71,000} \times 1,000 = 11$$

Standardized death rate

$$= \frac{\text{Total no. of expected deaths}}{\text{Standard population}} \times 1,000 = \frac{790 \times 1,000}{1,00,000} = 7.9$$

Indirect method

Crude death rate of study population:

$$= \frac{\text{Total no. of deaths}}{\text{MYP of the area}} \times 1{,}000 = \frac{782 \times 1{,}000}{71{,}000} = 11.01$$

Crude death rate of standard population:

$$= \frac{\text{Total no. of estimated deaths in study population}}{\text{Standard population}} \times 1{,}000$$

$$= \frac{832 \times 1{,}000}{1{,}00{,}000} = 8.32$$

Index death rate for study population:

$$= \frac{\text{Total no. of estimated deaths in study population}}{\text{MYP of study area}} \times 1{,}000$$

$$= \frac{832 \times 1{,}000}{71{,}000} = 11.7$$

Standardizing factor (SF or CF):

$$= \frac{\text{Crude death rate of standard population}}{\text{Index death rate of study population}}$$

$$= \frac{8.32}{11.70} = 0.71$$

Standardized death rate:

= Observed crude death rate of study population × SF

= 11.01 × 0.71 = 7.82

If the standardizing factor is greater than one, it means that the age-sex distribution of the area is favorable to low mortality rates and vice versa.

EPIDEMIOLOGICAL STUDIES (METHODS)

There are two types—observational and experimental.

Observational Studies

Here, the studies are based on the field observations made on the experiments carried out by nature. They are of two types—namely descriptive and analytical studies.

Descriptive Studies (Descriptive Epidemiology)

These are concerned with observation of the distribution of a disease in a community, with reference to time, place and person, and identifying the associated characteristics of the disease to formulate an etiological hypothesis.

Procedures

- Defining the population of the community
- Defining the disease under study
- Describing the distribution disease with reference to time, place and person
- Measurement of disease
- Making comparison with known indices
- Formulation of etiological hypothesis.

Defining the population under study: This means specifying the type of population under study, i.e. whether the entire population of the area, or a representative sample or a particular group of population like children, all hostelites, industrial workers, pregnant mothers, etc. The population must also be defined in terms of area (place) and time.

For example, if we want to study the problem of measles in a primary health center area, during a given year, the population under study is all under fives, the area is the entire jurisdiction of PHC and the time is the particular year.

Thus, the study population (defined population) becomes the population at risk, i.e. it becomes the denominator and helps in calculating the rates, i.e. in measuring the disease frequency.

Defining the disease under study: That means the disease which is taken up for study has to be defined in such a way that the epidemiologist should not only be able to identify those with disease from those without the disease, but also be able to measure it with accuracy. This is called 'Operational definition.'

For example, leprosy is defined as a case with hypo-pigmented patch/patches with partial or total loss of sensation, with thickening of nerves and demonstration of acid-fast bacilli in the skin smear examination. Thus, the definition of the disease must be precise and valid. If not, it becomes the source of error.

Describing the distribution of the disease with reference to time, place and person.

TIME DISTRIBUTION

This means describing the time of occurrence/onset of the disease with reference to year, month, week, day, hour of onset, season, atmospheric temperature, climate etc. This study often gives a clue about the etiology of the disease or the predisposing factors, so that preventive measures can be adopted.

There are three kinds of time trends or fluctuations:

1. Short-term fluctuations.
2. Periodic fluctuations.
3. Long-term fluctuations.

Short-term Fluctuations

This means sudden occurrence of a disease in a given area, and lasting for a short period, e.g. an epidemic disease.
There are three types of epidemics:

- Common source epidemics
- Propagated epidemics
- Slow (Modern) epidemics.

Common source epidemics: This is an epidemic occurring from a common source, either by single exposure or by repeated exposure. Accordingly, there are two subtypes.

Common source single exposure epidemic (Point source epidemic): This means all the cases develop almost simultaneously following single exposure. For example, food poisoning, Bhopal gas tragedy, fire accident in an industry.

When this data is represented in the form of a curve in a graph, it is called 'Epidemic curve.'

Salient features of point source epidemic curve are **(Fig. 18.3)**:

- There is sudden rise and sudden fall
- There are no secondary curves
- Large number of cases occur with a narrow interval of time
- All cases have the same incubation period
- Exposure is almost simultaneous and brief.

Common Source Repeated/ Continuous Exposure Epidemic

In this type, epidemic disease occurs from a common source, but the exposure occurs continuously or intermittently or repeatedly and not necessarily simultaneously. Therefore, the epidemic is not explosive. For example, A professional sex worker as a source of gonorrhea, infecting all her clients over a period of time. Similarly, a well with contaminated water can result in a similar outbreak of cholera. There is sudden rise and gradual fall of the curve **(Fig. 18.4)**.

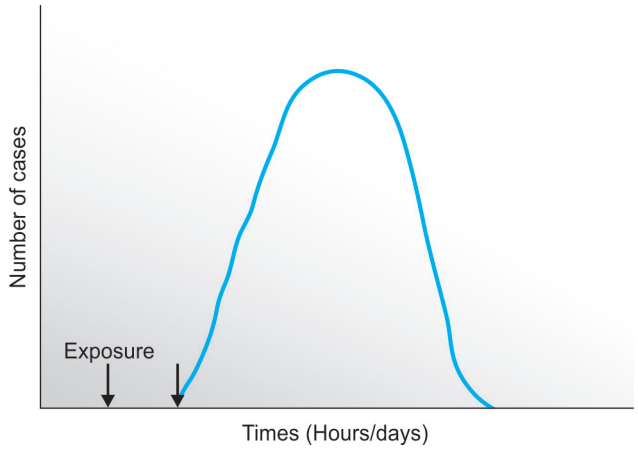


Fig. 18.3 Epidemic curve (Point source)

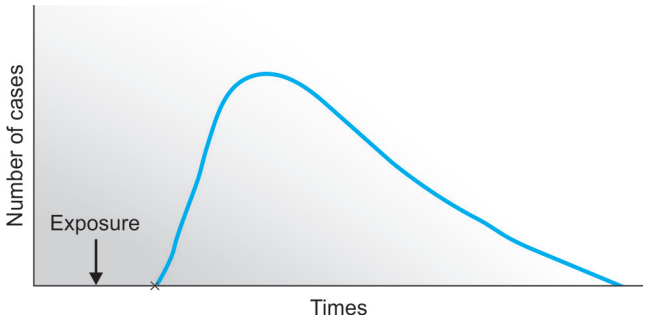


Fig. 18.4 Common source, repeated exposure

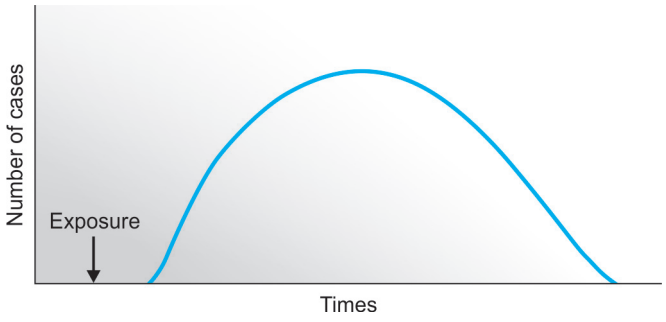


Fig. 18.5 Propagated epidemic

Propagated Epidemic

In this type, the epidemic does not originate from a common source like food or water, but spreads from person to person, until all the susceptibles are affected.

Thus, there is gradual rise and gradual fall of the curve **(Fig. 18.5)**. Example: Epidemic of meningitis, measles, etc.

Modern or Slow Epidemics

This is with reference to noncommunicable diseases, e.g. cancer, hypertension, diabetes, etc. These diseases have been increasing in number compared to the previous century, because of changes in the life-style and quality of life.

Periodic Fluctuations

This means occurrence of a disease in a community during a definite period, either in a particular season or periodically in a cyclic form. Accordingly, there are two types: Seasonal trend and cyclic trend.

Seasonal Trend

Some diseases occur in a definite season.

- Measles and chickenpox in the early spring season
- Upper respiratory infection in the winter season
- Diarrheal diseases during summer months.

The seasonal trend of the disease is because of the favorable environmental factors such as humidity, rainfall, atmospheric temperature, over crowding, etc.

Cyclic Trend

This means tendency of a disease to occur cyclically once in several days, weeks, months or years. Examples: Epidemic of measles once in 2 to 3 years, rubella once in 6 to 9 years, influenza once in 7 to 10 years. Accidents more on weekends.

Thus, the knowledge on periodic fluctuations helps to protect the community.

Long-term Fluctuations (Secular Trend)

This means changes in the occurrence of the disease over a long period of time, several years or decades. For example, coronary heart disease, diabetes, lung cancer have shown an upward trend in the developed countries during the last 50 years, followed by a downward trend of diseases like leprosy, tuberculosis, typhoid, amoebiasis, etc.

Thus, studying the time distribution of a disease helps the epidemiologist not only to formulate an etiological hypothesis but also to implement prevention and control measures.

PLACE DISTRIBUTION

This means the pattern of occurrence of a disease in different places. This helps to compare the disease occurrence from one country to another country, and within the same country from one state to another state, from rural to urban areas and local areas.

International Variations

For example, cancer of stomach is common in Japan, unusual in US.

- Ca cervix common in India, less in UK, US, etc.
- Breast cancer low in Japan, high in Western Countries, etc.

This helps the epidemiologist to identify the causative factors and thereby prevention. Other examples are yellow fever in South America, sleeping sickness in Africa.

National Variations

For example, goiter is more in subhimalayan region, lathyrism in Madhya Predesh, leprosy in Tamil Nadu and Andhra Pradesh, filariasis in coastal areas, etc. Thus, diseases show variations in the same country. This also helps the epidemiologist to find out the favourable factor for the disease, thereby appropriate health care services can be provided.

Rural-Urban Variations

The prevalence of noncommunicable diseases such as diabetes, hypertension, cancer, mental diseases are more in urban areas than rural areas. On the other hand, zoonotic diseases and soil borne diseases are more in rural areas than urban areas. These variations help the epidemiologist to identify the risk factors and the risk-groups, so that care can be taken.

Local Distribution of the Disease (in an Area)

This is studied by representing the number of cases in the area-map, in the form of spots, depending upon the area to which they belong. This is called 'Geographic spot map' or 'Shaded map' **(Fig. 18.6)**. Such a map at a glance shows area of high frequency and area of low frequency. Area of high frequency (Cluster of spots) gives a clue to the epidemiologist about the common source of infection. It was by such a study that John Snow of England in 1854 was able to focus attention that a common water pump in the Broad street of London was the source of infection of cholera epidemic. Thus, he was also able to hypothesize that cholera was a water borne disease, much before the organisms were isolated by Robert Koch. Similarly, Maxcy in 1920 hypothesized that rodents were the reservoir for typhus fever.

Thus, geographic spot map helps the epidemiologist to know the source of infection and also the mode of spread. Thereby he can formulate an etiological hypothesis.

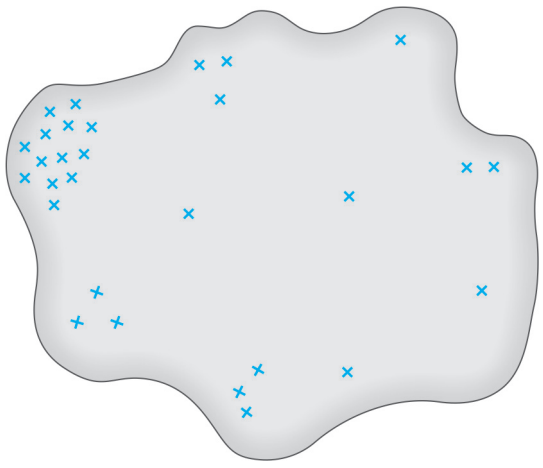


Fig. 18.6 Geographic spot map showing areas of high and low density

PERSON DISTRIBUTION

This means describing the distribution of a disease in the community with reference to the host characters of the persons affected, such as age, sex, occupation, literacy level, marital status, social class, behavior, and such other factors.

Age

Age of an individual is strongly related to the disease. Certain diseases occur more frequently in certain age group.

For example, measles and diphtheria among preschool children, cancer in the middle age, atherosclerosis among elderly.

But there are certain diseases like Hodgkin's disease and leukemia, which has increased incidence in two age groups. For example, Hodgkin's disease is more between 15 to 35 years and between 70 to 90 years. Such a tendency of a disease to show two separate peaks, is called 'Bimodality phenomenon.' Tuberculosis has 'Trimodality distribution': a small peak in early childhood, an extensive peak in adult age and a moderate peak in old age **(Fig. 18.7)**.

Sex

Certain diseases are more common among men. For example, lung cancer, TB, coronary heart disease and some are more common among women. For example, diabetes, obesity, myxedema, etc. such a difference may be because of either genetic constitution or cultural and behavioral factors like smoking, drinking alcohol, etc.

Marital Status

This often becomes a risk factor. Cancer cervix is rare in nuns compared to married women. Similarly, mortality rates are high among unmarried than among married persons. This is because married people lead a secured and protected life.

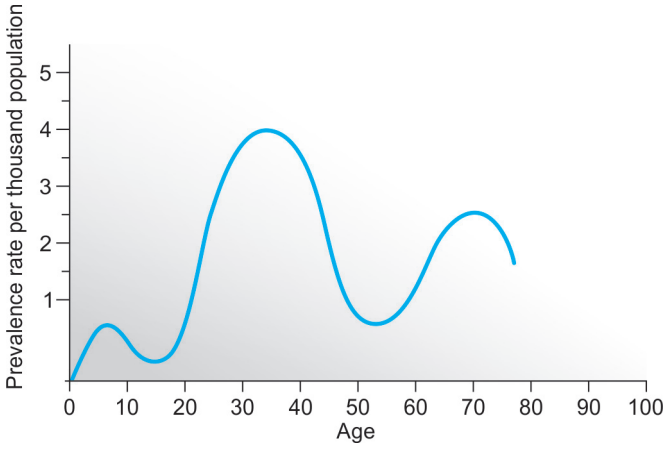


Fig. 18.7 Trimodality distribution of tuberculosis disease

Occupation

Many diseases are related to occupation. Persons working in particular occupations are exposed to particular types of risks. Example, Tetanus, Ankylostomiasis are common among agriculturist workers, Respiratory dusty diseases (Pneumoconioses) are common among industrial workers, Accidents among drivers, etc.

Social Class

Diseases like hypertension, diabetes, coronary artery diseases are common among people of higher socioeconomic class and diseases like malnutrition, rheumatic heart disease and communicable diseases are common among people of lower socioeconomic class. Thus, social factors like poverty, illiteracy, ignorance, poor standard of living, overcrowding, etc. play a very important role in the development of the diseases in the community. Since the social classifications vary from one country to another country, it is difficult to compare the results.

Behavior

Human life-style or behavior such as smoking, alcoholism, over eating, multiple sexual partnership, drug-abuse, etc. influence the development of the disease. Thus, study of these risk factors help the epidemiologist to formulate an etiological hypothesis.

Stress

Stress increases the susceptibility of an individual to the disease and often exacerbates the symptoms.

Migration

Movement of the people from rural to urban areas has resulted in the spread of diseases from one place to another. Migration of the people is a challenge for the prevention and control of the disease.

Measurement of Disease

This means estimating the 'Disease load' or magnitude of the problem in terms of morbidity, mortality, disability, etc. Mortality is measured directly in terms of death rates. Morbidity is expressed in terms of incidence (Longitudinal study) and prevalence (Cross-sectional study) rates **(Table 18.5)**.

Making Comparison with Known Indices

The observations are compared with different groups. This helps to find out the etiological factors and also helps to identify the 'Risk' group, so that preventive measures can be adopted.

Table 18.5 The differences between longitudinal and cross-sectional studies

Longitudinal studies	Cross-sectional studies
• Observations are repeated by means of follow-up examinations, in a population	• Observations are done only once in the population
• Carried over a long period of time (minimum one year)	• Carried over a given point of time or period of time
• This is compared to a running cine film	• This is compared to a still photograph
• This helps to find out the occurrence of new cases (Incidence rate).	• This helps to find out the existence of both old and new cases (Prevalence rate)
• This helps to study the natural history of the disease and the risk factors.	• This does not help to study the natural history of the disease and the risk factors
• This study is time consuming, difficult and costly.	• This is not time consuming, not difficult and cheap

Formulation of Etiological Hypothesis

By studying the distribution of a disease in the community, with reference to time, place and person, the epidemiologist can formulate an etiological hypothesis (supposition). The hypothesis must be correct and complete.

For example, 'Chronic alcoholism causes cirrhosis of liver'—is an incomplete hypothesis. Better statement would be 'Drinking 200 to 300 ml of alcohol per day causes cirrhosis of liver among 20 percent of drunkards after 25 years of exposure'. Thus, a correct and complete statement of the hypothesis helps the epidemiologist to test the hypothesis.

Uses of Descriptive Epidemiology

- It helps to know the extent/magnitude of the disease in the community, in terms of morbidity and mortality rates.
- It helps to know the distribution of the disease with reference to time, place and person.
- It helps to identify the risk group.
- It helps to formulate an etiological hypothesis.
- It helps to plan, organize and implement curative and preventive services.
- It helps in doing research.

ANALYTICAL STUDIES (ANALYTICAL EPIDEMIOLOGY)

This is also an observational study of epidemiology which deals with testing the etiological hypothesis, formulated by descriptive epidemiological study (i.e. to confirm the determinants of the disease.)

There are two types of analytical studies:

1. Case-control study.
2. Cohort study.

From each of these studies one can show:

- Whether any association exists between the suspected factor and the disease of the hypothesis.
- If so, what is the strength of the association between the suspected factor and the disease under study.

Case-Control Study

Study-Design

It is a study between the two groups, one group of persons having a particular disease under study called 'Cases' and another group of persons called 'Controls' who are all comparable with cases in respect of age, sex, literacy level, occupation, marital status, socioeconomic status but free from the disease under study. The control group is taken for the purposes of comparison of observations.

Study is now made by obtaining information from each member of both the groups, about the exposure to the suspected factor made in the hypothesis. The information may be obtained either by interview method, or questionnaire method or by E-mail, etc.

Suppose the hypothesis is, 'Smoking 20 cigarettes per day over 20 years, results in lung cancer,' or alcoholism results in cirrhosis of liver or oral pills results in cancer of the breast, etc. the study proceeds backwards to know the history of exposure to the suspected factor under study.

Then the 'Exposure rate' (or frequency of exposure) is calculated in both the groups and compared. If the exposure rate is more among the cases than among the controls, an association is said to exist between the suspected risk factor and the disease (e.g. smoking and lung cancer; alcoholism and cirrhosis of liver).

Steps in case-control study.

- Selection of cases
- Selection of controls
- Matching
- Measurement of exposure among both the groups
- Analysis.

Selection of Cases

There are two specifications to be satisfied, i.e. Diagnostic criteria and eligibility criteria.

a. *Diagnostic criteria (Defining the disease)*: This must be specified before the study is undertaken. For example, for the diagnosis of lung cancer, all cases should have malignant cells in sputum or similar radiological lesions. Once the criteria is established, it should not be altered.

b. *Eligibility criteria*: Usually employed criteria is that only 'New' cases are eligible for the study and not the old ones or advanced cases.
c. *Size*: The size of the sample of cases is estimated by the particular formula and selection is done by a particular sampling procedure/method (explained in statistics).
d. *Sources*: The cases may be drawn either from the hospital or from the general population. All the new cases should be collected during a specified period of time.

Selection of Controls

This group should have all the features as those of cases, except that they do not have the disease under study. (explained already).

a. *Sources*: They are drawn from the sources like hospital, relatives, neighborers or general population.

   The control group drawn from the hospital, may be having a different disease but that does not matter. For example, in a study of cancer cervix, the control group would be women admitted either for delivery or other gyneco-logical problems.

   The control group drawn from the relatives has an advantage of sharing common attributes and easy accessibility.

   The control group can also be selected from the same locality or from the same industry or from the same school as that of cases.
b. *Size of the control group*: The size of the control group depends upon the size of the cases. If the size of the cases (i.e. study group) is small (say less than 50), then the size of the control should be double, triple or even four times that of the study group.

   Thus, selection of cases and controls is crucial. Failure to select a comparable group can introduce 'Bias' in the results.

Matching

It is a process of selection of controls in such a way that not only they resemble cases (study group) in all the attributes and free from the disease under study but also free from the 'Confounding factor'. A confounding factor is the one which is not only associated with 'exposure' under investigation but also independently can act a 'risk-factor' for the development of the disease under study.

For example, in a study of role of alcohol in the etiology of esophageal cancer, smoking is a confounding factor. That means smoking, which is invariably associated with alcoholism can independently result in cancer of esophagus.

For another example, in a study of role of oral contraceptive pills in the etiology of cancer breast if the women taking pills (cases) are of younger age group and if the control group belong to higher age group and not taking the pills, 'Age' is a confounding factor because as the age advances, the women are otherwise at a risk of Ca-breast. So, to remove the confounding factor, control group should also belong to the same age group as the cases.

Matching procedures: There are two procedures. One is 'Group matching', wherein the control group is similar to study group (cases) in all the attributes and free from the disease and also the confounding factor, as already explained. The other is 'Paired matching' wherein the control group is resembling (matching) the study group very closely. For example, in twin studies of monozygotic twins, if one of the twins is a case, the other one is selected as control.

Measurement of Exposure in Both the Groups

This consists of collection of data among both cases and control groups about their exposure to the suspected cause with reference to duration and frequency of exposure.

This is done in the following dimensions depending upon the hypothesis formulated.

- How many of both the groups had exposed to the suspected factor? For example, in the study of lung cancer, how many of them were smoking?
- What was the duration of exposure?, i.e. since how long were they smoking?
- What is the frequency of exposure?, i.e. how many cigarettes per day?

Such information can be obtained either by questionnaires, interviews or from the hospital records, etc.

Thus, this step consists of measuring exposure rate in both the groups (i.e. exposure rate among cases and controls).

Analysis

The data is analyzed to find out:

- Whether any association exists between the disease and the suspected factor;
- If so, what is the strength of the association;
- To know the existence of the relation between the disease and the suspected factor, exposure rate (i.e. frequency of exposure) has to be estimated in both the groups and compared.

Framework of Case-Control Study

Suspected factor (H/o exposure to risk factor)	Cases (Disease present)	Controls (Disease absent)
Present	a	b
Absent	c	d
Total	**(a + c)**	**(b + d)**

Exposure rate (Frequency of exposure) among cases $= \frac{a}{a+c} \quad 100$

$$= \frac{\text{No. of cases giving H/o exposure}}{\text{Total no of cases}} \quad 100$$

Exposure rate among controls $= \frac{b}{b+d} \quad 100$

$$= \frac{\text{No. of control giving H/o exposure}}{\text{Total no of controls}} \quad 100$$

If exposure rate among cases $\left(\frac{a}{a+c} \times 100\right)$ is greater than that of controls $\left(\frac{b}{b+d} \times 100\right)$, that means there is the existence of the association between the disease and the suspected factor (i.e. cancer lung and smoking).

- To know (measure) the strength of the association between the disease and the suspected factor, an indicator called 'Odd's ratio' (i.e. cross-product ratio) has to be calculated. It is the ratio of chance of occurrence of the disease among cases to the chance of occurrence among controls.

  Using the above framework,

  Odd's ratio $= \frac{ad}{bc}$

  Higher the value of odd's ratio, greater is the strength of the association between the disease and the suspected factor.

To ascertain whether the relation/association between the disease (lung cancer) and suspected factor (smoking) is statistically significant or not, a test of significance called 'Chi-square' is applied, to calculate 'p'-value. p-value indicates whether the probability of association between the disease and the suspected factor has occurred by chance or by real fact.

If the p-value is 0.05 or less than that, the relation is considered as significant. Smaller the p-value, greater is the statistical significance. p-value lesser than 0.001 is highly significant. Thus, lesser the p-value, higher the significance that means the probability of occurrence of the disease by chance is ruled out. In otherwords, the relation between the disease (lung cancer) and suspected factor (smoking) is a fact. Only if it is a fact, then it can be applied (projected) to the population at large stating that cancer lung results from smoking (Explained in detail under Biostatistics).

Example: On interrogation, 40 out of 50 cases of lung cancer and 60 out of 150 controls gave the history that they were smoking cigarettes. Does smoking predispose to lung cancer.

The study tests the hypothesis 'Smoking predisposes to lung cancer'

Exposure	Cases	Controls
Yes	40 (a)	60 (b)
No	10 (c)	90 (d)
Total	**50 (a + c)**	**150 (b + d)**

Exposure rate among cases $= \frac{a}{a+c} \quad 100 = \frac{40}{50} \quad 100$

Exposure rate controls $= \frac{b}{b+d} \quad 100 = \frac{60 \quad 100}{150}$

Since the exposure rate is more among cases than among controls (80% > 40%) the relation between smoking and lung cancer exists.

Odd's ratio $= \frac{ad}{bc} = \frac{40 \quad 90}{10 \quad 60} = \frac{3600}{600} = 6$

That means smokers are '6' times at a greater risk of getting lung cancer. (This indicates the strength of the association).

Bias in Case—Control Study

Bias is an error, often occurring in research works, resulting in contradictory results and thus leading to wrong conclusions. The different types of bias in case—control study are:

- *Memory or recall bias:* Since there is collection of retrospective data, the recall of events would be better among the cases than controls, because the cases are more likely to remember the past events better. However, due to recall of events, there is possibility of recall bias. This can be reduced by using biogic markers of exposure. Biologic marker is a metabolite in the body fluid, used to validate human exposure to the hazardous substance.
- *Selection bias:* This occurs when the selected sample does not represent the universe or whole population from which it is drawn. This can be overcome by proper sampling technique and the sample size shall be sufficiently large as to represent the population from which it is drawn.
- *Confounding bias:* Since the confounding factor itself independently can result in the disease, care must be taken while selecting the controls that they must be free from the confounding factors also. That means there must be proper "matching" between cases and controls.
- *Berksonian bias:* This occurs specially in the hospital based studies because the patients with different diseases will have different rates of admission to hospitals. This bias is named after Joseph Berkson, who was the first person to recognize this problem.
- *Interviewer's bias:* This occurs when the interviewer knows who is in the study group and who is in the control group. So the interviewer may ask questions thoroughly to the cases then controls, regarding the history of exposure to the suspected cause. This can be overcome by double blind study, wherein neither the interviewer not the participants know their group allocation.

Cohort Study

This is also an another type of analytical study undertaken to support (accept) or refute the association between the suspected factor and the disease of the etiological hypothesis.

Cohort study is so called because it is done on 'Cohorts'. A 'Cohort' is a group of persons possessing common characteristics. For example, those born during a particular time constitute birth cohort, those married during a particular period constitute marriage cohort, those exposed to a common drug or a vaccine are called exposure cohort, etc.

Study Design

This is also a study involving two groups of persons, one group called study cohort, (Exposure cohort) who share common characteristics (like age, sex, occupation income, literacy level, marital status, etc) and are exposed to the suspected etiological factor and another group called 'Control cohort', who also have the same attributes as that of study cohort but are not exposed to the particular factor and are used for comparison of observations.

Both the groups are then observed (followed) over a period of time, under the same identical conditions, to determine the 'Incidence' (frequency) of disease in both the groups and compared. Thus, the study proceeds forwards from 'cause to the effect', unlike case-control study which proceeds backwards from 'effect to the cause'. The synonyms for cohort study are follow-up study, forward looking study, prospective study, longitudinal study, and incidence study.

$$\text{Incidence rate of the disease among study cohort (Frequency)} = \frac{\text{No. of persons developing the disease}}{\text{Total no. of persons exposed (at risk)}} \quad 1{,}000$$

$$\text{Incidence rate of the disease among control cohort (Frequency)} = \frac{\text{No. of persons developing the disease}}{\text{Total no of persons exposed (not at risk)}} \quad 1{,}000$$

If the incidence of the disease is more in the study (exposed) cohort than the control cohort, it suggests that there is an association between the cause and the effect.

Types of Cohort Studies

There are three types namely:

a. Prospective cohort study
b. Retrospective cohort study
c. Combination of prospective and retrospective cohort study.

The schematic representation of case control study and cohort studies is shown in **Fig. 18.8**.

Prospective Cohort Study

This is the most common and most scientific method of cohort studies. It begins in the present and continues in the future and then terminates. It is also called as 'Current cohort study'. Famous example are Doll and Hills study on smoking and lung cancer, US Public Health Services

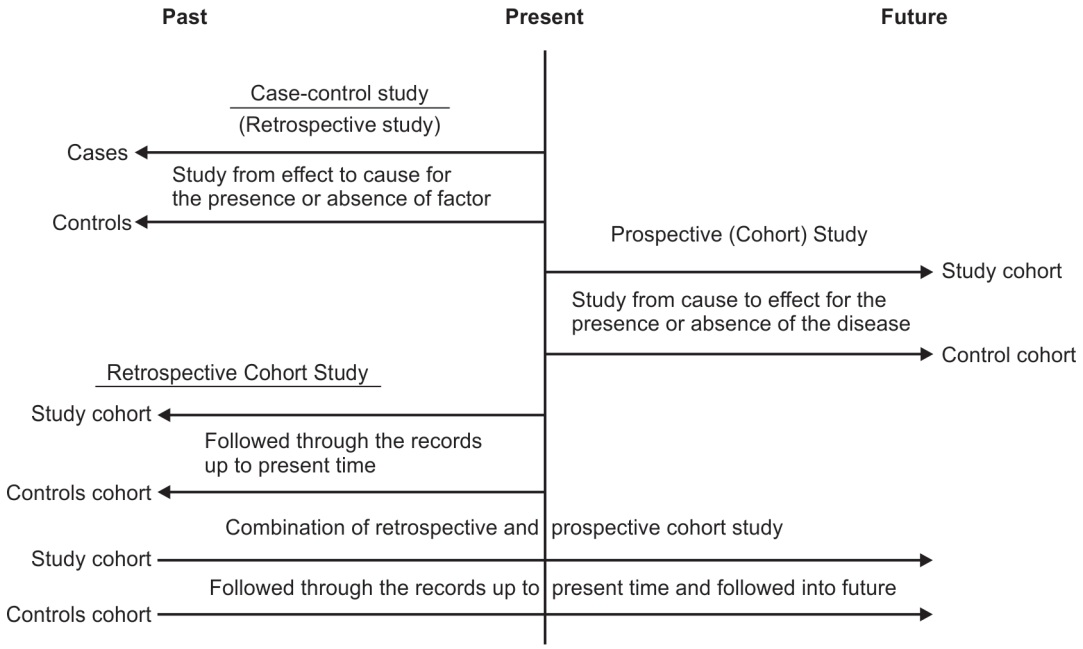


Fig. 18.8 Schematic representation of case-control study and Cohort studies

Framingham Heart Study and study of oral contraceptives and health by the Royal College of General Practitioners. In this type, the exposure and the study for outcome occurrence start simultaneously.

Framingham heart study: Framingham heart study is a long-term, ongoing, cardiovascular study done on residents of the town Framingham, Massachusetts. The longitudinal study began in 1948 with 5209 adult healthy persons, both men and women, aged 30 to 62, who had not developed overt symptoms of cardiovascular disease or heart attack or stroke and is now on its third generation of participants. Prior to this study, almost nothing was known about the epidemiology of cardiovascular disease. It is a research project of the National Heart, Lung and Blood Institute, in Collaboration with (since 1971) Boston University. Various health professionals from hospitals and universities of Greater Boston staff the project. This study has committed to identify the common factors or characteristics that contribute to cardiovascular disease.

The study was started in 1948. The second generation of participants were enrolled in 1971 and in April 2002, a third generation was enrolled in the core study. A new offspring spouse cohort in 2003 and a second generation Omnicohort in 2003 was taken up.

In this study, the participants, their children and grand children, voluntarily consented to undergo a detailed medical history, physical examination and medical tests every two years, creating a wealth of data about cardiovascular disease.

Framingham heart study is the origin of the term "Risk factor". This study led to the identification and understanding of risk factors of cardiovascular diseases. Before this study, it was believed that atherosclerosis was normal part of aging and hypertension and hypercholesterolemia were also seen as normal consequences of aging and no treatment was initiated. These and further risk factors, e.g. homocysteine, were gradually discovered over the years.

This study also showed the importance of healthy diet, not being obese (overweight) and regular exercise in maintaining good health. It also confirmed that cigarette smoking is a highly significant factor in the development of heart disease, leading to angina pectoris, myocardial infarction and coronary death.

In this study risk factors for dementia have been and continue to be investigated. In addition the relationships between physical traits and genetic patterns are being studied. The study has amassed a DNA library of blood samples from two generations of participants over 5,000 individuals. The library will help researchers investigate whether and what diseases run in families and identify the genes for a host of serious disorders. They are now in the forefront of investingating how genes contribute to common metabolic disorders such as obesity, hypertension, diabetes and Alzheimer's.

Major findings of Framingham heart study

1960s: Cigarette smoking, obesity and increased cholesterol and elevated blood pressure increase the risk of heart and exercise decreases the risk.

1970s: Elevated blood pressure increases the risk of stroke. The risk of heart disease is more among postmenopausal women than premenopausal women. Psychosocial factors also affect this risk of heart disease.

1980s: High level of HDL (High Density Lipoprotein) cholesterol reduces the risk of heart disease.

1990s: Left ventricular hypertrophy increases the risk of stroke. Elevated blood pressure can progress to heart failure. Framingham risk score correctly predicts 10 years risk of future coronary heart disease events.

2000s: High normal blood pressure (prehypertension increases the risk of cardiovascular disease.

William B Kannel, from New York, born in 1923, was pioneer in cardiovascular epidemiology. He died in 2011.

Retrospective Cohort Study (Historical Cohort Study)

In this type, the investigator goes back in time for about 15 to 20 years, to select a study group from the existing records. Thus, exposure has occurred sometime back in the past but the disease (outcome) has not occurred and traced forward up to the present time for the occurrence of the outcome (disease). It is also called 'Noncurrent prospective study'. The control cohort is also selected from the records and followed through the records for the outcome but they are not exposed to the factor. These studies are not only economical but also produce results more quickly than prospective cohort studies.

Combination of Retrospective and Prospective Cohort Studies

In this type, cohort and control groups are identified from the past records and are followed-up prospectively up to present time and continued to follow-up into future.

Steps in Cohort Study

a. Selection of study cohorts
b. Selection of control cohorts
c. Follow-up
d. Analysis.

Selection of study cohorts (exposure cohorts): The estimated sample size (usually large in number) having common characteristic features, is obtained either from the general population as marriage cohort, birth cohort, exposure cohort, etc. or from a special homogeneous group of population such

as doctors, lawyers, nurses, industrial workers, etc. who are not only easily accessible but also can be followed-up easily. (Reference population is the one to which the results are applicable).

Selection of control cohorts (unexposure cohorts): This group is selected from the reference population. All of them have the same characteristic features such as age, sex, occupation, literacy level, socioeconomic status, etc. but not exposed to risk factor.

Examples for study cohorts and control cohorts are respectively smokers v/s nonsmokers to study the effects of smoking; radiologist v/s ophthalmologists to study the radiation hazards.

Follow-up: This consists of periodical medical examination or doing special tests or reviewing the records for the occurrence of disease (outcome) in both the groups (Measurement of frequency of disease).

However, a certain percentage of losses can occur either due to death or migration or withdrawal by the volunteers of the group.

At the beginning of the study, both the groups are healthy. They are followed up for a period as per the hypothesis, at the end of which the number of cases (disease) occurring in both the groups is noted.

Analysis: The data is now analyzed to find out:

i. Whether any association exists between the suspected factor and the disease under study;
ii. If so, what is the strength of the association?

i. To know the association between the suspected factor and the disease under study, incidence rate (frequency of disease) has to be determined in both the groups and compared as follows:

Framework of Cohort Study

Cohort group	Development of disease		Total
	Yes	No	
Study cohort (exposed to suspected factor)	a	b	a + b
Control cohort (Not exposed to suspected factor)	c	d	c + d

$$\text{Incidence rate in study (or exposure) cohort (IE)} = \frac{a}{a+b}\ 1{,}000$$

$$\text{Incidence rate in control (nonexposed) cohort(IO)} = \frac{c}{c+d}\ 1{,}000$$

If IE $\left(\frac{a}{a+b}\times 1{,}000\right)$ is greater than IO $\left(\frac{c}{c+d}\times 1{,}000\right)$ it suggests the existence of the association between the suspected factor (e.g. smoking) and the disease (lung cancer).

ii. To study the strength of the association between the suspected factor and the disease, it is necessary to estimate the risk of getting the disease in both the groups, by the following indicators:

- Relative risk
- Risk difference
- Attributable risk
- Absolute risk
- Population attributable risk
- Population attributable risk proportion.

Example: 2,000 smokers and 1,000 matched nonsmokers were followed-up. Lung cancer developed in 120 smokers and 20 nonsmokers. Estimate the strength of the association between smoking and lung cancer by the appropriate indicators.

Framework

Smoking	Developed lung cancer	Not developed lung cancer	Total
Present	120 (a)	1880 (b)	2,000
Absent	20 (c)	980 (d)	1,000

Relative risk (Risk ratio): Risk ratio (RR) is the ratio of the incidence of the disease among exposed and the incidence of the disease among unexposed. It is a direct measure of the strength of the association between the suspected cause (smoking) and the disease (lung cancer).

$$RR = \frac{IE}{IO} = \frac{\frac{a}{a+b}\ 1000}{\frac{c}{c+d}\ 1000} = \frac{\frac{120}{2{,}000}\ 1{,}000}{\frac{20}{1{,}000}\ 1{,}000} = \frac{60}{20} = 3$$

RR 3 means, smokers are relatively 3 times at a greater risk of developing lung cancer than nonsmokers.

Note: RR1 indicates no association.

RR greater than 1 indicates positive association and

RR lesser than 1 indicates negative association.

Negative association means the suspected factor is regarded as a protective factor. For example, yoga exercises v/s hypertension/diabetes mellitus.

Larger the RR greater is the strength of the association between the suspected factor and the disease.

Risk difference: Risk difference (RD) is the mathematical difference between the incidence of the disease among exposed and unexposed. This is an indicator of public health problem caused by the exposure.

$$RD = IE - IO$$

$$= \left(\frac{a}{a+b}\times 1000\right) - \left(\frac{c}{c+d}\times 1{,}000\right)$$

= 60 – 20 = 40 per 1,000 population

Attributable risk: Attributable risk (AR) is the ratio of risk difference and the incidence of the disease among exposed, often expressed as percentage.

$$AR = \frac{RD}{IE} = \frac{IE - IO}{IE} = \frac{60 - 20}{60} = \frac{40}{60} \times 100 = 66.6\%$$

Attributable risk is the extent to which smoking is attributed as the cause of lung cancer among smokers. In the above example, 66.6 percent of lung cancers among the smokers is attributed to smoking. This suggests the amount of disease that might be eliminated if smoking is controlled. In other words, higher the AR, greater the reduction in the incidence of the disease by elimination of that risk factor.

The differences between relative risk and attributable risk is shown in **Table 18.6**.

Absolute risk: It is the risk of developing the disease, irrespective of exposure to the risk factor and is expressed as percentage. (In otherwords, it is the percentage of both the groups, exposed and unexposed, at a risk of developing the disease).

$$\text{Absolute risk} = \frac{a+c}{a+b+c+d} \quad 100$$
$$= \frac{120+20}{120+1,880+20+980} \quad 100$$
$$= \frac{140}{3,000} \quad 100 = \frac{14}{3} = 4.67\%$$

Table 18.6 Differences between relative risk and attributable risk

Relative risk (RR)	Attributable risk (AR)
It is the extent to which exposed persons are relatively at a greater risk of developing the disease than the unexposed persons.	It is the extent to which the suspected cause is attributed as the cause of the disease.
It is the ratio of the incidence of the disease among exposed persons (IE) and the incidence of the disease among unexposed persons (IO). $RR = \frac{IE}{IO}$	It is the ratio of risk difference (RD) and the incidence of the disease among the exposed (IE) RD = IE – IO $AR = \frac{RD}{IE} \times 100$
It is expressed in absolute numbers.	It is often expressed in percentage.
It measures the strength of the association between the suspected cause and the disease (e.g. Smoking and Lung cancer)	It suggests the extent to which the disease can be prevented, if suspected cause is removed.
Higher the RR, stronger is the association between the cause and the effect.	Higher the AR, greater the reduction in the incidence of the disease by elimination of the risk factor.
If RR is 20, that means smokers (exposed persons) are relatively twenty times at a greater risk of developing the disease (lung cancer) than non-smokers (unexposed).	If AR is 60%, that means, 60% of lung cancer (disease) can be prevented if smoking (cause) is eliminated.
RR does not give any information on the prevention of the disease.	AR does give the information about prevention of the disease.
Thus, RR is not of public health importance.	Thus, AR is of much public health importance.

Population attributable risk: Population attributable risk (PAR) is the difference between the incidence of the disease occurring in the total population (IP) of both the groups irrespective of risk factor smoking and the incidence of the disease among the control (unexposed) group (IO).

$$PAR = IP - IO \qquad IP = \frac{a+c}{a+b+c+d} \quad 1,000$$
$$= \frac{140}{3,000} \quad \frac{1,000}{1} = \frac{140}{3} = 46.67$$

(IP is equal to absolute risk but expressed per 1,000 population).

$$IO = \frac{c}{c+d} = \frac{20}{20+980} = \frac{20}{1,000} \quad 1,000 = 20.00$$

IP – IO = 46.67 – 20 = 26.67 per 1000 population.

This quantifies the avoidable incidence of the disease due to exposure in the entire population (both the groups).

Population attributable risk proportion: Population attributable risk proportion (PARP) is the percentage of the ratio of population attributable risk and the incidence of the disease in both the groups of the population.

$$PARP = \frac{PAR}{IP} \quad 100 = \frac{26}{46} \quad \frac{100}{1} = 56.5\%$$

Thus, PARP is an indicator, which measures the proportion of the disease in the total population of both the groups, which can be removed if exposure is avoided completely.

Advantages and Disadvantages of Cohort Studies

Advantages

- It provides information about true incidence rates.
- Several other outcomes related to exposure can be studied simultaneously, e.g. in a study of association between smoking and lung cancer other outcomes related to smoking such as coronary artery disease, peptic ulcer, throat cancer, etc. can also be studied.
- It helps to estimate the relative risk and attributable risk.
- It allows the assessment of dose-response relationship.
- It helps to accept or to refute the hypothesis with a high degree of validity.

Disadvantages

- Cohort studies are expensive, time consuming and difficult.
- Unsuitable for investigating uncommon diseases.
- Certain administrative problems are inevitable such as lack of experienced staff, lack of funds, etc.
- Attrition (reduction) in the size of the cohort or control group can occur due to death or migration or dropouts, etc.
- It involves ethics (People cannot be deliberately kept under the influence of the potentially harmful factor).

Differences between Case-control and Cohort Studies (Table 18.7)

Table 18.7 Differences between case control study and cohort study

Case-control study	Cohort study
• It involves the study between the cases and controls	It involves the study between the study cohort (experimental cohort) and the control cohort
• The study starts with the disease	Study starts with the people exposed to risk factor
• Study proceeds backwards from effect to cause (Retrospective study)	Study proceeds forwards from cause to effect (Prospective study)
• Thus, exposure and disease have already occurred at the time of initiation of study	Exposure has already occurred but the effect (disease) has not occurred at the initiation of the study
• Study is done to find the frequency of exposure (exposure rate)	Study is done to find the frequency of disease (incidence rate).
• Study is easy and cheap	Study is difficult and expensive
• Yields results quickly	Yields delayed results
• Involves less number of people	Involves more number of people
• Techniques are crude	Techniques are refined
• Strength of the association is estimated by Odd's ratio.	Strength of the association is estimated by relative risk and attributable risk.
• Results are less reliable.	Results are more reliable
• Suitable for study of rare diseases	Not suitable
• Study cannot yield in formation about diseases other than that selected for study.	Study can yield information about other outcomes (diseases) also other than the disease under study

EXPERIMENTAL EPIDEMIOLOGY (EXPERIMENTAL EPIDEMIOLOGICAL STUDIES)

Experimental studies are also called 'Intervention studies'. In this study, some action or intervention is involved such as deliberate application (of a drug) or withdrawal of the suspected cause in the experimental (or study) group and no change in the control group. Later the outcome of the experiment is compared in both the groups. Thus, it differs from the observational studies in that the experiment is directly under the control of the investigator and involves cost, ethics and feasibility whereas in the observational studies the investigator (epidemiologist) takes no action but only observes the outcome.

The aim is to provide 'scientific proof' of the etiological factors. (or risk factors) and to evaluate the health services.

There are three types of experimental studies:

A. Clinical trial (or Randomized Controlled Trial) with patients as the unit of study.
B. Field trial (or Community Intervention Studies) with healthy people as the unit of study.
C. Community trial with entire community as the unit of study.

Clinical Trial (Randomized Controlled Trial)

Randomized controlled trial (RCT) is so called because the patients who constitute the unit of study are allocated into 'Study group' (experimental group) and 'Control group' at random, depending upon whether they receive or do not receive the intervention. Random allocation eliminates bias.

Aim: is to test the efficacy of a new drug or a new drug regimen or a new therapeutic or surgical procedure.

Basic steps: In conducting a clinical trial (RCT) are:

a. Drawing of a protocol.
b. Selecting reference population (unit of study).
c. Randomization (Allocation into experimental and control group).
d. Manipulation (intervention).
e. Follow-up.
f. Assessment of outcome.
g. Reporting.

Drawing of Protocol

This means specifying the follow-ing basic information before the commencement of the clinical trial. They are:

- Aims and objectives of the study.
- Criteria for the selection of study group and control group.
- Size of the sample.

- Procedures for allocation into study group and control group.
- Intervention to be done (Methodology of procedure).
- The cooperation of the participants till the end of the study.

Selection of Reference Population

Reference population is the target population, to which the results if found successful, are expected to be applicable. Reference population, depending upon the study, could be all suffering from a particular disease under experiment, e.g. TB/leprosy patients for new therapy/new regimen or patients with hernia for new surgical procedure, etc.

Randomization (Selection of Study and Control Group)

This is the 'Heart' of the clinical trial. Every individual has an equal chance of being selected into either study group or control group, from the reference population.

- *Selection of study group (Experimental group)*: It is the actual population (or volunteers) derived from the reference population randomly, participating in the experiment, still retaining the same characteristics as the reference population. Randomization eliminates bias and allows comparability.

  The study group should fulfil the following three criteria:

  i. It should be 'Representative' of the reference population.
  ii. They must give 'informed consent', after being fully informed about the procedure and possible dangers of the trial.
  iii. They must be 'Susceptible' to the disease under study. (i.e. qualified or eligible) Example: Suppose the trial is on the effect of a new drug for Anemia, the volunteers must be anemic.

  The study group receives the intervention (experimental procedure).
- Selection of control group. Another group of the same size as that of the study group is selected at random from the reference population, maintaining the similar characteristics (e.g. age, sex, occupation, literacy level, income, etc.) as that of the study group but they do not receive intervention.

  One group should not be made of old, frail, malnourished patients in advanced stage and the other young, well nourished and in early stage of illness.

Manipulation or Intervention

The next step is to intervene or manipulate the study group by the deliberate application or withdrawal or reduction of the causal factor, i.e. new drug, whereas the control group is put on the inert (or placebo) or the old drug.

Follow-up

This consists of examination of both the groups at defined intervals of time for the time framed and the results are submitted to the statistician.

At times, some losses occur to follow-up due to death or migration or noncooperation of the participants. This is known as attrition. If attrition is substantial the results may be affected. Therefore, effort must be made to minimize the losses during follow-up.

Assessment of Outcome

This is the final step of clinical trial. The results may be positive (e.g. the new drug is better and safer) or may be negative (e.g. the new drug is not good and/or more hazardous).

The incidence of results (positive or negative) is compared in both the groups and the differences are tested for the tests of significance.

Bias may arise from three sources resulting in errors, as follows:

i. *Subject variation*: Patients may report better/improvement, if they know that they are under new treatment.
ii. *Observer bias*: Is made by the investigator while observing.
iii. *Bias in evaluation*: Is made by the investigator subconsciously.

In order to overcome these errors and bias, a technique known as 'Blinding' is adopted, which is done in three ways.

i. Single blind trial
ii. Double blind trial
iii. Triple blind trial

- *Single blind trial*: In this type, the participants do not know whether they belong to study group or control group. That means they do not know whether they are receiving new drug or the placebo. However, the investigator knows who belong to which group. This trial helps to overcome subject variation.
- *Double blind trial*: In this type, neither the investigator, (Doctor) nor the participants (patients) know the group allocation and the treatment (new drug) received. However, statistician knows it. He assigns the code numbers and hands over the drugs with code number to the investigator (doctor) indicating which one to be given to whom. At the end, the results are given back to statistician alongwith the code numbers for analysis. He will decode and analyse the results.
- *Triple blind trial*: In this type, it goes one step further. All the participants, doctor and the statistician are unaware (blind) of the group allocation. The findings of the trial by the doctor are handed over to the statistician, with code numbers. He will decode and analyze the results.

  Ideally, double blind trial is the most frequently used method. It is scientifically sound also.

Phases of clinical trials: Clinical trials are conducted under the following phases:

Phase I: Trial is done on a small group of healthy individuals to (10 to 30) know the safety, the efficacy and the side effects of the vaccine. Usually, it takes 8 to 12 months to complete phase I trial.

Phase II: Trial is carried out on a larger group of persons (50-500), to know not only the safety of the vaccine but also refining the dosage schedule. This is often carried out in multiple centers.

Phsse II trials generally take 18 to 24 months to complete. In Phase II b trails (Step study or test of concept trial) enables the researcher to decide whether the vaccine is worth testing in larger. Phase III trial.

Phase III: In this phase, trial is carried out on thousands of volunteers not only to know the safety, efficacy and immune response but also to decide whether the vaccine is fit for manufacturing. The minimum duration of phase III trial is up to three years

Phase IV: This is a continuous ongoing process to know the long- term effects of the vaccine.

Types of study designs

1. *Concurrent parallel study design*: From the reference population, patients are drawn randomly and allocated into 2 groups namely study group (experimental group exposed to new drug) and control group (exposed to placebo or old drug) and they would remain in the same group for the duration of the experiment.
2. *Double blind cross-over study design*: As before, the patients are randomly allocated into study group and control group and respectively put on new drug and old drug. Half way through the study, the drugs are withdrawn for the elimination of drugs from the body. Afterwards, the groups are interchanged, i.e. the study group is now put on old drug and the control group on the new drug.

   Suppose, those who were on the new drug initially showed good recovery and then failed to do so after changeover (cross-over) in the latter half of the study period, the new drug is regarded as a really effective one.
3. *Co-operative (Multicentric) trial*: This is a clinical trial jointly planned and simultaneously carried out in different parts of the country or in different countries.

Reporting

A detail report of the trial is written and sent to a medical journal for publication.

Field Trial

This differs from the clinical trial in that 'Healthy people' constitute the unit of study and not the sick persons. The trials are of the following types:

1. *Preventive trial*: This involves trial of preventive measure in a study group of individuals, e.g. trial of a vaccine; of a nutrient (nutritional supplementation) and no such trial in the control group. Both the groups are followed over the stipulated period to detect the occurrence of that particular vaccine preventable disease, i.e. attack rate (or incidence rate) is calculated in both the groups and compared for statistical significance.
2. *Risk factor trial*: This is another type of field trial, wherein the trial involves modification or elimination of the risk factor of the disease. The risk factor trial can be 'Single factor' or 'Multi factor' trial. For example, the major risk factors of coronary artery disease are increased cholesterol level in the serum, smoking habits, hypertension, and sedentary habits. So, there are four main possibilities of intervention in coronary artery disease such as reduction of cholesterol level, cessation of smoking, control of hypertension and promotion of regular physical activity.

In the above example **(Flow chart 18.2)** the risk factor, increased serum cholesterol level was 'modified by giving clofibrate drug to the study group. But in a similar study, if the risk factor is 'eliminated' totally, and the effect is studied, it is called 'Cessation Experiment' **(Flow chart 18.3)**.

Community Trial

In this type of experimental studies, the unit of study is neither the sick persons as in clinical trial nor the healthy persons as in the field trial, but is the entire community. Since the etiological factor lies in the group behavior, the intervention is directed to the entire community, one taking as the study community, receiving the intervention and the other as the control community not receiving the intervention, i.e. for the intervention such as nutrition education, education on breast-feeding, on oral hygiene, etc. After the period of observation, reduction in the incidence of malnutrition, infant mortality rate or caries tooth respectively, in the study community indicates statistical significance.

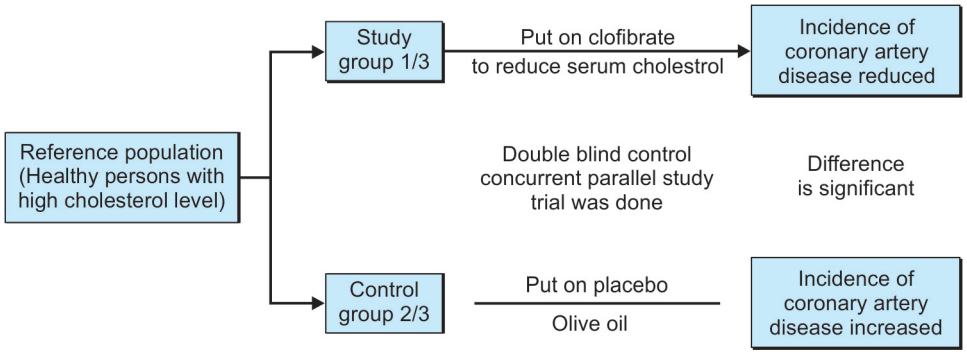
NONRANDOMIZED TRIALS

Since it is not always possible to resort to randomized controlled trial in human beings due to ethical, administrative and other reasons, (e.g. smoking and lung cancer, long period of follow-up of thousands of people for more than a decade when the disease frequency is low as in cancer of cervix, etc.) we can resort to other study designs, such as nonrandomized (or nonexperimental) trials.

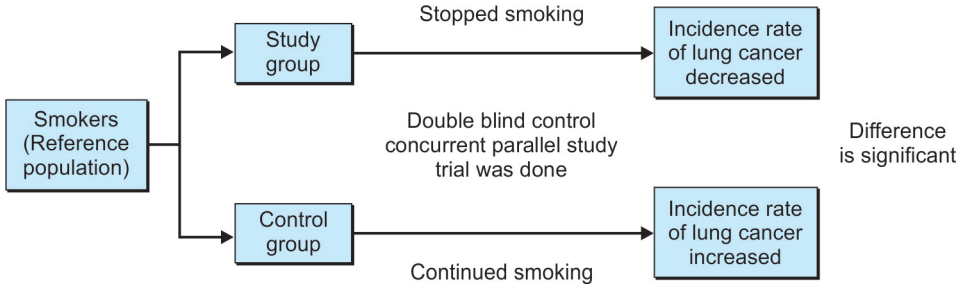
But compared to randomized controlled trials, these are crude, with more frequent spurious results and of less validity. So, vital decisions are not made.

These nonrandomized trials are uncontrolled trials, natural experiments and before and after trials.

Flow chart 18.2 Risk factor trial involving modification of risk factor



Flow chart 18.3 Risk factor trial showing elimination of risk factor (Cessation experiment)



Uncontrolled Trials

These are the trials without controls, (comparison group) because necessity is not felt due to peculiar nature of the outcome. For example, in human rabies, the mortality is 100 percent. If a new drug for human rabies is invented, control group is not required. In otherwords, 'historical controls' (i.e. experience of earlier untreated patients) are used.

Natural Experiments

In this type, the 'natural circumstances' such as earthquake, famine, floods, etc are identified as the experiment, because such events cannot be artificially created for the sake of the experiments. Famous example is John Snow's discovery that cholera is a water borne disease, was the outcome of the cholera epidemic in London in 1852. This was demonstrated much before the organisms were identified as the causative agent.

Before and After Comparison Trials

In this type, the group receiving the intervention (experiment) itself serves as control. Classical examples are prevention of scurvy among sailors by James Lind in 1750, by providing fresh fruit. Introduction of seat-belt legislation for prevention of deaths and injuries caused by motor vehicle accidents, in Victoria (Australia) (1971). It was observed that there was definite fall in the number of deaths and injuries in occupants of car after the introduction of compulsory seat-belt legislation.

ASSOCIATION AND CAUSATION

Association

It is the relation between the two variables namely the suspected factor (smoking) and the disease (lung cancer). The relation is said to be 'associated' when the two variables occur concurrently more frequently.

Causation

The association is said to causally associated when one event invariably gives rise to another event without exception. If the sales of the cigarettes is associated with increased incidence of lung cancer, their causality is proved. Their causality is also proved when the relation is stronger (i.e. when relative risk is increased). Similarly, the causal nature between maize

consumption and development of pellagra is established, if on changing the diet of the patients from maize to wheat, they are cured of pellagra.

Similar examples of association with causal relation are air pollution and chronic bronchitis, tobacco chewing and oral cancer, soft water and cardiovascular diseases, alcoholism and cirrhosis of liver, maize eating and pellagra, saturated fats and coronary artery disease, mouldy nuts and liver cancer, etc.

Since, the experiment to establish the causal association between smoking and lung cancer cannot be carried out on human beings because of involvement of ethics, many criteria will have to be taken into consideration to obtain a scientific proof of causal association between smoking and lung cancer. Additional criteria for judging the causality are:

- Temporial association
- Strength of the association
- Specificity of the association
- Consistency of the association
- Coherence of the association
- Biological plausibility.

Temporial Association

The two variables are said to be causally associated temporially when the putative factor precedes the development of the disease. In other words, the cause must precede the effect, e.g. smoking preceding lung cancer.

Strength of the Association

The two variables are said to be causally associated strongly when the relative risk or Odd's ratio is high. Higher the relative risk and Odd's ratio, greater is the strength of the association. For example, smokers are relatively at a greater risk than nonsmokers, establishes strong association between smoking and lung cancer.

Specificity of the Association

The two variables are said to be specifically associated, when the attributable risk is high. Higher the attributable risk, greater is the specificity of the association between the two variables. This establishes 'one-to-one' relationship. For example, smoking is 'the' cause of lung cancer. But it is difficult to establish the specificity because not all smokers develop lung cancer nor all cases of lung cancer had smoked. Moreover lung cancer can occur due to multiple factors other than smoking such as air pollution, occupational exposure to asbestos dust, thus deviating from 'one-to-one' relationship. Thus, specificity supports causal relationship and lack of specificity does not rule out specificity. Therefore, 'attributable risk' is taken into consideration. If attributable risk is 80 percent, that means among 80 percent of lung cancer cases, smoking is attributed as the (specific) cause.

Consistency of the Association

The association between the two variables is said to be consistent, when similar results are reported from different places, in different settings and by different methods. Lack of consistency will weaken the causal relationship. A consistent association has been found between cigarette smoking and lung cancer from various prospective and retrospective studies carried out in various parts of the world lending support to a causal relationship. Similar consistent association has been shown between smoking and coronary artery disease, smoking and chronic bronchitis, smoking and peptic ulcer and smoking and lung cancer.

Biological Plausibility

The causal association between the two variables (cause and the effect), i.e. smoking and lung cancer, is said to be biologically plausible, if there is a biological mechanism involved in the body. For example, deposition of carcinogen of the smoke in the lungs, over a period of time, builds up to a threshold level and then induces neoplastic changes in the lung tissue. That means there is a biological response of the cells, tissues, organs or system to the stimulus. Another example of biological plausible association is smoking and coronary artery disease. Smoking releases nicotine and carbon monoxide. Nicotine raises the oxygen demand of the myocardium, resulting in increased heart rate, cardiac output and blood pressure. Meanwhile carbon monoxide reduces oxygen carrying capacity of the blood by formation of methemoglobin in place of oxyhemoglobin. So, there is raise of oxygen demand on one hand and fall of oxygen supply on the other hand, eventually leading to coronary artery disease.

Coherence of the Association

The causal association between the two variables is said to be coherently associated when there is historical evidence since ancient times. For example, the historical evidence of rising consumption of tobacco smoking and rising incidence of lung cancer are coherent. Similarly, male and female differences in trends of lung cancer death rates are also coherent with the more recent adoption of cigarette smoking by women.

The association between the two variables can be broadly grouped under three headings:

A. Spurious association
B. Indirect association
C. Direct (causal) association.

Spurious Association

Sometimes, the observed association between the two variables may not be real but false. For example, it was observed in a study done in UK that the perinatal mortality

was higher in hospital deliveries, than home deliveries, which is contradictory to the expected, leading to spurious association that home deliveries are better and safer places.

Such a conclusion is spurious because usually hospitals attract mothers of high-risk and therefore associated with high perinatal mortality and not that the quality of care is poor. This spurious observation occurs if the selection of study group and control group is biased (i.e. selection bias). Since selection bias results in spurious observation, selection bias must be absent.

Indirect Association

The two variables are said to be associated indirectly, when the third factor, known as 'confounding factor' is present. Confounding factor is the one which is related to both the variables and can independently results in a disease (i.e. effect) For example, endemic goiter is generally found in high altitudes showing an association between high altitudes and goiter. But now it is clearly known that endemic goiter is not due to high altitude but due to deficiency of iodine intake in the food. Thus, iodine deficiency is a common (confounding) factor showing an indirect association between high altitude and goiter, when no association exists in reality. Thus, indirect association is only a statistical association which does not necessarily mean causation.

In another study made by Yudkin and Roddy, it was observed that higher intake of sugar was associated with myocardial infarction. Later Bennet and others found that cigarette smoking was associated with myocardial infarction and not sugar consumption. Thus, smoking was found to be a confounding factor because smoking was positively associated with increased consumption of coffee and tea.

Direct (Causal) Association

This is of two types: one-to-one causal relationship and multifactorial causation.

One-to-one Causal Relationship

This means if causative factor (A) is present, disease (B) must result conversely when disease (B) is present, causative factor (A) must be present. This concept of one-to-one causal relationship is the essence of Koch's postulates of Germ theory. For example, tubercle bacilli is the causative agent of tuberculosis. This relationship holds good in communicable diseases.

But the drawback is that single causative factor can result in more than one disease. For example, hemolytic streptococci can not only result in tonsillitis, but also in scarlet fever and erisepalas.

Multifactorial Causation

This is often found in noncommunicable diseases such as cancer, obesity, coronary artery disease, protein energy malnutrition, etc. wherein multiple factors are involved, which may act independently or synergistically. This concept of multifactorial causation was put forward by Pettenkofer.

USES OF EPIDEMIOLOGY

1. It helps to study the natural history of a disease, i.e. in relation to agent, host and environmental factors and further evolution of the disease to its termination as death or recovery, in the absence of prevention or treatment. This is a necessary framework for application of preventive measures.
2. It helps to measure the disease frequency in terms of the magnitude of the problem (i.e. morbidity and mortality rates).
3. It helps to make 'Community diagnosis' by studying the distribution of the disease with reference to time, place and person. Therefore, epidemiology has been considered as 'Diagnostic tool', in community medicine. Community diagnosis also helps in under-standing of the social, cultural and environmental characteristics of the community.
4. Descriptive epidemiology helps to formulate an 'etiological hypothesis'.
5. It helps to identify the determinants of the disease and the risk factors.
6. It helps to study historically the rise and fall of the disease in the population, i.e. As old diseases are conquered (e.g. smallpox) new diseases have been identified such as (SARS, AIDS, etc.). Similarly, as the quality of life improved in the developed countries, the incidence of diseases like tuberculosis, malnutrition declined.
7. It helps to estimate the individual's risk of a particular disease by using the indices like Absolute risk, Atributable risk, Relative risk, Odd's ratio, etc.
8. It helps to identify syndromes, e.g. AIDS.
9. It helps to formulate the 'plan of action' for providing the health services including preventive and control measures.
10. It helps to 'evaluate' the health services to find out whether the measures undertaken are effective in controlling the disease or not. Further it also helps to find out the cost-effectiveness of different methods.
11. It helps to make researches in epidemiology.
12. It contributes to the standardization of biostatistical techniques.

BIBLIOGRAPHY

1. Anitha Nath. HIV/AIDS vaccine: An update. IJCM; 2010;35(2).
2. Available at www.framinghamheartstudy.org

3. Barker DJP, Rose G. Epidemiology in Medical Practice. Churchill Livingstone 1976.
4. Barker DJP. Practical Epidemiology. ELBS 3rd edn, 1983.
5. GOI MOHFW. Family Welfare Statistics in India. 2011.
6. Gupta MC, Mahajan BK. Text Book of Preventive and Social Medicine 3rd edn, 2003.
7. Johnson FN, Johnson S. Clinical Trials. Oxford, Blackwell, 1977.
8. Last John M. A Dictionary of Epidemiology. Oxford University Press 1983.
9. Lilienfield AM, Lilienfield DE. Foundations of Epidemiology. Oxford University Press 2nd edn, 1980.
10. Mathur JS. A Comprehensive Text Book of Community Medicine 1st edn, 2008.
11. Morris JN. Uses of Epidemiology. Churchill Livingstone 3rd edn, 1975.
12. Park K. Park's Text Book of Preventive and Social Medicine 18th edn, 2005.
13. Schlesselman JJ. Case – Control Studies. Oxford University Press, New York 1982.
14. WHO Basic Epidemiology. Beaglehole R, Bonita R, Kjelistrom T 1993.
15. WHO Health For All Sr No 4.

CHAPTER 19

Epidemiology of Infectious Diseases

COMMONLY USED TERMS

Infection: Means successful entry, development and/or multiplication of the organisms (pathogenic) in the body of a living being (human or animal). Such an infection may or may not lead to the development of a disease.

Infectious disease: Disease resulting from an infection.

Clinical infection: Infection in a dose as to result in a disease.

Subclinical infection: Infection in a dose not sufficient to result in a disease. An individual with a subclinical infection may or may not transmit the disease to others. It is also called 'inapparent infection.' Such persons are responsible for the endemicity of disease. Identification of such an individual is not possible unless laboratory investigations are done.

Colonization: The infection resulting in the constitution of the normal flora of the tissue or organ. Colonization is non-pathogenic, e.g. staphylococci in the skin and nasopharynx.

Latent infection: A subclinical infection flaring-up into an active clinical disease, when the host defence breaks down. For example, varicella virus of chickenpox later flares up into herpes-zoster; flaring up of tuberculosis following measles, etc. (Latent means hidden).

Mixed infection: Infection caused by more than one type of pathogens.

Primary infection: Infection occurring in an individual, who is not having any other infection.

Secondary infection: Infection occurring in an individual, who is already having an infection of another nature.

Cross-infection: An infection spreading from person to person, animal to animal, animal to person or vice versa.

Terminal infection: An infection occurring towards the end of the disease (usually a chronic disease) and often results in death.

Endogenous infection: The normal nonpathogenic flora of the body, when assume the pathogenic character and result in a disease.

Droplet infection: Infection acquired through the inhalation of droplets or aerosols of saliva or sputum containing the pathogens, expelled during sneezing, coughing, laughing or talking by someone, harboring the pathogen.

Nosocomial infection: An infection acquired by a patient during the stay in the hospital, either from the hospital staff, or from other patients or from hospital procedures. For example, urinary infection following catheterization. Hepatitis B following injection or blood transfusion.

Opportunistic infection: An infection caused by those organisms which take the opportunity provided by the host due to breakdown of the immune mechanism, resulting in a disease. It is common in AIDS. The opportunistic organisms are *Mycobacterium tuberculosis, Cytomegalovirus, Pneumocystitis carnii,* Herpes virus, *Toxoplasma gondii,* cryptococci, etc.

Infestation: The lodgement, growth, development and reproduction of the parasites, either on the surface of the host (like louse, ticks, mites) or inside the body of the host (like helminths). These parasites are respectively called as Ecto and Endoparasites.

Contamination: Presence of infectious organism on the surface of the inanimate objects like clothes, utensils, furnitures, instruments, vehicles of transmission (like water, milk, food, blood, etc.) and makes it impure.

Pollution: Presence of offensive matter in the environment. For example, air pollution.

Host: A person or an animal including birds and arthopods, that affords lodgement to an infectious agent or a parasite.

Definitive host (Primary host; final host): In which the parasite undergoes sexual phase of its development in its life-cycle and attains maturity. For example, dog in hydatid disease; female anopheline mosquito in malaria.

Intermediate host (Secondary host; alternate host): It is the one in which the parasite undergoes asexual phase of its development in its life cycle (i.e. Larval stage). For example, man in malaria and hydatid disease; female *Culex* mosquito in filariasis.

Obligate host (Compulsory host): It means the only host status available for a particular disease. For example, human being is the only host status available in measles, poliomyelitis, typhoid fever, etc.

Transport host (Mechanical carrier): The host in which the organisms, remain alive but does not undergo multiplication or development. For example, housefly.

Contagious disease: A disease transmitted from person to person, when they are in close physical (skin to skin) contact. For example, scabies, STDs, ophthalmia neonatorum.

Communicable disease: It is being communicated or transmitted, directly or indirectly, from man to man, animal to animal, man to animal, animal to man, or from environment (through air, soil, food, water, etc.) to man or animal. Tetanus is an infectious disease but not a communicable disease.

Noncommunicable disease: It is not being transmitted from person to person. For example, malnutrition, cancer, diabetes, hypertension, cardiovascular diseases, mental illness, etc.

Vector: It is an arthopod, which spreads the disease from person to person. For example, housefly, louse, mosquito, etc.

Epidemic disease (Epi = upon; among; Demos = people): Unusual occurrence of a disease or health related behavior (smoking) or health related event (like accidents) among the people, in a number, which is more than the expectation, based on the previous experience. The expected frequency of a disease, is what was before the onset of outbreak. For example, occurrence of a case of poliomyelitis in an area where routine immunization coverage is more than 85 percent, because the expected frequency is zero. Often the term 'outbreak' is also used.

Endemic disease (En = in; Demos = people, population): It means constant presence of a disease in a given geographic area, throughout the year, without importation from outside. This refers to the usual, expected frequency of the disease. For example, goiter, malaria, filariasis, typhoid, amoebiasis, STDs, leprosy, tuberculosis, viral hepatitis A, etc. When conditions are favorable, an endemic disease can become an epidemic disease.

Sporadic disease (means scattered about): Occurrence of a disease in a scattered manner, irregularly/haphazardly, in a community, in singles, separated widely in time and space. For example, chickenpox. When conditions are favorable, a sporadic case can become the starting point of an epidemic.

Pandemic disease (Pan = all; Demos = population): A disease which spreads from one country to another or from one continent to another affecting large number of people all over the world simultaneously. For example, influenza in 1918 and 1957. Cholera Eltor in 1962, acute hemorrhagic conjunctivitis in 1971 and 1981 and now AIDS and SARS in 2002-2003 (Severe Acute Respiratory Syndrome).

Exotic disease: A disease imported from one country to another country, where it does not exist. For example, yellow fever in India, rabies in UK.

Zoonotic disease (Zoonosis) (Zoo = animal; Nosis = disease): A disease, which is naturally transmitted between vertebrate animals and human beings, in either direction. They are of three kinds:

1. *Anthropozoonoses:* Diseases transmitted from animals to human beings. For example, rabies from dogs, plague from rats, Kyasanur forest disease from monkeys, brucellosis from cattle, Japanese encephalitis from pigs, etc.
2. *Zooanthroponoses:* Diseases transmitted from human beings to animals. For example, human tuberculosis in cattle. Filariasis caused by *Brugia malayi* from man to cats, dogs and monkeys.
3. *Amphixenoses:* Diseases maintained in both human beings and lower vertebrate animals, which may be transmitted in either direction. For example, Chaga's disease (trypanosomiasis), the reservoirs being both human beings and armadillos. Schistosomiasis, the reservoirs being both man and domestic animals like cats, dogs.

Epizootic disease: The outbreak of the disease among animal population, often affecting the human beings. For example, rabies among dogs, brucellosis among cattle, foot and mouth disease among sheep, etc.

Enzootic disease: It is an endemic disease among animals. For example, all anthropozoonoses.

Epornithic disease (Epi = upon, among; Ornis = birds): It is an outbreak of the disease occurring among birds. For example, psittacosis, histoplasmosis, avian influenza, etc.

Iatrogenic disease: A disease induced by a medical person, as a consequence of diagnostic or therapeutic or preventive procedure. It is not intentional but accidental. For example, reaction to penicillin, hepatitis B following blood transfusion, leukemia following exposure to radiation, etc.

Eradication of a disease (Similar to removal of a plant along with the roots and rootlets): Complete removal or wiping off of the causative agent from the entire nature, resulting in the absence of clinically identifiable disease, so that the future generation should be free from the fear (risk) of getting the disease without immunization. For example, smallpox has already been eradicated from the world. Dracontiasis (guineaworm disease) has been eradicated in India. Other diseases which are amenable for eradication are diphtheria, pertussis and measles; poliomyelitis has been eradicated in 125 countries and India is in the verge of eradication of polio. A noncommunicable disease which is amenable for eradication is goiter.

Elimination of a disease: Means reducing the incidence of a disease to such a low level, that it is no more a public health problem. For example, elimination of neonatal tetanus, elimination of leprosy. It is one step before eradiation. Tetanus cannot be eradicated because the spores of *Clostridium tetani* cannot be removed from the nature.

SURVEILLANCE

It is a process of collection of reliable information about the status (or occurrence and spread) of a specific disease in the given population and the factors related thereto, for monitoring and reporting on trends in specific health problems for prevention and control of that health problem/disease. In other words, it is the exercise of close scrutiny over the distribution of the disease with reference to time, place and person and the factors related thereto for the effective control. This helps to know the incidence and prevalence rates (magnitude of the problem and CFR). Population under surveillance may be a city or region or nation.

The components of this process are:

- Collection of data
- Complication of data
- Analysis of data
- Interpretation of the data
- Reporting of this information
- Action or intervention
- Feedback.

Since the surveillance systems are typically operated by public health agencies, the term 'Public health surveillance' is often used. Locally the surveillance provides the basis for identifying the people who need treatment, prophylaxis or education. When new public health problems emerge, the implementation of surveillance is critical to an effective early response. It often becomes a first step to inform priority setting for new programs.

History of Surveillance

Beginning in the late 1600s and 1700s, death reports were first used as a measure of the health of populations, a use that continues today also. In the 1800s, Shattuck used morbidity and mortality reports to relate health status to living conditions following the earlier work of Chadwick, who demonstrated the relationship between poverty and disease. Farr combined data analysis and interpretation and disseminated to policy makers.

In the late 1800s and early 1900s, physicians were required to report selected communicable diseases (like smallpox, tuberculosis, cholera, plague, yellow fever) to local health authorities in US and Europe and the term surveillance was evolved to describe a population—wide approach to monitor health and disease by Langmuir in 1963.

In the 1960s, networks of 'Sentinel' general practitioners were established in UK and Netherlands and surveillance was used to target smallpox vaccination campaigns, leading to global eradication and to control malaria in India. Meanwhile WHO broadened its concept of surveillance to include a full range of public health problems (beyond communicable diseases).

During 1980s, the introduction of microcomputers allowed more effective decentralization of data analysis and electronic linkage of participants in surveillance networks, thus revolutionized the surveillance practice.

During 1990s and early 2000s the automation of surveillance was accelerated by the use of internet. Meanwhile the increasing threat of bioterrorism provided an impetus for the growth of the systems and lead to the growth in 'Syndromic surveillance', aimed at early detection of epidemics.

Objectives of Surveillance

The primary objective of surveillance is to monitor the incidence or prevalence of specific health problem, to document their effect in defined populations and to characterize affected people and those at greatest risk. At the community level, surveillance can guide health departments in providing services to people; in the aggregate, surveillance data can be used to inform and evaluate public health programs. Trends detected through surveillance can be used to anticipate future trends, assisting health planners. In addition to providing basic information on the epidemiology of health problems, surveillance can lead to hypotheses or identify participants for more detailed epidemiologic investigations. To be effective, surveillance data must be

appropriately communicated to the full range of constituents who can use the data, ranging from health care providers to policy makers.

Thus surveillance highlights the magnitude of the problem, in terms of morbidity and mortality rates to identify the high risk areas, thereby it helps to plan for the program interventions, to monitor the quality of services and also to evaluate the services.

Elements of a Surveillance System

Surveillance systems require an operational definition of the disease under surveillance and of the target population. Events within the target population may be usefully monitored by attempting to identify all occurrence within a statistically defined sample. Surveillance systems encompass not only data collection but also analysis and dissemination. This 'cycle' of information flow may depend on manual or technologically advanced methods, including the internet. The protection of confidentiality is essential and requires protecting the physical security of data as well as policies against inappropriate release. The best incentive to maintaining participation in surveillance system is demonstration of usefulness of the information collected. The ethical conduct of public health surveillance requires an appreciation of both the benefits and risks of obtaining population health information.

Approaches to Surveillance (Data Collecting Procedures)

This means methods to conduct surveillance. Following are the methods:

a. *Active and passive surveillance:* An active approach means that the organization conducting surveillance initiates procedures to obtain report. (For example, in malaria, active surveillance means cases detected by the health worker by visiting the houses). A passive approach means the organization does not contact potential reporters and leaves the initiatives for reporting to others. (For example, in malaria, cases are detected by the static agencies like nursing homes, hospitals, etc.)
b. *Reporting of notifiable diseases:* Under public health laws, certain diseases are deemed 'notifiable', meaning that physicians or laboratories must report cases to public health officials. Traditionally this includes infectious diseases. Recently cancer is also included. Some diseases have to be reported immediately or within 24 hours to allow an effective public health response.
c. *Laboratory based surveillance:* This is highly effective for some diseases, e.g. the serum levels of a toxin or the antibiotic sensitivity/resistance of a bacterial pathogen. The disadvantage is that the laboratory records alone may not provide all the information and that the patients having laboratory tests may not be representative of all persons with the disease.
d. *Volunteer providers:* This approach to surveillance is required whenever the capabilities of routine approaches exceed. Such situation occurs when more detailed or timely information is required.
e. *Registries:* This provides comprehensive population-based data for specific health events, such as births defects, cancer, etc. Registries collect relatively detailed information and may identify patients for long-term follow up.
f. *Surveys:* Population surveys done periodically (or ongoing) provide a method for monitoring behaviors associated with disease, attributes that affect disease risk, attitudes that influence health behaviors, use of health services, etc.
This approach is preferred in those countries, where vital registration systems are underdeveloped.
g. *Information systems:* These are large data bases collected for general rather than disease specific purpose, which can be applied to surveillance. For example, records from hospital discharges are computerized to monitor the use and costs of hospital services. Data on discharge diagnoses, however, are a convenient source of information on morbidity.
h. *Sentinel events:* The occurrence of a rare disease known to be associated with a specific exposure can alert health officials to situations where others may have been exposed to a potential hazard. Such occurrences have been termed 'sentinel events', because they are harbingers of broader public health problems. Surveillance for sentinel events can be used to identify situations where public health investigation or intervention is required.
i. *Record linkages:* Records from different sources may be linked to extend their usefulness for surveillance by providing information that one source alone may lack. For example, in order to monitor birth weight, infant mortality rates, it is necessary to link information from corresponding birth and death certificates for individual infants. The former provides information on birth weight and other infant and maternal characteristics (e.g. gestational age at delivery, number of antenatal visits, mother's age and marital status, hospital where birth occurred, etc.) and latter provides information on age at death (e.g. neonatal versus postneonatal) and causes of death. By combining information based on individual level linked birth and death records, a variety of maternal, infant and hospital attributes can be used to make inferences about the effectiveness of maternal and infant health programs or to identify potential gaps in services. Thus, record linkage may be used to expand the scope of surveillance data.

j. *Combinations of surveillance methods:* For many conditions a single data source or surveillance method may be insufficient to meet information needs. Under such circumstances, combinations of multiple sources may be used to provide complimentary perspectives.

Analysis and Interpretation of Surveillance Data

The analysis of surveillance data is generally descriptive, using standard epidemiologic techniques. However, following considerations may arise during analysis and interpretation of data.

a. *Attribution of date:* A decision must often be made whether to examine trends by the date events (or were diagnosed) occurred or the date they were reported. Date of diagnosis provides a better measure of disease occurrence. Using the date of report is easier but subject to irregularities in reporting. There may be long delay between diagnosis and report. So it may be necessary to adjust recent counts for reporting delays, based on previous reporting experience.
b. *Attribution of place:* It is often necessary to decide whether analysis will be based on where events or exposures occurred, where people live or where health care is provided, which may all differ. For example, if people cross geographic boundaries to receive medical care, the places where care is provided may differ from where people reside. Place of care is more important in surveillance system to monitor the quality of health care whereas the place of residence is important to track the need for preventive services among people who live in different areas.
c. *Use of geographic information system (GIS):* GIS computer software can facilitate the study of spatial associations between health services and health outcomes.

Presentation of Surveillance Data

The mode of presentation of data should be geared to the intended audience in the form of tables, graphs or maps, to convey the key points.

Improvement in the Surveillance System

An increase in the reported number of cases or deaths is not always a negative sign or reflection of inadequate program interventions. An increase in the reported incidence occurring in the first few years as a result of improvement in the surveillance system is a 'positive sign'. This increase will be due to:

- Increase in the number of reporting sites
- Improvement in the completeness of reporting
- Increased awareness among people
- Active surveillance through paramedical personnel.

Types of Surveillance

There are nutritional surveillance, epidemiological surveillance in malaria, AFP surveillance in poliomyelitis, demographic surveillance, serological surveillance, etc.

Attributes of Surveillance

These are used to evaluate the existing systems or to conceptualize proposed systems. These attributes are:

- *Sensitivity:* To what extent does the system identify all targeted events?
- *Timeliness:* How promptly does information flow from collection to dissemination ?
- *Predictive value:* To what extent are reported cases really exist?
- *Representativeness:* To what extent do events detected through the surveillance represent persons with the condition of interest in the target population?
- *Data quality:* How accurate and complete are descriptive data in case reports, surveys or information systems?
- *Simplicity:* Are surveillance procedures and processes simple or complicated?
- *Flexibility:* Can the system readily adapt to new circumstances or changing information needs?
- *Acceptability:* To what extent the participants in a surveillance system accept the system enthusiastically?

Certain attributes are likely to mutually reinforcing. For example, simplicity is likely to enhance acceptability. Others are likely to be competing.

Ultimately the test of a surveillance system depends on its success or failure in contributing to the prevention and control of disease, injury, disability or death.

Uses of Surveillance

- To highlight the magnitude of the problem in terms of morbidity and mortality rates.
- To plan for the program intervention
- To monitor the quality of the services.
- To identify the high risk areas for additional action.
- To identify the outbreaks early for preventive measures.
- To estimate the needs for drugs.
- To achieve the goals of elimination or eradication.
- To document the impact of services.

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DYNAMICS OF DISEASE TRANSMISSION

Basically there are three pre-requisites for the transmission of a disease in the community, namely the reservoir, the susceptible person and the different routes of transmission from the reservoir to the susceptible persons.

Reservoir

It is the one in whom the causative organism lives, multiplies and depends primarily for its survival (i.e. the natural habitat of the organism). Such a reservoir may be human being, animal or soil.

Source of infection is a person, animal, arthropod, soil or the substance from which the organism directly enters the host.

The terms reservoir and source are not synonymous always. The following diseases have different reservoir and source of infection **(Table 19.1)**.

In certain diseases like scabies, STDs the same infected person not only acts as a reservoir but also as a source of infection to others. Similarly, Madura foot caused by actinomadura madurae, soil is both the reservoir and the source of infection.

A homologous reservoir state is the one, in which both the reservoir and the susceptible person belong to the same species. For example, chickenpox, measles, poliomyelitis (Human-Human being).

A heterologous reservoir state is the one, in which both the reservoir and the susceptible belong to the different species. For example, salmonellosis (Cattle-human being), Rabies (Dogs-human being), etc. Reservoirs are of three types—Human, Animal and Soil.

Table 19.1 Diseases having different reservoir and source of infection

Diseases	Reservoir	Source
Ankylostomiasis	Human being	Soil containing larvae
Tetanus	Herbivorous animal	Soil containing spores
Plague	Rodents	Rat-flea
Japanese encephalitis	Pigs	Female culex mosquito
Kyasanur forest disease	Monkeys	Hard tick

Human Reservoir

May be case or carrier.

Case: A case is an infected person having clinical features of the disease. Such a case may be mild, moderate or a severe case. Mild cases are more dangerous than the severe cases because they are ambulatory and go on spreading the disease wherever they go. Severe cases are usually bedridden.

Cases do not act as source throughout the duration of illness. They do so only during the 'period of communicability', which varies from disease to disease. For example, in typhoid it is from 1st day of fever until two stool samples (24 hours apart) are negative. In measles, it is from 1st day of fever to 4th day (onset of rash).

In epidemiological studies, 'Primary case' refers to the first person developing the disease in an outbreak, in the defined population. 'Index-case' is the first case which comes to the attention of the investigator. 'Secondary cases' are those who get the disease by contact from the primary case.

Carrier: A carrier is an infected person but not having the clinical features of the disease (thus harboring the organisms) and serves as a source of infection to others in the community. Such carriers are seen in typhoid, diphtheria, gonorrhea, AIDS, hepatitis B, meningitis, salmonellosis and amoebiasis. They can be detected only by doing laboratory investigations. 'Pseudocarrier' is the one who carries avirulent organisms. For example, diphtheroids. They are not important epidemiologically. The carriers constitute the submerged portion of ice in iceberg phenomenon.

Classification

A. *Type:* According to the stage in the disease cycle, there are three types of carriers, namely—incubatory, convalescent, and contact carriers.
   a. *Incubatory carrier:* Is the one who is spreading the disease during the incubation period-itself (i.e. before the onset of the disease itself). Such a state occurs in diseases like measles, mumps, diphtheria, poliomyelitis, pertussis, influenza and hepatitis A and B. After the incubation period, that individual develops the clinical features and become a case.
   b. *Convalescent carrier:* Is the one who is acting as a carrier during the period of convalescence (recovery) from an illness. That means such a person is getting cured clinically but not bacteriologically, may be due to incomplete course of treatment. Such a state occurs in conditions like diphtheria, typhoid fever, amoebiasis.

c. *Healthy or contact carrier:* Is the one who is subclinically infected and acts as a source of infection to others. The nursing staff, the patient's attendants or the family members who are in close association with the cases often become healthy carriers. They never suffer from the disease. This often occurs in diphtheria and cholera.

B. *Duration:* Depending upon the duration of the carrier state, they are grouped into temporary and chronic carriers.
   a. *Temporary carriers:* These are those who are acting as carriers and spreading the disease for a short period of time (for several days). All incubatory, convalescent and healthy carriers are temporary carriers.
   b. *Chronic carriers:* These are those who are transmitting the disease for a long period of time, several weeks to several months. This state occurs because of persistence of the organisms in the organs like gallbladder in typhoid fever, tonsils in diphtheria, liver in hepatitis B, etc.

C. *Route of exit:* Depending upon the route of exit, the carriers are also grouped into the following:
   a. Urinary carriers, where the focus of organisms is the kidney as in typhoid
   b. Intestinal carriers, where the focus of organisms is the intestine, as in typhoid, amoebiasis
   c. Biliary carriers, where the focus of organisms is the gallbladder as in typhoid
   d. Cutaneous carriers as in staphylococci
   e. Nasal carriers as in nasal diphtheria
   f. Genital carriers as in gonorrhea, AIDS.

The epidemiological importance of these carriers is related to their occupational status. An intestinal and urinary carrier working in food establishment and water works is more dangerous than working in an office establishment.

'Typhoid-Mary' is classical example of a carrier found to be dangerous to the community. She was a chronic typhoid carrier working in the food establishment as a cook. She was responsible for 25 deaths due to typhoid and 1250 cases of typhoid, because of her poor personnel hygiene and poor sanitation.

Thus from epidemiological point of view, the carriers are more dangerous than the cases because they are not recognized and are ambulatory. Among the carriers, chronic carriers are more dangerous than temporary carriers. Longer the duration of carriers, greater the risk to the community. Such carriers may shed the organisms intermittently or continuously. They are respectively called as intermittent and continuous carriers. Carriers are responsible for the endemicity of the disease in the community. They may spread the disease to those areas also, which are otherwise free of infection. They correspond to the 'submerged' portion of ice in iceberg phenomenon. Therefore, their detection and treatment is essential to limit the spread of the disease in the community and that is a challenge to the modern technique of community medicine.

Animal Reservoir

There are many animals, which act as reservoir and transmit the diseases to human beings. These diseases are called zoonotic diseases (anthropozoonoses).

Animal reservoir	–	**Diseases transmitted**
Cattle	–	Bovine tuberculosis, salmonellosis, Tetanus, brucellosis, Q-fever, Taenia-saginnata.
Horses	–	Tetanus
Dogs	–	Rabies, hydatid disease
Monkeys	–	Yellow fever, dengue fever, kyasanur forest disease.
Sheep	–	Anthrax, liver fluke (Fasciola hepatica)
Pigs	–	Japanese encephalits, tenia solium.
Rodents	–	Plague, leptospirosis, endemic typhus.
Birds	–	Psittacosis, histoplasmosis, ornithosis.

For most of the zoonotic diseases, there is no treatment. Prevention is the only intervention. These animal diseases occur among human beings, because of our close association with them.

Zoonotic diseases can also be classified as viral, bacterial, parasitic and rickettsial diseases.

1. **Viral:** Rabies, yellow fever, dengue fever, Japanese encephalitis, KFD.
2. **Bacterial:** Salmonellosis, brucellosis, leptospirosis, plague.
3. **Parasitic:** Teniasis, hydatid disease, leishmaniasis.
4. **Rickettsial diseases:**
   a. *Typhus group:* Rickettsial zoonoses, epidemic typhus, scrub typhus: Murine typhus
   b. *Spotted fever group:* Tick typhus, Rocky mountain spotted fever, Rickettsial pox
   c. *Others:* Q fever, trench fever.

Soil Reservoir

Soil acts not only as a reservoir but also as source of infection and transmit diseases like tetanus, gas-gangrene, ankylostomiasis, anthrax, malignant edema, aspergillosis, coccidioidomycosis, mycetoma (Soil borne diseases).

Routes of Transmission

A communicable disease is transmitted from the reservoir/source to a susceptible person either directly or indirectly, depending upon whether they are in close proximity or not.

Direct Modes of Transmission

There are five direct modes:

1. *Direct contact:* When the reservoir and the susceptible person are in close, physical, skin to skin contact. Example,

scabies, STDs AIDS, lepromatous leprosy, ophthalmia neonatorum (these are also called as contagious diseases).

2. *Droplet infection:* When the susceptible person inhales the infected droplets, of 5 to 10 μ diameter, coming out of the mouth or nose from the reservoir during the act of coughing, sneezing, talking and laughing. For example, pulmonary tuberculosis, diphtheria, measles, pertussis, etc.
3. *Contact with the contaminated soil:* For example, all soil borne diseases, e.g. tetanus, anthrax, ancylo-stomiasis.
4. *Contact with the animal:* Classical example is rabies transmitted from a rabid animal by bite and inoculating the virus into the skin or mucous membrane.
5. *Transplacental (vertical) transmission:* Means transmission of the disease from the mother to the fetus through the placenta.

   For example, toxoplasmosis, rubella, syphilis, AIDS, hepatitis B, cytomegalovirus, herpes virus (TORCH-agents).

   Some drugs also pass transplacentally resulting in fetal damage. For example, thalidomide, tetracycline, steroids, streptomycin, etc.

   Transplacental immunization is immunization of fetus through the mother. For example, two doses of tetanus toxoid to the pregnant mother immunizes the fetus against neonatal tetanus.

Indirect Modes of Transmission

There are five indirect modes:

1. **Vehicle route:** The vehicles which are capable of transmitting the diseases are water, food, milk, ice-cream, vegetables, biological products like blood, tissues or organs (as in organ transplantation).
2. **Vector route:** Vector is an arthropod, capable of transmitting the disease. For example, mosquitoes, flies, fleas, lice, ticks, mites, cyclops, etc. The vectors transmit the diseases in the following ways:
   - *Mechanically:* Carrying the pathogens from the filthy substances to food substances by soiling the legs. For example, house-fly transmitting typhoid, trachoma, etc.
   - *Biting* and inoculating the pathogens percu-taneously. For example, mosquitoes, fleas, ticks, etc.
   - *Defecation:* Scratching in of the infected feces, into the abrasions of the skin. For example, epidemic typhus, trench fever transmitted through the feces of infected louse.
   - *Contamination* of the abraded skin of the host by the body fluid of the infected arthropod when it is crushed.

     For example, transmission of relapsing fever, when infected louse is crushed in the scalp.
   - *Biologically:* When the pathogen undergoes multiplication or development from one stage to another stage or both multiplication and development, inside the body of the vector. Thus, biological mode of transmission is of three types:
     1. **Propagative type:** In this type, the pathogen undergoes only multiplication inside the vector. For example, plague bacilli in the body of the rat-flea; yellow fever virus in the body of female Aedes mosquito; KFD virus in the body of hard tick.
     2. **Cyclopropagative type:** In this type, the pathogen undergoes not only multiplication but also a phase of development in its life cycle. For example, *Plasmodium* (malarial) parasites in the body of the female anopheline mosquito (Zygote → Ookinite → Ocyst → Sporozoites).
     3. **Cyclodevelopmental type:** In this type, the pathogen undergoes only a phase of the development but not multiplication.

     For example, microfilariae developing into larval stage in the body of female culex mosquito; Guineaworm embryos developing into larva in the body of Cyclops.
3. **Air-borne route of transmission:** By droplet nuclei and infected dust:
   - *Droplet nuclei:* The infected droplets, smaller than 5 μ in diameter, coming out of the reservoir through the mouth or nose, will be floating in the air. Meanwhile the moisture content is evaporated leaving behind only a mass of pathogens as residue, which are disseminated by the air current to different places, resulting in epidemics and pandemics. For example, influenza, SARS, measles, tuberculosis, etc.
   - *Infected dust:* The infected droplets, larger than 10 μ diameter, will settle on the floor and become part of the dust in the hospitals. During the act of sweeping the floor, bed-making or whenever wind blows, the dust is released into the atmosphere thus promoting the spread of cross-infections in the wards. For example, pulmonary tuberculosis, streptococcal and staphylococcal infections, etc.
   - *By air pollution:* For example, bronchitis, bronchial asthma, Hay fever, pneumoconiosis, allergic respiratory diseases, Bhopal gas tragedy, etc.
4. **Fomite route of transmission:** Fomites are the inanimate objects capable of transmitting the diseases. For example, clothes, linen (Scabies), clinical thermometer, spoons, pencils, tongue depressor (Diphtheria, streptococcal infections) surgical instruments, syringes, needles, toothbrush, shaving brush, razor (Hepatitis B, AIDS), etc. Such infections are also called as 'mediate infections.'
5. **Unclean hands and fingers:** These contaminate the food and drinks and transmit diseases like typhoid, streptococcal and staphylococcal infections, diarrheas and dysentery.

Susceptible Host

A susceptible person is the one who is likely/prone to develop the disease. For a disease to occur in an individual, there must be a portal of entry, a site of election and poor defence mechanism.

Portal of entry may be respiratory route, alimentary route, per cutaneous route or genital route. There may be even more than one route of entry. For example, AIDS, Hepatitis B, etc.

A site of election means, a site (on organ) where the pathogen finds optimum favorable condition for its growth, development, multiplication and survival. It is called 'Target Organ'.

Defence mechanism is at three levels—anatomical protection by healthy and intact skin, chemical protection by gastric acidity, and biological protection by immunity.

For successful parasitism, there must be a portal of entry, a site of election, a portal of exit (similar to portal of entry) and must survive in the external environment for a sufficient period till it finds a new host, to propagate its species.

If there is a portal of entry, site of election and no portal of exit, it is called 'Dead-end' infections. That means they are infectious diseases but not communicable from person to person. For example, hydatid disease, rabies in man (Hydrophobia), Japanese encephalitis, tetanus, Kyasanur Forest disease, Bubonic plague, trichinosis. The disease agent dies in human being.

A successful disease agent is the one which has a portal of entry, a site of election, a portal of exit, survives in the external environment, enters a new host, propagates its species and does not cause the death but produces only a low grade of immunity, so that the host is vulnerable again and again to the same infection. For example, common cold virus.

INCUBATION PERIOD

Definition: It is defined as a 'period between the successful entry of a pathogen and the appearance of the first clinical sign or symptom of the disease', in an individual. It is also called 'intrinsic incubation period'.

Events that take place during incubation period: After entering the body the pathogen circulates and reaches the target organ, where it lodges, gets adopted, multiplies and reaches an optimum number, overcomes the body's defence mechanism, disturbs the structure and function of that organ, produces changes in the body fluid and body tissues, disturbs the health equilibrium and ultimately results in the manifestations of clinical signs and symptoms of the disease.

Factors influencing the incubation period: These are virulence of the pathogens, infective dose and the susceptibility of the individual. In short, the incubation period depends upon the host-parasite relationship.

Variability: Every infectious disease has an incubation period. It varies from disease to disease and in the same disease it varies from person to person, depending upon the above factors. Thus incubation period may be few hours, few days, few weeks, few months or few years.

Diseases having very short incubation period (few hours to few days): For example, food-poisoning, bacillary dysentery, gonorrhea, meningococcal meningitis, cholera, etc.

Diseases having incubation period varying from few days to few weeks (1 to 3 weeks).

For example, Chickenpox, common cold, chancroid, measles, mumps, malaria, diphtheria, tetanus, pertussis, typhoid, poliomyelitis, yellow fever, etc.

Diseases having incubation period varying from few weeks to few months:

For example, Amoebiasis, hepatitis A and B, kala-azar, rabies, etc.

Diseases having incubation period varying from few months to few years:

For example, Tuberculosis, leprosy, filariasis, AIDS, dracontiasis, etc.

Communicability during the incubation period: It is the capacity of an infectious agent to spread to others. Usually the infectious diseases are not communicable during the incubation period. Exceptions are chickenpox, diphtheria, pertussis, poliomyelitis, measles, mumps, hepatitis A. Such persons who are spreading the disease during the incubation period itself are called 'Incubatory carriers'.

Related Terms

Extrinsic incubation period: It is the period between the entrance of the pathogen inside the body of the arthropod till the arthropod (vector) becomes infective. For example, 10 to 14 days in malaria, filariasis and yellow fever.

Serial interval: It is a period between the onset of the first or index case and the secondary case. From a series of such secondary cases, the range of the incubation period of a particular disease can be guessed. Since the exact time of entry of the organism in the body cannot be known in practice, serial interval is used.

Generation time: It is a period between the onset of the infection and the maximum infectivity of the host. This period may be shorter than the incubation period as in mumps or longer than the incubation period as in measles.

Latent period: It is similar to incubation period but with reference to noncommunicable diseases such as diabetes, hypertension, cancer, etc. It is a period between the initiation of the disease and the detection of the disease.

Window period: It is the period between the entry of the pathogen and the production of the antibodies. It is 2 to 8 weeks in HIV/AIDS. ELISA test is negative during this period. But infected person is infectious to others during this period.

Prepatent period: It is the interval between the entrance of the parasite (infective larvae of the *Wuchereria bancrofti*) and the first appearance of the microfilariae in the blood as in filariasis. It varies from 12 to18 months.

Minimum and maximum incubation period: Since the incubation period always varies, every infectious disease has a minimum and a maximum incubation period. But it is almost constant in diseases like smallpox (14 days) and measles (10 days).

Median incubation period: It is the time required for 50 percent of the cases to occur following exposure **(Fig. 19.1)**.

Communicable period: It is a period during which the reservoir is infectious to others. This can be reduced by making an early diagnosis and correct treatment. The communicability of a disease can be measured by an indicator 'Secondary attack rate', i.e. Percentage of the exposed persons/susceptible contacts, developing the disease, following exposure to primary case (The rate at which the disease is spreading in the community).

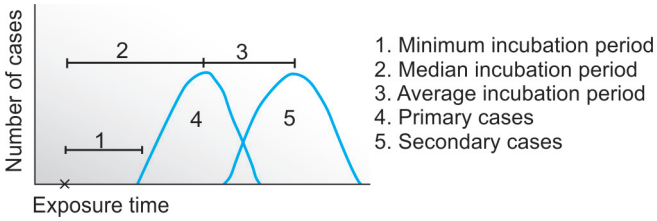


Fig. 19.1 Showing incubation period (*Source:* Rothman, Greenland and Lash. Modern epidemiology Lippincot Wiliams and Wilkins—a Wolters Kluwer Business. Third Edn. 2012)

$$\text{SAR} = \frac{\text{No. of persons developing the disease following exposure to primary case}}{\text{Total number of exposed persons or susceptible contacts}} \times 100$$

Higher the SAR, higher will be the communicability of the disease and vice versa.

Uses of Incubation Period (Table 19.2)

1. **Helps in making diagnosis:** Short incubation period helps in making the diagnosis, as in food poisoning, gonorrhea, donovanosis, etc.
2. **Helps to trace the contacts or the source of infection:** As in diseases having short incubation period (mentioned above). This is not possible if the incubation period is long. Tracing the source of infection or contacts helps to implement the control measures.
3. **For quarantine purposes:** Quarantine means limiting the movement of the healthy persons, who are suspected to have been exposed to a communicable disease, for such a period equal to the longest incubation period of the disease.

   This was adopted to prevent the international spread of the diseases like smallpox, cholera, plague and yellow fever by quarantining those who were not producing the valid International Certificate of Vaccination, in the international airports and seaports. Now it is outdated procedure.
4. **For immunization purposes:** The at-risk person can be protected by immunizing after exposure to the disease by making use of the long incubation period as in rabies, tetanus, etc.

Table 19.2 Differences between intrinsic and extrinsic incubation period

Intrinsic incubation period	Extrinsic incubation period
It is with reference to human being.	It is with reference to arthropod (vector).
It is the period between the entrance of the pathogen in a person and the appearance of the first sign or symptom.	It is the period between the entrance of the pathogen/parasite inside the body of vector, till the agent reaches an optimum number or full development.
During this period the pathogen reaches the target organ, gets adapted, multiplies, causes damage of the target organ.	During this period, the parasite undergoes biological transmission inside the vector (i.e. multiplication or development or both).
This period varies from few hours/days to few months/years.	This period varies from 10 to 14 days.
This is influenced by virulence, infective dose and individual susceptibility.	This is influenced by atmospheric temperature and humidity.
Usually, the person is not infective during this period, except in diseases like measles, mumps, chickenpox, diphtheria, pertussis.	Usually, the vector is never infective during this period and it becomes infective only after this period.
The infected person never remains infective throughout the life.	The infective vector remains infective throughout its life.
Uses: Intrinsic incubation period is used for making diagnosis, finding out the source of infection, for immunization purposes and also for assessing the prognosis.	Extrinsic incubation period is utilized for control of vectors.

5. **Helps to assess the prognosis:** Shorter the incubation period, worse is the prognosis, as in tetanus.

INVESTIGATION OF AN EPIDEMIC DISEASE

Importance

Whenever an outbreak of a disease occurs in the community affecting large number of people, it becomes a public health emergency and calls for a thorough investigation and implementation of control measures.

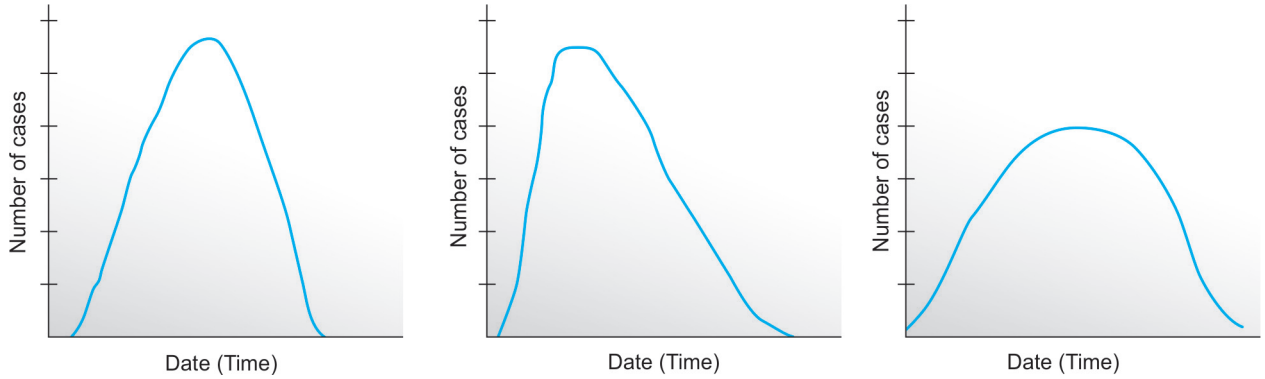
Objectives

The objectives of the epidemiological investigations are:

- To know the distribution of the outbreak in the community with reference to time, place and person including environmental conditions
- To know the magnitude of the problem in terms of morbidity and mortality
- To identify the causative agent, source of infection, mode of transmission
- To implement immediate control measures
- To give recommendations for prevention of future recurrences of epidemic.

Steps

1. **Confirmation of the epidemic:** This is important because at times, there will be false reports. So it is necessary to verify and confirm the existence of an epidemic by observing large number of people being affected simultaneously with similarity of signs and symptoms and also by comparing the disease frequencies during the same period of previous years. Often such comparison is not necessary as in common source epidemic such as acute gastroenteritis, food poisoning. Meanwhile baseline epidemiological data is also collected such as name of the village, primary health center, district, total population of the area, availability of the nature of the health services, date of visit and names of the investigating officers.
2. **Confirmation of the diagnosis:** This is done from the history and clinical examination of a sample of cases. The necessary material is sent for laboratory investigations. However, time is not wasted by waiting for the investigation report to come.
3. **Collection of other relevant, ecological information:** Such as fair or *mela*, season, atmospheric temperature and humidity, which often favor the onset of an epidemic.
4. Studying the distribution of the epidemic with reference to time, place and person.
   a. Time distribution of the epidemic is studied by plotting the number of cases against the dates on a graph, the curve so obtained is called 'Epidemic curve' and the shape of the curve helps to know the type of the epidemic **(Fig. 19.2)**.
   b. Place distribution of the epidemic is studied by plotting the number of cases as 'Dots' or 'Stars' with respect to their localities in the geographical area map. This is called 'Geographical spot/shaded map' **(Fig. 19.3)**. The pictorial presentation shows at a glance, the area of high and low density. The area of high density gives a clue about the source of infection and even the mode of spread. This is how John Snow was able to focus the attention on the particular water



'Sudden rise and sudden fall' of the epidemic curve. This indicates 'common-source, single exposure' epidemic. For example, food poisoning.

'Sudden rise and sudden gradual fall' of the epidemic curve. This indicates 'common source, repeated exposure' epidemic. For example, cholera.

'Gradual rise and gradual fall' of the epidemic curve. This indicates 'propagated epidemic'. For example, viral hepatitis A.

Fig. 19.2 Different types of epidemic curves

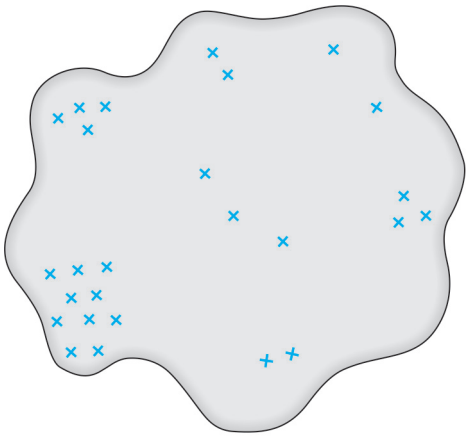


Fig. 19.3 Geographical spot map

pump in the broad street of London, as the source of infection of the epidemic of cholera, in 1854 and was able to hypothesize that cholera was a water-borne disease, much before the organisms were isolated.

c. *Person distribution of the epidemic:* This is studied by collecting the following data:
   - Total population of the area
   - Total number of persons being affected
   - Total number of deaths, if any
   - Age wise and sex wise distribution of the diseased and the dead
   - The 'population at risk' can thus be defined, which becomes the denominator to calculate the 'Attack rate'.
   - The other relevant characteristics such as their movement to any pilgrimage center, etc. is also noted down. All these information is recorded in 'epidemiological case sheet'.

5. Rapid search is made by the area health worker by door to door survey to detect many more such new cases. The search for the new cases (secondary cases) should be carried out everyday, till the area is declared free of the epidemic. This period is usually taken as twice the incubation period of that disease, since the occurrence of the last case.
6. **Analysis of the data:** The data is now analyzed to know the magnitude of the problem by calculating morbidity (attack) rate and mortality (case fatality) rates.

$$\text{Attack rate (AR) (\% of population at risk being affected)} = \frac{\text{Number of persons being affected}}{\text{Population at risk}} \times 100$$

Incidence rate and prevalence rate are not studied because it is an epidemic.

$$\text{Case fatality rate (CFR) (\% of the cases dying)} = \frac{\text{Number of cases dying}}{\text{Total number of cases}} \times 100$$

7. **Formulation of etiological hypothesis:** This is done in terms of the diagnosis, causative agent, possible source of infection, mode of spread, environmental factors favoring the occurrence of the epidemic.
   For example, it is an outbreak of acute gastroenteritis, caused by *Vibrio eltor* organisms, transmitted from the river/well, through water.
8. **Testing of hypothesis:** The hypothesis can be tested by doing 'case-control' study to calculate exposure rate. If exposure rate is more among cases than among controls, then there is an association between the suspected factor and the disease.

		Cases	Controls
H/o exposure	Present	40 (a)	60 (b)
	Absent	10 (c)	90 (d)

Exposure rate among cases (% of cases exposed) =

$$\frac{a}{a+c} \times 100 = \frac{40}{50} \frac{100}{} = 80\%$$

Exposure rate among controls (% of controls exposed) =

$$\frac{b}{b+d} \quad 100 = \frac{60}{150} \frac{100}{} = 40\%$$

Since is $\frac{a}{a+b}$ greater than $\frac{b}{b+d}$, there is an association between acute gastroenteritis and water.

9. **Implementation of the control measures:** This should be done at the commencement of the epidemic on the basis of known facts of the disease. After the detail investigations, measures can be modified for better control of the epidemic.
10. **Submission of the report:** This should be systematic, correct, comprehensive, complete and convincing including the recommendations for the prevention of recurrence of the epidemic.

The area is declared free of the epidemic when twice the incubation period has lapsed from the date of detection/death of the last case.

PREVENTION AND CONTROL OF AN EPIDEMIC DISEASE

The basic concept of control of an outbreak of the disease is to break the weakest link in the chain of transmission of the disease. These are three major steps:

1. Elimination of reservoir
2. Breaking the channel of transmission
3. Protection of susceptibles.

Elimination of Reservoir

- Elimination of environmental reservoir, such as air, water, soil, etc. is impossible and out of question.
- Elimination of animal reservoir means keeping the animals away from the human habitation and that is possible but difficult.
  For example, pigs in the outbreak of Japanese encephalitis and cattle in brucellosis.
- Elimination of human reservoir means they are eliminated from acting as a source or reservoir of infection by the following measures, i.e. the infectious person is made noninfectious.
  i. **Early diagnosis:** Earlier the diagnosis is made and earlier the treatment started, further transmission can be prevented. Delay in making the diagnosis results in further spread of the disease. It is aptly said that early diagnosis and prompt treatment of a case or carrier is like 'stamping the spark rather than calling the fire brigade to put out the fire caused by the spark'. Early diagnosis also helps to know the source of infection, so that they can also be traced and treated as in STDs, food poisoning, Act GE, etc.
  ii. **Notification:** This means giving an official report to the concerned local health authorities, whose responsibility is to rush to the spot and implement control measures early in order to prevent further spread. This notification to the health authorities can be made not only by the medical and para-medical personnel but also by the lay public. The notification inturn will reach district, state, national and international authorities, specially now the disease poliomyelitis.
  iii. **Epidemiologic investigations:** A detail epidemiologic investigations will have to be carried out in the area:
    - To know the distribution of the disease with reference to time, place and person
    - To know the causative agent, source of infection, mode of transmission, factors influencing
    - To know the magnitude of the problem by estimating the attack rate and case fatality rate.
  iv. **Isolation:** This means separation of sick person or animal from others in such a place like isolation ward of the hospital, for such a period of time, till he becomes noninfectious, under such conditions, as to prevent further transmission to others. This is physical isolation. The purpose is to 'contain' the disease, i.e. to see that it remains confined to that particular person and that it is not transmitted to others.

    This is of distinctive value in highly infectious diseases like diphtheria, pneumonic plague, severe acute respiratory syndrome (SARS), pertussis. etc. where the risk of transmission is very high.

    This is of limited value in those diseases where large number of subclinical and carrier state occurs, as in typhoid, viral hepatitis A, etc.

    Isolation is of no values in the control of disease like tuberculosis, leprosy, etc. which carry social stigma. In such cases the concept of physical isolation is replaced by chemical isolation, i.e. giving domiciliary treatment.

    Isolation may also be achieved by 'Ring immunization', i.e. encircling the infected person/house with a barrier of immunized persons, so that disease does not spread. This was practiced to eradicate Smallpox and now practiced in US to eradicate measles.
  v. **Disinfection (Concurrent disinfection):** It is the disinfection of body discharges such as sputum, urine, and stools of the patient. It is carried out as long as the patient is in the isolation ward.

    Terminal disinfection: It is the disinfection of the left over articles of the patient, after the death or discharge of the patient.
  vi. **Treatment:** This is done with the objective of killing the disease agent when it is still within the reservoir, so that the infectious person becomes noninfectious. This is 'Individual treatment'. In high endemic areas, the entire population is given treatment with the drug irrespective of whether they have the disease or not, as in malaria, filariasis. This is called 'Mass treatment'. 'Blanket treatment' is the treatment of the entire family members, as in scabies.
  vii. **Quarantine:** It is defined as 'the limitation of the freedom of the movement of those healthy persons, who are suspected to have been exposed to a communicable disease for a period equal to the longest incubation period of the disease, in the international airport or seaport, in such a manner as to prevent the International spread of the diseases.' That means those who were not possessing the valid certificate of vaccination were quarantined. This was practiced against diseases such as smallpox, plague, cholera and yellow fever. Now it is outdated. That was called 'Absolute quarantine'.

'Modified quarantine' (partial quarantine) is selective limitation of the freedom of movement. For example, exclusion of children from going to school during the period of treatment, as in scabies, diphtheria, chickenpox, etc.

'Segregation' means separation of a group of healthy but susceptible persons to protect them from getting a disease from the infected persons, thereby controlling the disease.

For example, placing the susceptible children in the homes of immune persons.

Breaking of Channel of Transmission

a. **Direct** modes of transmission can be broken as follows:
   - Contact: Transmission can be broken by avoiding close, physical, skin to skin contact with infectious, (contagious) cases
   - Droplet infection transmission can be broken by advising the reservoir (suffering from respiratory diseases) to cover the nose and mouth, while coughing, laughing, sneezing and talking
   - Soil borne transmission can be prevented by using *chappals* or shoes while walking
   - Bite by the animal can be prevented by being away from them
   - Transplacental transmission (perinatal or vertical transmission) can be broken either by giving treatment to the mother during pregnancy as in syphilis or by terminating the pregnancy as in rubella.
     Prevention of parent to child transmission (PPTCT) in HIV +ve pregnant mothers is done by giving zidovidine or nevirepine during pregnancy or with the onset of labor pain respectively followed by a dose of nevirepine to the newborn. Efficacy is 40 percent.

b. **Indirect** modes of transmission can be broken as follows:
   - Vehicle route of transmission can be broken depending upon the vehicle as follows:
     Water to be chlorinated, milk to be pasteurized, blood to be screened, fruits and vegetables to be disinfected, and by adopting food hygienic measures.
   - Vector route of transmission broken by control of vectors.
   - Air-borne transmission can be prevented by controlling air pollution, control of infected dust in the hospital wards and other measures such as adequate ventilation, etc.
   - Transmission through fomites can be prevented by disinfection of fomites.
   - Transmission through contaminated hands and fingers can be prevented by adopting personal hygiene.

Protection of Susceptibles

Susceptible population can be protected by two measures:
1. Specific measures such as immunoprophylaxis, chemoprophylaxis.
2. General measures such as improvement in the quality of life (such as good living, better nutrition, clean sanitation, etc). Implementation of legislative measures (such as ESI Act, PFA Act).

Immunization (Table 19.3)

It is a procedure in which immunobiological substances are administered to strengthen the defence (immune) mechanism as to protect the individual against the disease. When this is implemented in the community at large, the susceptible population can be reduced.

There are two types of immunization—active and passive. The differences are as follows:

Table 19.3 The differences between active and passive immunization

Active immunization	Passive immunization
This consists of administration of antigens. For example BCG, DPT, MV, OPV, etc.	This consists of administration of antibodies. For example ADS, ATS, etc.
Immunity is produced after sometime (10-15 days)	Immunity is produced instantaneously
Reticuloendothelial cells are educated. So it is an active process	Reticuloendothelial cells are not educated. So passive process
Immunity lasts longer	Immunity lasts shorter
Usually not associated with reactions	Often associated with reactions
Usually it is given before exposure to the disease	Usually it is given after exposure to the disease
This procedure is never used for treatment purposes	This is often used as a part of treatment, as in tetanus, diphtheria
This is more useful	This is less useful

IMMUNIZING AGENTS

They have been classified into three groups, namely vaccines, immunoglobulins and antisera.

Vaccines

These are the antigenic substances which when administered in an individual, stimulate the production of specific antibodies and protects the individual against that particular disease. Therefore, they are used for active immunization.
The vaccines are the following types:

- Live vaccines, killed vaccines, toxoids, cellular fractions, sub-unit vaccines, recombinant vaccines, combined vaccines, Tissue culture vaccines and related vaccines (or terms).
  i. **Live vaccines:** They are so called because, the organisms (antigen) in the preparation are living but attenuated. That means they are made to retain the antigenicity and to loose pathogenicity. Since the organisms are living, they multiply in the body after administration and so the antigenic stimulus becomes more than what is administered and the production of the antibody is also quick and more, thereby the immunity also lasts longer. Usually they

are given in single dose, except oral polio vaccine. Thus live vaccines are safe, effective, more potent with long lasting immunity and require single dose compared to killed vaccines. There are no untoward reactions.

The only limitation is to maintain the 'Cold-chain' to retain the potency of the vaccines.

Live vaccines should not be given to persons with immunodeficiency states like AIDS, steroid therapy, radiotherapy, chemotherapy for malignancy and acute febrile conditions. These are absolute contraindications.

However, pregnancy is not an absolute contraindication but a relative contraindication. That means if the merits are more than the demerits, vaccine can be given during pregnancy also. For vaccines like OPV, tissue culture anti-rabies vaccine, there are no contraindications at all. For examples, live vaccines: BCG, OPV, MV, MMR, R-Vac, oral typhoid vaccine, Influenza live vaccine, yellow fever (17D) vaccine and Hepatitis A live vaccine.

ii. **Killed vaccines:** In this type, the organisms are inactivated or killed by heat or chemicals like phenol, β-propriolactone. Usually they are given in multiple doses in the primary course (2 to 3 doses) followed by booster dose subsequently. Immunity lasts shorter than live-vaccines and reactions are also frequent. Thus compared to live-vaccines, killed vaccines are less safe, less effective, less potent with short lasting immunity, requiring multiple doses.

For example, cholera V, plague V, BPL antirabies vaccine, influenza killed V, salk polio vaccine, JE vaccine, KFD V, Dakar yellow fever vaccine, Hepatitis A killed vaccine, etc.

iii. **Toxoids:** They are modified toxins. The toxins of the organisms are modified (detoxified) so as to maintain only antigenicity and not pathogenicity (toxicity). Thus, they are used as vaccines. They also require multiple doses in the primary course followed by booster doses. They are quite safe and effective. For example, diphtheria toxoid, tetanus toxoid.

iv. **Cellular fractions:** These vaccines are prepared from the extract of the bacterial cell-wall or capsule. They are also safe, effective and some require booster doses.

For example, meningococcal vaccine, pneumococcal vaccine, parenteral typhoid vaccine.

v. **Subunit vaccine:** This is prepared from a component of the virus.
For example, influenza vaccine.

vi. **Recombinant vaccines:** These are genetically engineered recombinant DNA vaccines, i.e. the sub-unit of the virus (antigen) is inserted into the genome of another avirulent virus and vaccine is prepared.

For example, hepatitis B vaccine.

vii. **Combined vaccines:** They are so called because the preparation contains more than one antigen. Therefore, they are also called 'Mixed vaccines'. For example, easy five (pentavalent), DPT, DT, MMRV. The merits are:
- The individual is simultaneously protected against 2 to 3 diseases
- One antigen enhances the effect of other antigen
- It reduces the number of visits to the clinic.
- Thus it becomes economical.

viii. **Tissue culture vaccines:** These are prepared by culturing the seed viruses in special cells such as chick-embryo cells, vero cells of kidney of monkeys, human embryonic lung fibroblasts, etc. They are highly safe, highly antigenic, highly effective, highly stable, highly potent, highly protective and highly purified. They are costly and are given in multiple doses. They are least reactogenic.
For example, PCECV (Purified chick embryo cell vaccine)
PVRV (Purified vero cell rabies vaccine)
HDCV (Human diploid cell vaccine) all used against rabies.

ix. **Related terms:**
- *Polyvalent vaccines:* Vaccine containing more than one strain of the same species. For example, OPV (Trivalent vaccine); influenza vaccine.
- *Adjuvant vaccines:* Adjuvants like aluminium phosphate are used to enhance the antigenic property. But they are painful and often result in fever. For example, purified toxoid adsorbed on aluminium phosphate tetanus toxoid, i.e. PTAP tetanus toxoid.
- *Freeze dried vaccines:* These are the vaccines, which are frozen and dried. Therefore, they are in the form of powder. Hence they are always supplied along with the diluents. Such vaccines are highly stable and retain the potency for a long time than liquid vaccines. Diluents have to be added only at the time of use along the side wall of the vial. After adding the diluent the vial should not be shaken but rolled between the fingers to prevent the formation of froth. It should be used as early as possible but not beyond 30 minutes. Freeze dried vaccine could be live or killed vaccine.

For example, BCG, PVRV (Diluent is sterile normal saline).
MV, MMRV, yellow fever 17D vaccine PCECV, JEV. Hepatitis A vaccine (Diluent is sterile distilled water).

Immunoglobulins

These are readymade antibody preparations, obtained from the human beings. They produce immunity instantaneously.

Therefore they are used for passive immunization, i.e. for those who are at-risk such as young close contacts and not immunized before. Since they are human preparations, reactions are nil. They are of two types:

Human Normal Immunoglobulins and Human Specific Immunoglobulins

- **Human normal immunoglobulins:** This is prepared from the pooled plasma of at least 1000 (multiple) donors. It is a general antibody preparation. It consists of IgG. It produces instantaneous but temporary immunity.
  For example, against measles, it is given to susceptible young close contacts. Against viral hepatitis A, it is given to those who are traveling to endemic areas.
  This should not be given simultaneously along with live-vaccines because this IgG will interfere with the development of immunity. If this is given first, live vaccine should not be given for 12 weeks and if live vaccines is given first, this should not be given for 2 weeks.
- **Human specific immunoglobulins:** This is prepared from the plasma of those persons, who have been recently immunized or recovered from the disease. Therefore, this contains specific antibodies. This is highly safe, effective and costly. Passive immunity lasts longer than that of human normal immunoglobulin. Not only it is used for passive immunization (i.e. for postexposure prophylaxis) but also it is used as a part of treatment to neutralize the circulating toxins in the patient (i.e. for both prophylaxis and therapeutic measures) as in rabies and tetanus.

For example, human rabies immunoglobulin (HRIg); human tetanus immunoglobulin (HTIg); hepatitis B immunoglobulin (HBIg); varicella zoster immunoglobulin (VZIg).

These can be used simultaneously alongwith active immunization, unlike human normal Ig.

Human immunoglobulin preparations are viscous in nature. So they require big bore needles to inject. They are given deep IM.

Anti-sera

These are the specific immunoglobulins prepared from the plasma of immunized animals, such as horses. They are cheap and less effective. Immunity lasts for about 2 to 3 weeks only. Reactions are frequent because of animal protein. So test dose is a must.

For example, anti-tetanus serum (ATS); anti-diphtheria serum (ADS);

Equine rabies immunoglobulin (ERIg); anti-snake venom; Anti-gas-gangrene serum.

Related immunoglobulin preparation: It is Rh-antibody (RhIg).

It is given to Rh negative mother during pregnancy to prevent erythroblastosis fetalis.

Vaccines are grouped into four groups:

1. *Vaccines included in the National Immunization Schedule:* BCG, OPV, DPT, MV, DT, and TT
2. *Vaccines commercially available but not included in the schedule:* Hepatitis B vaccine, hepatitis A vaccine, MMR vaccine, Rubella vaccine, typhoid vaccine (both oral and parenteral), hemophilus b influenzae vaccine (Hib vaccine), antirabies vaccine, meningococcal vaccine, pneumococcal vaccine, Japanese encephalitis vaccine, Kyasanur forest disease vaccine (KFDV), chickenpox vaccine (Varilrix).
3. *Vaccines under experimental phase:* HIV vaccine, rotavirus vaccine, dengue fever vaccine, cytomegalovirus vaccine, anti-malaria vaccine, anti-leprosy vaccine (candidate vaccines), birth control vaccines.
4. *Prospective vaccines:* Synthetic peptides, anti-idiotype vaccine, naked DNA vaccines.
   Split virus vaccine, recombinant vaccines.

Chemoprophylaxis

This is another type of specific measure to protect the susceptibles. That means it is a prophylactic (preventive) chemotherapy. If given to uninfected person to prevent the occurrence of the infection, it is called 'Primary chemoprophylaxis' and if given to an infected person to prevent the development of the disease, it is called 'Secondary chemoprophylaxis'.

Secondary chemoprophylaxis is given for those who are at-risk of getting the disease. For example, diamino diphenyl sulphone (DDS) given to the family members (contacts) of lepromatous leprosy case, INH to the young children of the open case of pulmonary tuberculosis. Penicillin eye drops to the newborn of a mother suffering from gonorrhea, tetracycline to a contact of pneumonic plague.

General measures for the protection of susceptibles are:

- Improvement in the quality of life such as good living condition, with clean sanitation in and around the house with adequate lighting and ventilation along with good nutrition, etc. will protect the individuals against many communicable diseases. This is how all developed countries are free from common infectious diseases.
- *Legislative measures:* Government of India has implemented certain Acts, for the protection of the health of the people. For example, Indian Factories Act; Prevention of Food Adulteration Act, etc.
- *Health education:* People are educated about the protection of their health by adopting certain healthy life-style such as personnel hygiene, avoiding habits like smoking and drinking alcohol, getting immunization, using sanitary latrine, etc.

Adverse Events Following Immunization

An adverse event following immunization (AEFI) is an unwanted or unexpected event, occurring after the administration of

the vaccine(s). Such an event may be caused by the vaccine(s) or may occur by chance after vaccination (regardless of vaccination).

The frequency of adverse events can be classified as follows. Very common (>10%), common (1-10%), uncommon (0.1–1%), rare (0.01-0.1%) and very rare (<0.01%).

The adverse events are grouped into the following groups:

1. **Events inherent to inoculation:** These may be local or general.
   Local reaction: These are pain, swelling, erythema, induration, sterile abscess, nodule.
   General reaction: These are malaise, fever, headache, syncopal attack.
2. **Events due to programmatic errors:** These are usually due to faulty techniques. These may be in the production of the vaccine (such as inadequate attenuation or detoxication), improper route of administration, improper constitution with wrong diluents, improper techniques, lack of aseptic precautions, ignoring the contraindications, etc.
3. **Events due to hypersensitivity to the vaccines:** This can be immediate or delayed. Immediate reaction is anaphylactic shock, which is dangerous, characterized by hypotension, rapid, thready, feeble pulse, perspiration, cyanosis, cold extremities and collapse. Delayed reaction is characterized by urticaria, difficulty in breathing, swelling of mouth (lips), itching all over the body, arthralgia and edema.
4. **Events due to neurological complications:** Such as vaccine associated polio paralysis following administration of OPV, postvaccinal neuroparalysis following BPL vaccine, subacute sclerosing panencephalitis following measles vaccine, brachial neuritis following diphtheria and tetanus vaccine, Guillian-Barre syndrome following swine influenza vaccine, etc.
5. **Events due to provocative reaction:** These are vaccine potentiated trigger reactions. This means occurrence of a disease which is totally unconnected with the immunizing agent. For example, development of poliomyelitis following administration of DPT vaccine. The mechanism is that the pain of the vaccine triggers the latent infection of poliomyelitis into a clinical attack and reduces the incubation period also.
6. **Other events:** Damage to the fetus following rubella vaccination to pregnant mother, Toxic Shock syndrome due to contamination of the measles vaccine with *Stapylococcus aureus*, intussusception following, Rotateq vaccine.
7. **Miscellaneous events but no causal association with the vaccine:**
   - Sudden infant death syndrome (SIDS)
   - Autism and MMR vaccine
   - Multiple sclerosis and hepatitis B vaccine.
   - Inflammatory bowel disease and MMR vaccine.
   - Diabetes and Hib vaccine.
   - Asthma and any vaccine.

Management of immediate AEFI:

- Patient should remain under observation for 15 to 30 minutes.
- Adrenaline 1:1000 is the corner stone of treatment of anaphylaxis. If no improvement, repeat adrenaline every five minutes until improvement occurs.
- Oxygen if available, preferably.
- If central pulse (carotid) is not palpable, commence external cardiac massage.
- Antipyretics for pain, fever.
- Antihistamine for allergic reaction.

Reporting AEFI:

Surveillance of AEFI is an integral part of the national immunization program.

Any AEFI should be reported. No time limit has been set to report. But reporting system is not existing in India.

Key points:

- These events may be recognized during clinical trials or postmarketing surveillance.
- These often impact immunization program.
- There is no such thing as 'perfect' vaccine and is entirely safe for every one.
- Majority of events are actually not due to vaccine itself-many are simply coincidental events, others are due to human or programmatic errors.
- By looking for contraindications, the risk of serious adverse events can be minimized.
- Vaccines are used strictly as per recommendations.

IMMUNIZATION PROGRAM

Under Global Smallpox Eradication Program, it was experienced that immunization is the most powerful and cost-effective weapon for the prevention and control and even eradication of a disease. So in May 1974, WHO officially launched a global immunization program, known as Expanded Program of Immunization (EPI) for the prevention and control of six major, killer diseases of children, namely tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis and measles, all over the world, because of the following reasons:

- These childhood diseases are highly fatal
- Those children, who recover will have permanent sequelae
- These diseases are responsible for increased morbidity and mortality among children
- They are easily preventable by immunization
- Available vaccines are simple, safe, effective and affordable. It was called 'Expanded' because:
  - Number of diseases covered are more (six diseases)

- Services are extended to all corners of the world, irrespective of cast, creed, community and ability to pay for it.
- The child is immunized much before it is born (because mother is immunized during pregnancy).

The beneficiaries were all expectant mothers and children up to 16 years of age. Immunization was recommended from 3rd month of infancy and for pregnant mothers, 3 doses of tetanus toxoid, respectively during 16 to 24 weeks, 24 to 32 weeks and during 36 weeks. It was a continuous on-going program.

Government of India launched same program with the same schedule on 1st January 1978 with the same objectives of reducing child morbidity and morality rates.

Meanwhile, WHO launched a social target of achieving 'Health for All by 2000 AD in the international conference held at Alma-Ata, capital of Kazakistan. Government of India became signatory to the Alma-Ata declaration of achieving the social target. One of the indicators was to reduce infant mortality rate to less than 60 per 1000 live-births by 2000 AD. So in 1983, the schedule was revised and recommended only two doses of tetanus toxoid during pregnancy, first dose during 16 to 24 weeks and second dose during 24 to 36 weeks and commencing routine immunization as early as 6 weeks during infancy.

In October 1985, UNICEF celebrated its 40th anniversary and in that connection, it emphasized the goal of achieving universal immunization 10 years early, i.e. by 1990 and so the global program was renamed as 'Universal Child Immunization–1990'. Thus it aimed at adding impetus to WHO global program of EPI. But otherwise there was absolutely no change in the schedule.

Meanwhile it was observed that IMR was not coming down proportionately in India to the expected level. So it was felt that the immunization must be concentrated to the expectant mothers and infants only starting as early as at birth and not the children up to 16 years. Therefore, on 19 November 1985, Government of India renamed EPI program modifying the schedule as 'Universal Immunization Program' (UIP) (Late Prime Minister Mrs Indira Gandhi's birthday), dedicated to the memory of Late Mrs Indira Gandhi. Thus, impetus was added to the existing program by shifting from under-five to under-one year of age and the quality of service was also improved. It was recommended to give first dose of TT to the pregnant mother in the first contact and second dose after one month and BCG and OPV to the newborn as early as at birth.

The objectives of UIP were:

- Elimination of neonatal tetanus (to reduce the incidence of NNT from 5 cases/1000 live births to less than 1 case/1000 live birth)
- Eradication of paralytic poliomyelitis (Under CSSM program in 1992).

The strategy under UIP was:

a. Hundred percent coverage of expectant mothers with 2 doses of tetanus toxoid
b. At least 85 percent coverage of infants with 3 doses of DPT and OPV and one dose each of BCG and MV, before the child celebrates its first birthday.

Thus, the program became time bound (2000 AD) and target oriented program (100% coverage of expectant mothers and at least 85 percent infants, considering 15 percent would develop herd-immunity). During 1992, under CSSM program, it was recommended to cover 100 percent among infants also.

The present criteria for eradiation of poliomyelitis is maintaining 'Zero' incidence for at least three calendar years.

The program gained momentum during 1980s. The ultimate objective was to rapidly increase the immunization coverage:

- To improve the quality of service
- To maintain 'cold-chain'
- To train health personnel to deliver quality service
- To achieve self-sufficiency in vaccine production.

The schedule of only expectant mothers and infants is called 'UIP-schedule'.

The differences between EPI and UIP are given in **Table 19.4**.

The current National Immunization Schedule recommended under NRHM is given in **Table 19.5** and the Immunization Schedule as recommended by Indian Academy of Pediatrics with effect from April 2012 is given in **Table 19.6**.

Table 19.4 Differences between EPI and UIP

EPI	UIP
1. WHO program launched by Govt. of India in Jan 1978.	• Renamed so by Govt. of India on 19th Nov 1985, to improve the quality of services.
2. Beneficiaries are expectant mothers and children up to 16 years of age.	• Beneficiaries are expectant mothers and infants
3. Commencement of immunization was recommended from 3rd month of infancy and from 1983, it was recommended from 6th week onwards.	• Commencement of immunization is recommended from birth-itself.
4. Objective is to control the vaccine preventable diseases.	• Objectives are elimination of NNT and eradication of poliomyelitis
5. It is a continuous on-going program	• It is a time bound (2000 AD) and target oriented program (100% of expectant mothers and at least 85% of infants). Under CSSM program since 1992, the target is 100% of expectant mothers and 100% of infants.

Table 19.5 Current national immunization schedule for infants, children and pregnant women (NRHM)

Vaccine	When to give	Dose	Rate	Site
For pregnant women:				
TT-1	Early in pregnancy	0.5 mL	IM	Upper arm
TT-2	4 weeks after TT-1*	0.5 mL	IM	Upper arm
TT-Booster	1 dose if TT is given in last 3 years*	0.5 mL	IM	Upper arm
For infants:				
BCG	At birth or as early as possible till one year of age	0.1 mL (0.05 ml until one month of age)	ID	Left upper arm
Hepatitis B-O	At birth or as early as possible within 24 hours	0.5 mL	IM	Anterolateral side of mid thigh
OPV-O	At birth or as early as possible within first 15 days	2 drops	Oral	Oral
OPV-1, 2 and 3	At 6 weeks, 10 weeks and 14 weeks	2 drops	Oral	Oral
DPT-1, 2 and 3	At 6 weeks, 10 weeks and 14 weeks	0.5 mL	IM	Anterolateral side of mid thigh
Hepatitis B-1, 2 and 3	At 6 weeks, 10 weeks and 14 weeks	0.5 mL	IM	Anterolateral side of mid thigh
Measles – 1	9 completed months – 12 months	0.5 mL	Subcutaneous	Right upper arm
Vitamin – A (1st dose)	At 9 months with measles vaccine	1.0 mL	Oral	Oral
For Children:				
DPT Booster-1	16-24 months	0.5 mL	IM	Anterolateral side of mid thigh
OPV Booster	16-24 months	2 drops	Oral	Oral
Measles – 2	16-24 months	0.5 mL	Subcutaneous	Right upper arm
Japanese encephalitis**	16-24 months with DPT/OPV booster	0.5 mL	Subcutaneous	Left upper arm
Vitamin A, 2nd dose	With DPT/OPV booster	2.0 mL	Oral	Oral
Vitamin A, 3rd to 9th dose	One dose every 6 months up to the age of 5 years	2.0 mL	Oral	Oral
DPT Booster-2	5-6 years	0.5 mL	IM	Upper arm
TT Booster	10 years and 16 years	0.5 mL	IM	Upper arm

* Give TT-2 or booster dose preferably before 36 weeks of pregnancy.
** JE vaccine in selected endemic districts.
Note: In select states, pentavalent vaccine (DPT+Hib+Hep B) 1, 2 and 3 dose replaces DPT 1, 2 and 3 dose and Hepatitis B1, 2 and 3 doses. During the first phase, (2011) Kerala and Tamil Nadu states were selected. During 2012-13, in the second phase, Delhi, Jammu and Kashmir, Haryana, Gujarat, Goa, Puducherry and Karnataka have been selected. It is proposed to cover the entire country in the next phase. Thus pentavalent vaccine has been introduced by Govt. of India in a phased manner.
Source: Vipin M Vashistha. Key statements of IAPCOI and IAP immunization time table for the year 2012. Pediatirc infectious disease. 2012;4(3):112-24.

Table 19.6 IAP immunization time table 2012

1. IAP recommended vaccine for routine use

Age (Completed weeks/months/years)	Vaccines	Comments
Birth	BCG OPV Hep. B-1	*Hepatitis B:* Administer Hep.B vaccine to all newborns before hospital discharge.
6 weeks	DTP-1* Hib-1* Hep. B-2*	* These three are together available as Pentavalent vaccine (Easy five) *Polio:* • All doses of IPV may be replaced with OPV if IPV is unavailable/unaffordable.

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Age (Completed weeks/months/years)	Vaccines	Comments
	IPV-1 Rotavirus-1 Pneumococcal conjugate vaccine (PCV)-1	• Additional doses of OPV on all supplementary immunization activities. • Minimum age to start IPV is 6 weeks. • If IPV is started at 8 weeks, only two doses with 8 weeks interval. • IPV catch-up schedule : 2 doses at 2 months apart followed by a booster dose after 6 months. *Rotavirus:* Two doses of RV-1 (Rotarix) or three doses of RV-5 (Rotateq). (Only RV-1 is recommended). Maximum age for the first dose is 14 weeks and not to be initiated after 15 weeks. *Pneumococcal vaccine:* Minimum age 6 weeks for PCV and 2 years for pneumococcal polysaccharide vaccine (PPSV).
10 weeks	DTP-2 Hib-2 IPV-2 Rotavirus-2 PCV-2	DTP and Hib are together available as Tetravalent Vaccine (Easy four)
14 weeks	DTP-3 Hib-3 IPV-3 Rotavirus-3 PCV-3	
6 months	OPV-1 Hep-B-3	*Hepatitis B:* The third dose of HBV should not be administered before 24 weeks of age.
9 months	OPV-2 Measles vaccine	
12 months	Hep. A-1	*Hepatitis A:* For both killed and live hepatitis A vaccines, two doses are recommended with 6-18 months interval.
15 months	MMR-1 Varicella-1 PCV-Booster	*Varicella vaccine:* Second dose may be administered before age 4 years, provided at least 3 months have elapsed since the first dose.
16 to 18 months	DTP-Booster IPV-Booster 1 Hib-Booster-1	The first booster (4th dose) may be administered as early as 12 months, provided at least 6 months have elapsed since the third dose.
18 months	Hep A-2	
2 years	Typhoid – 1	*Typhoid:* Typhoid revaccination every 3 years, if Vi-polysaccharide vaccine is used.
4½ to 5 years	DTP-Booster 2 OPV-3 MMR-2 Varicella-2 Typhoid-2	*MMR:* The 2nd dose can be given at any time 4-8 weeks after the 1st dose. *Varicella:* The 2nd dose can be given at anytime months after the first dose.
10-12 years	Tdap HPV	*Tdap:* This is preferred to Td followed by Td every 10 years. Human papilloma virus vaccine: Only for females, 3 doses at 0, 1-2 (depending upon the brands) and 6 months.

Source: Vipin M Vashistha. Key statements of IAPCOI and IAP immunization time table for the year 2012. Pediatric infectious disease. 2012;4(3):112-24.

Note:

1. This time table/schedule includes recommendations in effect as of April 2012. Any dose not administered at the recommended age should be administered at a subsequent visit, when indicated and feasible. Use of a combination vaccine is generally preferred over separate injections of its equivalent component vaccines.
2. The current rotavirus vaccines have been associated with a risk of intussusceptions (about 1-2 per 1,00,000 infants vaccinated). Therefore history of intussusceptions in the past is an absolute contraindication for rotavirus vaccine (RV1 and RV5) administration.

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3. Prematurity and very low birth weight infants constitute a high risk category for pneumococcal vaccination because they are at a high risk of invasive pneumococcal diseases compared to full term babies.
4. The sequential schedule with IPV followed by OPV considerably decreases the risk of vaccine associated polio paralysis and also induces immunity against all the three sero types of polio viruses.
5. Changes in polio immunization schedule has become inevitable because of the following reasons.
   - India is polio free for >2 years !!
   - Type 2 wild polio virus has been eradicated in 1999.
   - Vaccine associated polio paralysis (VAPP) cannot be overlooked anymore!
   - New 'end game strategy' announced in November 2011.

2. IAP recommended vaccines for High-risk* children (vaccines under special circumstances):

1. Influenza vaccine
2. Meningococcal vaccine
3. Japanese encephalitis vaccine
4. Cholera vaccine
5. Rabies vaccine
6. Yellow fever vaccine
7. Pneumococcal polysaccharide vaccine (PPSV-23).

** High-risk category of children*

- Congenital or acquired immunodeficiency (including HIV infection)
- Chronic cardiac, pulmonary (including asthma if treated with prolonged high dose oral corticosteroids), hematologic, renal (including nephrotic syndrome) and liver disease.
- Children on long term steroids, salicylates, immunosuppressive or radiation therapy.
- Diabetes mellitus, cerebrospinal fluid leak, cochlear implant, malignancies.
- Children with functional/anatomic asplenia/hyposplenia.
- During disease outbreaks.
- Laboratory personnel and health care workers.
- Travelers.

1. **Influenza vaccine:** Two doses of trivalent inactivated vaccine, with four weeks interval for children between 6 months and 9 years. Above 9 years, single dose annually.
2. **Meningococcal vaccine:** Single dose of 0.5 mL of meningococcal polysaccharide vaccine, SC/IM, for children above 2 years and revaccination once after 3 years.
3. **Japanese encephalitis vaccine:** Single dose of 0.5 mL of live attenuated cell culture derived SA-14-14-2 JE vaccine is given as catch up vaccination up to 15 years only in endemic areas and not before 8 months of age. For persons without evidence of immunity, between the ages of 7 to 12 years, two doses with 3 months interval. For persons above 13 years, two doses with 4 weeks interval.
4. **Cholera vaccine:** Two doses of whole cell vibro cholera (Shancol) vaccine with two weeks apart, recommended for children above one year.
5. **Pneumococcal conjugate vaccine (PCV) and Pneumococcal polysaccharide vaccine (PPSV):** Both are used in certain high risk children. Minimum age is 6 weeks for PCV and 2 years for PPSV. A single dose of PCV may be administered to children aged 6 through 18 years, who have anatomical/functional asplenia, HIV, immunocompromising condition, cochlear implant or cerebrospinal fluid leak. A single dose of PPSV should be administered after 5 years to such children.

Appraisal Points

1. In the current UIP schedule, the beneficiaries are only expectant mothers and infants.
2. No pregnant mother should be deprived of at least one dose of tetanus toxoid. There is no time schedule to give TT. Even if she comes very late during pregnancy, she must be given tetanus toxoid.
3. BCG and zero dose of OPV at birth are recommended for institutional deliveries. Dose of BCG for the newborn is 0.05 ml (not 0.1ml), because the skin is thin. If BCG is not given at birth, as in home deliveries, it can be given along with any of the doses of DPT and OPV. Then the dose is 0.1 mL.
4. OPV given at birth is called 'Zero dose', because it is given before the recommended first dose and it induces only gut immunity (IgA) and not systemic immunity (IgG). However, subsequent doses of OPV produce both gut immunity and systemic immunity.
5. OPV given under Pulse Polio Immunization Program is only a supplementary dose and not a substitute to the routine immunization.
6. There is no basis for the mistaken belief that if the second or the third dose of DPT or OPV is delayed or missed, schedule should be started all over again. Delay in the doses does not interfere with the development of immunity. Therefore, even if the due dose is given late, it is considered as due dose and schedule continued.
7. Measles vaccine is not recommended as a routine before 9 months of age because the development of immunity will be interfered by the presence of maternal antibodies.

But under certain situations such as malnutrition, epidemic of measles or history of contact with a case of measles, the vaccine can be given to the child as early as 6 months of age. However, such children require a second dose of MV during 15th to 18th month of age.

8. Suppose the child is running 2nd year and not received any vaccine during infancy, can be given all the vaccines simultaneously, but on different sites.
9. Suppose the child has completed 2 years and not received DPT during infancy, it is given only two doses of DT with four weeks interval and not DPT because 'P' component, i.e. pertussis component is not necessary after two years and also may result in complications. Booster dose of DT is given during 5th year and the schedule is resumed.
10. If the older children are brought for immunization due to widespread publicity they can also be immunized accordingly.
11. Usually acute illness is a contraindication for immunization. However, mild illness, such as mild cough, mild fever or mild diarrhea are not contraindications. Children with malnutrition need immunization most because they are highly susceptible. There are no contraindications for pulse polio immunization.
12. All the vaccines mentioned under National (UIP and NRHM) schedules are given free of cost in all the Government Hospitals and PHCs. However, other vaccines which are commercially available but not included in UIP schedule, are recommended by Indian Academy of Pediatrics (IAP).
13. Vaccines which are commercially available but not included in the schedule can also be given accordingly such as MMR vaccine, typhoid vaccine, Hemophylus influenzae B vaccine, pneumococcal vaccine, chickenpox vaccine and rotavirus vaccine.
14. Other vaccines such as anti-rabies vaccine, KFD vaccine, JE vaccine are given only when indicated.
15. Administration of right vaccine, in right time, in right dose, in a right technique, supplemented by proper cold-chain maintenance, is the 'KEY' to the success of immunization.

COLD-CHAIN

Definition

It is a system of storage and transportation of the vaccines at recommended, low temperature (+2 to +8°C) all along from the time and place of the manufacture to the time and place of its use.

Importance

This system of maintaining the cold-life for the vaccines is necessary because the vaccines are sensitive to heat and light, i.e. they loose their potency, when exposed to heat and light. Once the vaccine looses the potency, it cannot be restored and it becomes a waste. So care must be taken to see that the vaccines do not loose their potency, before the date of expiry, by maintaining 'Cold-chain'. All the vaccines retain their potency at temperatures between +2° and + 8° C.

Polio vaccine (OPV) is most sensitive and tetanus toxoid is the least sensitive to heat and light. The sensitivity of the vaccines in the descending order is as follows:

OPV → highly sensitive MV	These two can be stored at subzero temperature for long-term use.
BCG	→ This gives a crack at sub-zero temperature
DPT DT TT → least sensitive	'T' series vaccines are denatured at sub-zero temperature.

Vaccines should not be exposed to direct sun light. The loss of potency depends upon the temperature and duration of exposure. A break in the cold-chain is indicated if the temperature goes above +8°C or falls below +2°C.

The cold-chain system consists of a series of transportation links with equipment and the persons concerned from the manufacturer to the point of use. Longer the chain, greater is the risk of cold-chain failure **(Fig. 19.4)**.

The cold-chain equipment are so designed to keep cold air inside and to prevent warm air from entering. So when vaccines are placed inside these equipment, they are protected from heat and light.

The cold-chain equipment consists of the following:

- Walk in coolers (WIC)
- Cold box
- Deep freezer
- Ice lined refrigerator (ILR)
- Refrigerator (conventional)
- Vaccine carrier
- Dial thermometer.

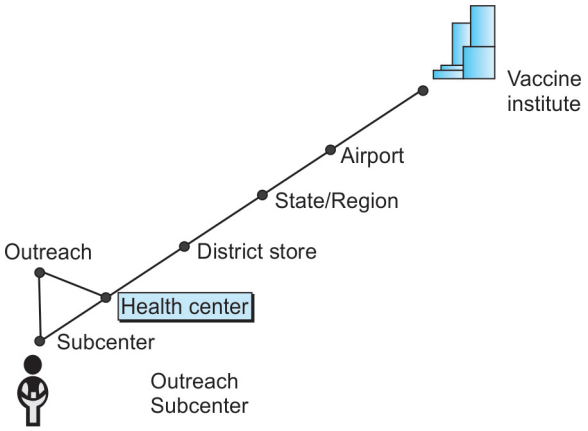


Fig. 19.4 Links in the cold-chain

Walk in Coolers (WIC)

These are the air-conditioned cold rooms, maintaining the temperature between +2° to +8°C. Such rooms exist in vaccine institutes, where vaccines are manufactured on large scale, in order to store large bulk of the vaccines.

They exist in Kasauli, Coonoor, Hakine institute, etc. One such WIC has also been established for every 3 to 4 districts to store vaccines required for 3 months.

Cold Box

This is a big, rectangular box (90 cm × 60 cm) made up of an insulated material (bad conductor of heat), lined with 24 ice-packs, which act as buffers and maintain the cold life inside the box for about 5 days. It does not have electrical connections.

Such boxes are used to collect, store and transport large quantities of vaccines from one place to another place, by refrigerator-vans.

Ice-packs: These are rectangular shaped, flat, plastic bottles, filled with water up to the neck. They have definite geometrical shape with two depressions in the center for finger grip. When the water is frozen into ice, it is then called 'Ice-pack'. It is used for lining the walls of cold boxes and vaccine carriers, as buffers to maintain cold life inside the equipment.

The ice packs are prepared by filling with water up to the neck of the cap and keeping them in the deep freezers and freezer compartment of refrigerator overnight. They are placed on their edges with little space between for free circulation of air, and not flat on one another (**Fig. 19.5**).

Ice packs maintain cold-life for 5 days in cold box and for 1 day in vaccine carrier, if it is not opened.

Deep Freezer

It is a top opening refrigerator, which maintains the temperature at –20° to –40°C. It has electrical connections. It is used to store only OPV and MV for long term use, and also to prepare ice-packs. 'T' series vaccines are never stored because they will be denatured and BCG vaccines are also not stored because the ampoule gives a crack. This equipment is supplied to state and dist. head Quarters, and teaching hospitals only.

Ice-lined Refrigerator

Ice-lined refrigerator (ILR) is also a top opening refrigerator. It has single compartment for vaccine storage (0 to + 8°C) equipped with baskets and lined by preinstalled and water filled ice-lining ready for use. It maintains the cold life, during power failure, up to 18 to 20 hours/day. It works entirely as a cold-box with electrical connections. There are two types, one lined with ice-tubes (electrolux) and the other with ice-packs (vest frost) **(Fig. 19.6A)**.

The electrolux type of ILR can also be used as deep freezer by changing the switch to the appropriate position. But before it is done, it is ensured that vaccines which are damageable at sub-zero temperature are transferred to cold-box or other refrigerator. There is no 'freezer compartment' in ILRs. So it is not used to prepare ice-packs.

The appliance **(Fig. 19.6B)** is equipped with a 'control panel' **(Fig. 19.7)**, which has three parts:

i. *Indicator:* The green lamp is on when there is electricity
ii. *Thermometer:* Which records the temperature of the compartment.
iii. *Thermostat:* To adjust the inside temperature, with a division from No.1 to 8. Setting 1 applies minimum cold and setting 8 maximum cold.

The bottom surface is the coldest place. 'T' series vaccines should not be kept directly on the floor, as they can freeze and get damaged. So the vaccines are placed in the baskets. There is no freezer compartment in the ILRs. It is important not to forget to place the water filled internal lids over the baskets (**Fig. 19.6B**).

Whenever it is opened, air enters and the moisture settles on the inner cold surface and form a layer of frost or ice. Therefore, for better performance defrosting and cleaning is done once in 3 months. But before defrosting, the vaccines are transferred to another working refrigerator or cold-box.

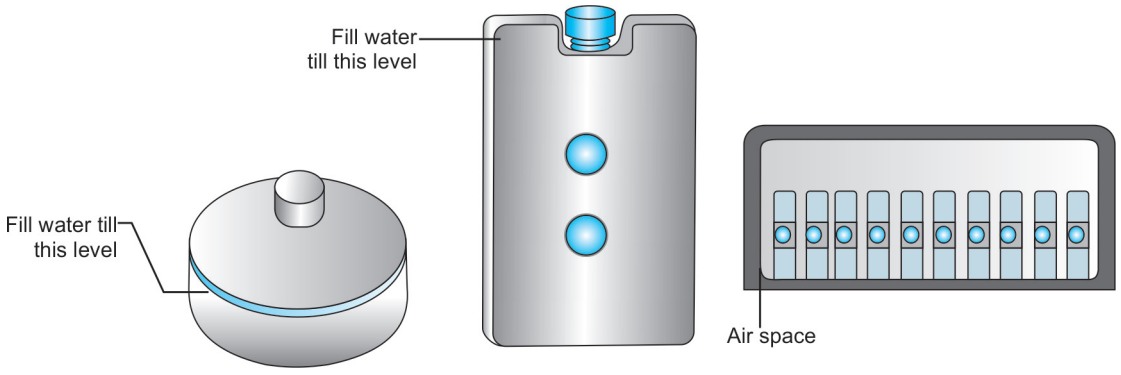
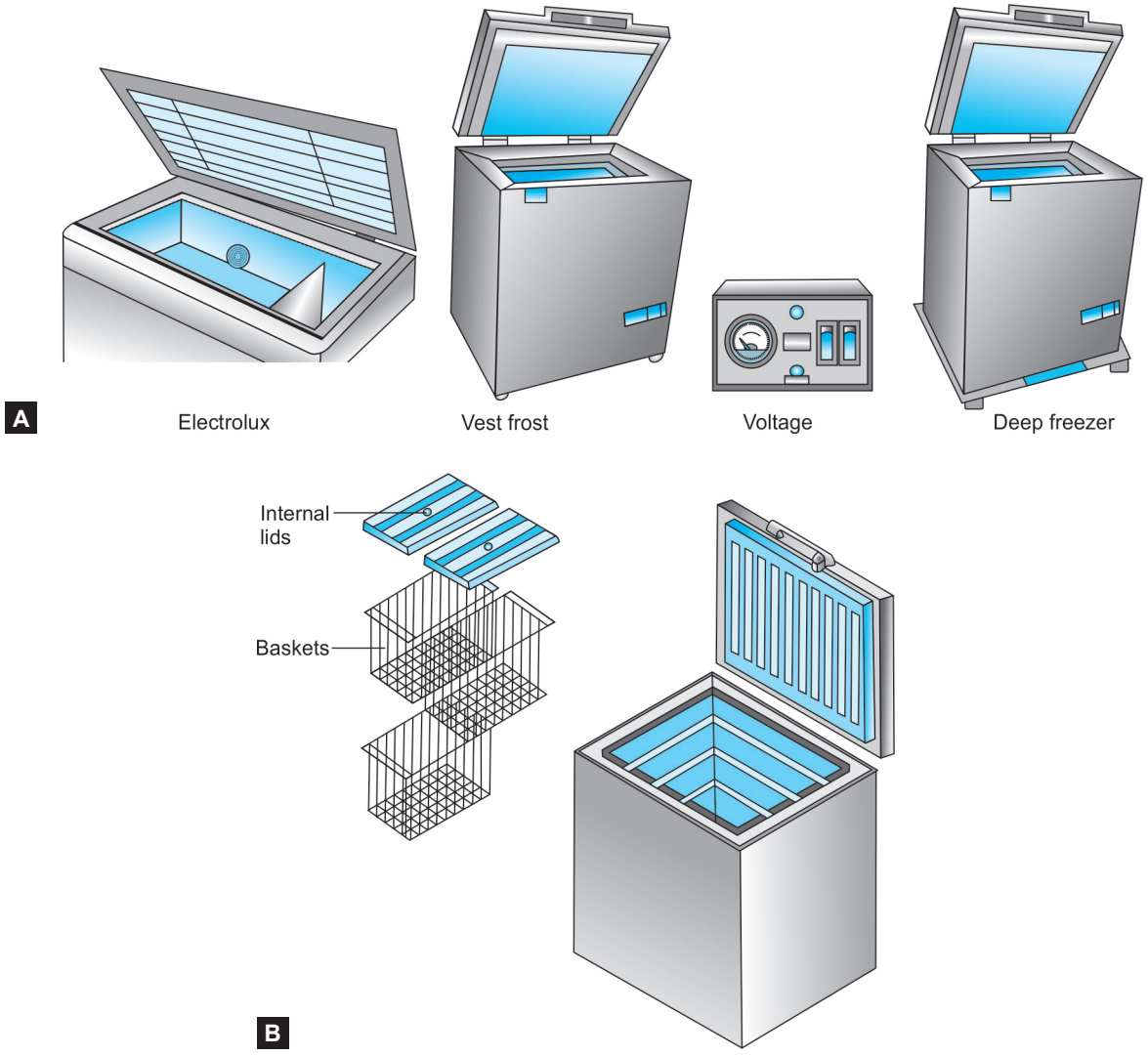


Fig. 19.5 Circular and rectangular ice-packs (*Source:* NRHM Bulletin. 2012;7(4))



Figs 19.6A and B Ice-lined refrigerators (ILRs) (*Source:* NRHM Bulletin. 2012;7(4))

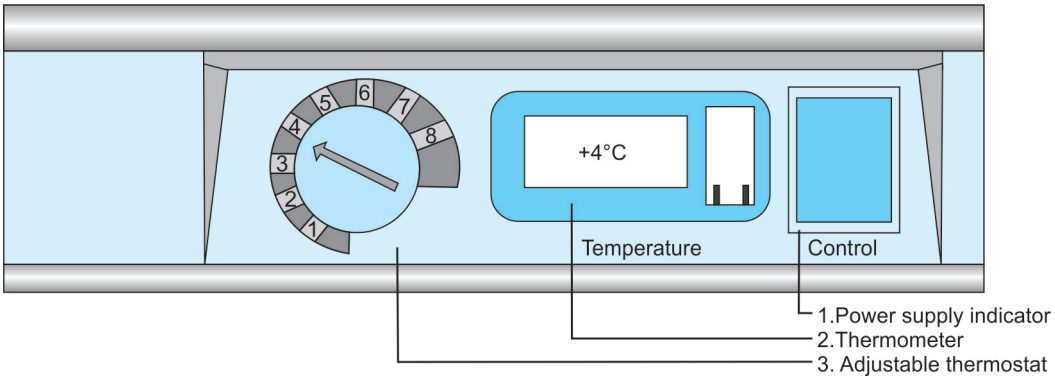


Fig. 19.7 Control panel of ice-lined refrigerators (ILR) (*Source:* NRHM Bulletin. 2012;7(4))

These ILRs must be used only as a refrigerator for storing the vaccines. It is better than the conventional refrigeration because the risk of cold chain failure is far less, specially when there is periodic power failure and also the storage capacity is more.

The commercial ILR is called 'Vestfrost.'

Refrigerator (Conventional)

This is provided to every Primary Health Center. It should be handled carefully so that the temperature inside the cabinet does not rise above +8°C and it gets out of order very soon only because of poor maintenance. For efficient working and to ensure proper storage of the vaccines, there are certain Dos and Don'ts to be followed.

Do's

- Refrigerator should be kept in a cool room away from direct sun light
- It should be 10 cm away from the wall
- Level must be correct
- Plug must be properly and permanently fixed to the socket
- Voltage stabilizer to be used
- Vaccines should be placed in a definite order, neatly, with the space between the vials for free circulation of air **(Fig. 19.8)**
- It should be opened only when necessary
- Ice-packs are placed in the freezer compartment and water bottles in the lowermost shelf, which act as buffer during power failure
- Defrosting is done periodically
- Temperature is recorded twice daily.

Don'ts

- Do not open the door frequently and unnecessarily
- Do not keep the vaccines in the door
- Do not keep the food and drinks in the refrigerator
- Do not keep more than one month's requirements
- Do not keep 'Date expired' vaccines.

Thus refrigerator is so important in maintaining the cold-chain that it is considered as one of the members of 'Health-team.'

Dial thermometer has been provided to record the temperature in the refrigerator. It is placed in the first or second shelf. One person should be made responsible for recording the temperature. The temperature must be monitored twice daily. Care must be taken to see that the temperature inside is maintained between +2° to +8°C, by adjusting the 'Thermostat' switch in different seasons accordingly.

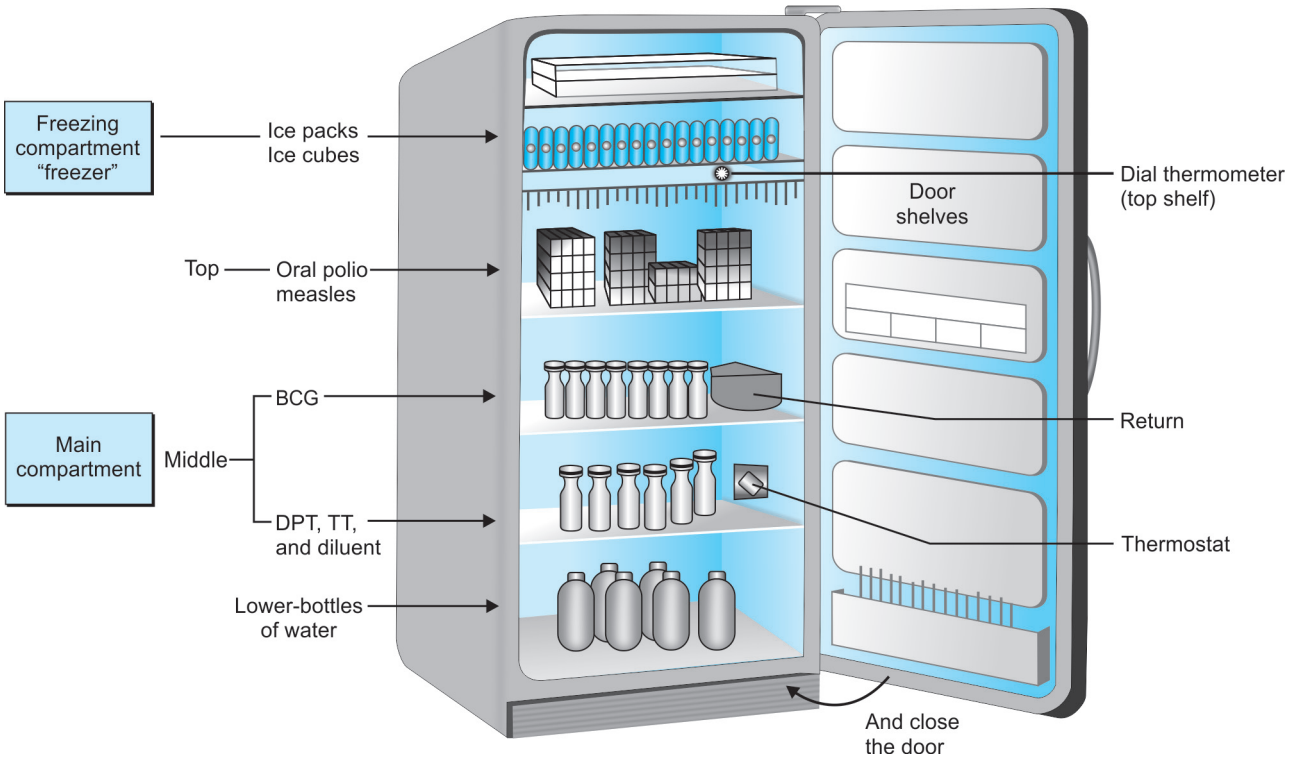


Fig. 19.8 Arrangement of vaccines in refrigerator (*Source:* NRHM Bulletin. 2012;7(4))

Instructions

- The remaining vaccines after immunization session, are placed in a box and labeled 'Returned', which should be used first in the next session
- Do not use date expired vaccines even if cold-chain is maintained
- Do not use 'T' series vaccines if frozen.

Vaccine Carrier

It is a square shaped box, made up of a special insulated material, lined by 4 ice-packs, one on each side, which maintains cold-life for 24 hours if not opened. It is used to carry small quantities of vaccines from the Primary Health Center or Sub-center to the out-reach station (i.e. immunization camp), by the health worker. The 'T-series' of vaccines should not be in direct contact with the ice-packs, because they get frozen. Therefore, those vaccines are placed inside a polythene bag and closed with rubber band. The lid of the vaccine carrier is secured tightly. It should not be kept in the sun-light nor it should be opened frequently and unnecessarily.

Thus 'Cold-chain' system is the 'Life-line' of the immunization program. Maintenance of cold-chain is difficult but not impossible.

Shake-test: Sometimes the 'T-series' vaccines look frozen. So before use, the vial is shaken. If the solution is not uniform and if granules (floccules) are seen, that means it is denatured and should not be used.

Reverse cold chain: This is maintaining the cold-chain in the reverse direction from the point of use to the vaccine testing laboratory. This is necessary, when the potency of the vaccine becomes doubtful and has to be tested for potency. Reverse cold-chain also becomes necessary when stool specimen of a case of acute flaccid paralysis has to be sent to viral research laboratory for isolation of poliovirus, under AFP surveillance.

OPV is considered as an 'Indicator' of quality of cold-chain, as it is highly sensitive to heat and light.

Estimation of Requirements for Immunization

Estimation of Eligibles

Estimation of eligibles, such as expectant mothers and infants. This is necessary for the universal immunization coverage.

The total annual number of the pregnant women and infants in any given area can be calculated by using the formula as follows:

No. of pregnant women = Population × Birth rate.

No. of infants at 1 year of age = Population × BR × (1-IMR).

For example: If the population of an area is 50,000, the birth rate being 30/1000 and infant mortality rate is 100/1000 live births, the expected number of pregnant women and infants will be:

No. of pregnant women = Population × BR

$$= 50000 \quad \frac{30}{1000}$$

$$= 1500$$

No. of infants at 1 year of age = Population × BR × (1-IMR)

$$= 50000 \times \frac{30}{1000} \times \left(1 - \frac{100}{1000}\right)$$

$$= 50000 \times 0.03 \times 0.9$$

$$= 1350$$

The estimated numbers should then be compared with the list maintained by the health workers to ensure completeness of registration and if the numbers do not fall within 10 percent of the estimates, then the enumeration list of pregnant women and infants maintained by the health worker should be updated immediately.

Estimation of Vaccine Needs

This is critical for the success of the program. The requirements depend upon the population to be covered and the number of sessions to be held (periodicity of supply).

The vaccine requirements will depend on the number of pregnant women and infants (children) and on the number of sessions held.

Vaccine requirement is calculated as follows:

Total number of pregnant women/infants to be covered × Expected coverage × Number of doses of the vaccine × Wastage multiplication factor ÷ No. of sessions to be held (or number of doses per vial).

(The Wastage Multiplication Factor (WMF) is 1.33 for DPT, DT, TT and OPV and 2 for BCG and MV).

The vaccines are supplied in 10 or 20 doses vials or ampoules. The required number of doses are divided by 10 or 20 and rounded off to the next nearest number of vials or ampoules.

Health centers should not keep more than one month's requirements and no vaccine should be stored at a sub-center. Continuing with the previous example,

Requirement of tetanus toxoid = $1500 \quad \frac{100}{100} \quad 2 \quad 1.33$

$= 3990$

$= 4000$ doses (approx).

This is annual requirement of TT for pregnant women.

Monthly requirement = $\frac{4000}{12} = 333$ doses

Number of vials = $\frac{333}{10} = 34$ vials (because each vial contains 10 doses)

If sessions are held fortnightly, the annual required dose is divided by 24 and if weekly, divide by 52.

Although minimum coverage required for DPT, OPV, measles and BCG is 85 percent, it is better to calculate the vaccine requirements for 100 percent. Accordingly in the examples cited, requirement of DPT/OPV will be:

$$1350 \quad \frac{100}{100} \quad 4 \quad 1.33 = 7182 \text{ doses}$$

(4 doses include 3 primary and 1 booster dose).

Accordingly monthly and fortnightly requirements will be 600 and 300 doses.

$$\text{Requirement of BCG/measles} = 1350 \times \frac{100}{100} \times 1 \times 2$$
$$= 2700 \text{ doses}$$

Accordingly monthly and fortnightly requirements will be 225 and 112 doses.

The vaccines are supplied in 10 or 20 dose vials or ampoules. The required number of doses are divided by 10 or 20 and rounded off to the next higher number of vials or ampoules.

Estimation of Requirements of Immunization Cards

Vaccination cards must be given to all the pregnant women and infants. The card used for the pregnant women can later be used for the infant after the birth of the child. The cards should be in the regional language. However, during the first year of the program, the need of the cards for the infants is more.

The requirement of the cards is as follows:

First year: The total number of pregnant women and infants + 10 percent.

Later: The total number of pregnant women + 10 percent.

Estimation of Cold Chain Requirements

It is estimated that cold storage facilities for roughly 30,000 to 40,000 vials of all vaccines will be necessary at the district level (>3 months requirements of an average district of 2.5 million population).

Storage capacity of around 900 to 1200 liters is required to store the above quantities of vaccines.

Estimation of Vaccine Efficacy

The term vaccine efficacy refers to the ability of the vaccine to prevent disease effectively. The vaccine efficacy is influenced by the age at immunization, quality of the cold chain and overall immunization coverage levels. A rapid assessment of vaccine efficacy can be done, if immunization coverage levels and proportion of cases with history of immunization are known, by the following formula:

$$\text{Vaccine efficiency rate} = \frac{\text{Attack rate among unvaccinated} - \text{Attack rate among vaccinated}}{\text{Attack rate among unvaccinated}} \times 100$$

Table 19.7 Framework of the data

Exposure to measles vaccination	Disease		Total
	Present	Absent	
Yes	10 (a)	90 (b)	100
No	90 (c)	10 (d)	100
Total	100 (a+c)	100 (b+d)	200

Or

$$\text{Vaccine efficacy rate (VER)} = 1 - \text{Relative risk}$$

$$\text{Relative risk (RR)} = \frac{\text{Incidence of disease among exposed}}{\text{Incidence of disease among exposed}}$$

Example,

Following an outbreak of measles in a community health center area, an immunization survey revealed the following data **(Table 19.7)**.

Number of preschool children—200

Number of children immunized against measles—100

Number of children with measles disease:

- Among unimmunized—90
- Among immunized—10

Calculate the vaccine coverage and vaccine efficiency rate (VER).

Give the VER for other UIP vaccines.

VER = 1 – RR

$$RR = \frac{I_D \text{ among exposed}}{I_D \text{ among unexposed}}$$

$$= \frac{\frac{a}{a+b}}{\frac{c}{c+d}} = \frac{\frac{10}{100}}{\frac{90}{100}} = \frac{10}{100} \quad \frac{100}{90} = \frac{1}{9} = 0.11$$

$$\text{VER} = 1 - \text{RR} = 1 - 0.11$$
$$= 0.89 = 89\%.$$

Other formula can also be applied as follows:

$$\text{VER} = \frac{\text{Attack rate among unvaccinated} - \text{Attack rate among vaccinated}}{\text{Attack rate among unvaccinated}} \times 100$$

$$= \frac{\left(\frac{c}{c+d}\right) - \left(\frac{a}{a+b}\right)}{\frac{c}{(c+d)}} \times 100$$

$$= \frac{\frac{90}{100} - \frac{10}{100}}{\frac{90}{100}} \times 100$$

$$= \frac{90-10}{90} \times 100$$

$$= \frac{800}{9}$$

= 89%

VER for other vaccines under UIP

For DPT—50%

For MV—95%

For OPV:

3 doses = 85% 4 doses = 90%

5 doses = 95% 7 doses = 97%

SCREENING FOR DISEASE

The major submerged portion of ice in iceberg phenomenon of disease, corresponds to subclinical cases, carriers, undiagnosed cases, who are all apparently healthy individuals and therefore are not recognized and constitute a mass of unrecognized disease in the community. They are responsible for the constant prevalence of the disease. Their detection and control is a challenge to the modern techniques of community—medicine.

Screening is defined as a search made for detecting the hidden disease among apparently healthy individuals in the community, by means of rapidly applied test.

Thus, screening test divides the apparently healthy population into two groups—those probably having the disease/risk factor and those probably not having the disease/risk factor.

The first group is then further subjected to history taking, clinical examination and diagnostic test, which divides this group into two sub-groups—those who have the disease, requiring treatment and those not having the disease, requiring surveillance and periodic screening.

The second group also require periodic screening (**Flow chart 19.1**).

A screening test differs from a diagnostic test as follows **(Table 19.8)**:

However, there are some tests which are used both for screening and diagnosis. For example, test for anemia, glucose tolerance test.

Aim

To sort out those having the disease and those not having the disease from a group of apparently healthy individuals.

Objective

To provide treatment to those detected persons, so that the disease is controlled in the community.

Flow chart 19.1 Screening for disease

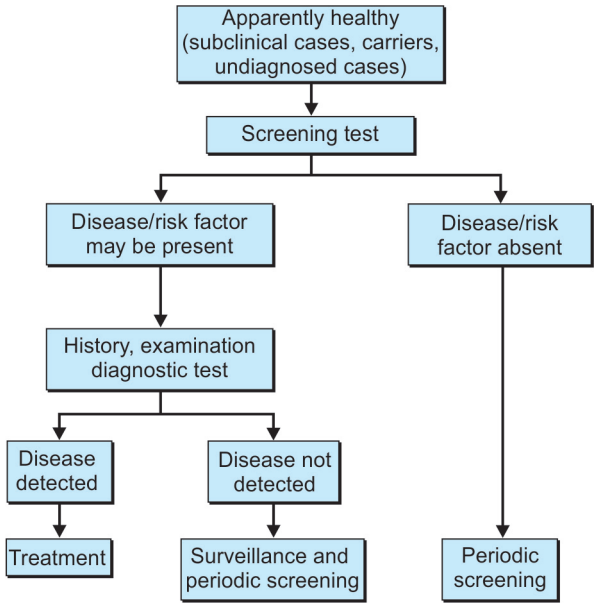


Table 19.8 The differences between screening test and diagnostic test

Screening test	Diagnostic test
Done on apparently healthy people	Done on sick people
Done on groups	Done on individual cases
Done by the epidemiologist	Done by the physician
Test results are final	Diagnosis is not final but based on other criteria also such as history and clinical findings
The purpose is to do community diagnosis, to launch a control program	The purpose is to make a diagnosis in the patient to give treatment
Less expensive	More expensive
Initiative is from the epidemiologist	Initiative is from the patient

Uses

1. *For case detection:* People are screened for their own benefit. For example, disease can be detected early and treated early so that complications are prevented. This is called 'Prescriptive screening'.
   For example, screening of the newborn, of the pregnant mother for bacteriuria, detection of CaCx, diabetes, hypertension, etc.
2. *For control of the disease:* People are screened for the benefit of others, i.e. by early diagnosis and early treatment, further spread in the community can be prevented. This is called 'Prospective screening'. Screening of the immigrants for HIV, or pulmonary tuberculosis

and syphilis, screening of blood donors. It thus helps in reducing morbidity and mortality.

3. *For research purpose:* Screening helps to know more about the natural history of the disease. For example, initial screening helps to know about the prevalence of the disease and subsequent screening, the incidence. It also gives information about risk factors and risk groups.
4. *For educational purpose:* Screening procedure creates awareness among the people about the disease, thus educating the public.

Types of Screening

There are five types of screening procedures—(1) Mass screening, (2) High-risk screening, (3) Multipurpose screening, (4) Multiphasic screening and (5) Opportunistic screening.

Mass Screening

This is the screening of the entire population of an area for a disease, for example, night blood smear examination for microfilariae of every individual in hyperendemic area of filariasis. However, this is not an useful preventive measure unless it is backed up by the treatment and follow-up.

High-risk Screening

This is the screening of only those groups of population, who are at a high-risk of the disease and not of the entire population. This is also called 'Selective screening or Targeted screening'. For example, screening of women of low socio-economic class for CaCx, of all obese people for hypertension or diabetes, of sex-workers for HIV, of family contacts of infectious pulmonary tuberculosis or lepromatous leprosy, etc.

Multipurpose Screening

This is the screening of a group of population by application of two or more tests, at one time to detect more number of diseases. For example, screening of pregnant mothers with blood for Hb percent, VDRL, Elisa for HIV, surface antigen for HBV, for blood grouping and Rh-typing, urine for albumin, sugar and microscopy; screening all school children with height and weight, vision defects, hearing defects, dental defects, congenital defects; screening of all elderly persons for diabetes, hypertension, hearing defects, cancer, cataract, refractive error, glaucoma, etc.

Multiphasic Screening

This is the screening of the population by applying different tests in different phases, for the diagnosis of one disease. For example, the whole population of an area is screened by testing urine for sugar. Those who are positive for glycosuria are subjected for fasting blood sugar level (FBS). Those who have FBS > 120 mg/dL are subjected for oral glucose tolerance test (OGTT) to find out true diabetics.

Opportunistic Screening

This is the screening of a patient, who consults the doctor for some other purpose. This is also called 'Case finding screening'.

Criteria for Screening

This is based on two considerations, namely the disease to be screened and the test to be applied.

Disease

The disease should fulfil the following criteria:

- It should be of public health importance
- It should have a recognizable early stage
- It should have a test by which the disease can be diagnosed before the onset of signs and symptoms
- There must be facilities available to confirm the diagnosis
- There must be effective treatment
- The disease with treatment, should have good prognosis.

Screening Test

This should fulfil the following criteria:

1. It should be simple, safe, cheap and rapidly applied.
2. It should be acceptable by the people, so that they can co-operate. If the test is painful, embarrassing and causing discomfort, people will not cooperate, e.g. injection, per-rectal or per vaginal exam.
3. It should be reliable (repeatable or reproducible). That means the test should give the same results even after doing repeatedly, under the same conditions. Sometimes, variations occur and they are of three types, namely observer, biological and mechanical variations.
   a. **Observer variations:** These are of two type—intra-observer and interobserver variations.
      i. **Intraobserver variation:** It is the variation observed in the test result, when the same observer applies the test on one individual at different times under identical situations. This is also called 'Within observer variation'. For example, recording different readings of blood pressure, in the same patient by the same observer. This can be overcome by taking the average of several readings.
      ii. **Interobserver variation:** It is the variation observed in the test result, when two or more observers apply the same test on one individual, under identical situations. This is also called 'Between observer variation'. For example, if one observer finds tubercle bacilli in the sputum smear, while second observer finds it normal. This can be overcome by standardization of the procedures and intensive training of the observers.

b. **Biological variation:** It is the variation observed in the test result in the same individual, when applied under identical conditions. For example, variations in the pulse rate and respiratory rate at two different times. This is also called 'Subject variation'.
c. **Mechanical variation:** It is the variation observed in the test result, due to defect in the machine or procedure. This can be overcome by checking the machine or the procedure.

4. It should be valid (accurate)—validity of a test means the ability of a test to correctly identify those with disease from those without the disease among the apparently healthy people. For example, oral glucose tolerance test is a more accurate (valid) test than examining urine for sugar. Similarly *Treponema pallidum* immobilization test is more valid than blood for VDRL test.

Validity has got two components—sensitivity and specificity; both the components can be determined by applying the screening test on two groups of persons, one group having the disease and another group not having the disease and expressed as percentages.

The relationship between a screening test result and the occurrence of disease is interpreted as follows:

Interpretation

True positive (a) = Means those who have the disease and the test result is also positive.

False positive (b) = Means those who do not have the disease but the test result is positive.

False negative (c) = Means those who have the disease but the test result is negative.

True negative (d) = Means those who do not have the disease and the test result is also negative.

Evaluation of a screening test for the validity (Expressed in percentages).

The following indicators are used to evaluate the screening test:

i. **Sensitivity:** It is the ability of a test to correctly identify those having the disease, i.e. true positives.
(i.e. percentage of diseased persons, showing the test result positive).

$$\text{Sensitivity} = \frac{a}{a+c} \quad 100\,.$$

The term 'Sensitivity' was introduced by Yerushalmy in 1940s as a statistical index of diagnostic accuracy.

Sensitivity of a screening test is 90 percent means, 90 percent of the diseased persons are correctly identified as 'True positives' and remaining 10 percent of diseased persons are wrongly identified as not having the disease, because the test is negative (False negatives).

ii. **Specificity:** If is the ability of the test to correctly identify those not having the disease, i.e. true negatives.
(i.e. percentage of nondiseased persons, showing the test result negative)

$$\text{Specificity} = \frac{d}{b+d} \quad 100\,.$$

Predictive value of a test: It means the diagnostic power of a test. The test has 2 results, positive and negative.

iii. **Predictive value of a positive test:** It means the probability of an individual really having the disease, if the test result is positive.
(i.e. percentage of positives probably having the disease.

$$\text{Predictive value of a positive test} = \frac{a}{a+b} \times 100.$$

iv. **Predicted value of a negative test:** It means the probability of an individual really not having the disease, if the test result is negative.
(i.e. percentage of negatives probably not having the disease)

$$\text{Predicted value of a negative test} = \frac{d}{c+d} \times 100.$$

v. **False positives:** These are the percentage of non-diseased persons wrongly identified as having the disease, because the test result is positive.

$$\text{False positives} = \frac{b}{b+d} \times 100.$$

vi. **False negatives:** These are the percentage of diseased persons wrongly identified as not having the disease, because the test result is negative.

$$\text{False negatives} = \frac{c}{a+c} \times 100.$$

Exercise

A new screening for a certain disease was administered to 480 persons, 60 of whom are known to have the disease. The test was positive in 50 of the persons with the disease as well as in 20 persons without the disease. Evaluate the screening test by all the measures. Analysis of data is shown in **Table 19.9 and 19.10**.

1. Sensitivity (True positive) = a/a+c × 100 = 50/60 × 100 = 83.33%.
2. Specificity (True negative) = d/b+d × 100 = 400/420 × 100 = 95.24%.
3. Predictive value of a positive test = a/a+b × 100 = 50/70 × 100 = 71.43%.

Table 19.9 Screening test result by diagnosis

Screening test result	Diagnosis		Total
	Diseased	Nondiseased	
Positive	a (50)	b (20)	a + b = 70
Negative	c (10)	d (400)	c + d = 410
Total	a + c = 60	b + d = 420	a + b + c + d = 480

Table 19.10 Diagnosis (Screening test result)

	Diseased	Not Diseased	Total
Positive	(True positive)	(False positive)	(Total positives)
	a	b	a + b
Negative	(False negative)	(True negative)	(Total negatives)
	c	d	c + d
Total	(Total diseased)	(Total nondiseased)	(Grand total)
	a + c	b + d	a + b + c + d

4. Predictive value of a negative test = d/c+d × 100 = 400/410 × 100 = 97.65%.
5. False positives = b/b+d × 100 = 20/420 × 100 = 4.76%.
6. False negatives = c/a+c × 100 = 10/60 × 100 = 16.67%.
7. Prevalence of the disease = a+c/a+b+c+d = 60/480 × 100 = 12.50%.

Lead Time

It is the length of time between the detection of the disease by screening procedure/test and the detection of the disease by clinical signs and symptoms (usual traditional method). In other words, the perceived survival time with the detection of the disease by screening test is longer than the perceived survival time with the detection of the disease by traditional method **(Fig. 19.9)**.

For example, most people with genetic disorder Huntington's disease are diagnosed when symptoms appear around the age 50 and they die around the age 65. The typical patient therefore lives about 15 years after the diagnosis. With a genetic test, it is possible to diagnose this disorder at birth. If this newborn dies around the age 65, he/she will have 'survived' 65 years after diagnosis, without having actually lived any longer than the people who are diagnosed late in life. Thus, screening will appear to increase the survival time. This gain is called 'Lead time'.

In this period there are usually a number of critical points, which determine both the severity of the disease and the success of any treatment in reversing the disease process.

However, when the different screening tests show different perceived survival time without affecting the course of the disease, it is called Lead time bias. This is an important factor when evaluating the effectiveness of a specific test. Lead time bias can affect the interpretation of the 'five year survival rate' as in cancer.

DISINFECTION

Disinfection is a process of destruction or removal of pathogenic organisms (such as bacteriae, viruses and fungi) outside the body, usually inanimate objects, and not necessarily the spores and not necessarily all the microbes, but reduction of their number to such a low level that it is not harmful to the health. The substances used for disinfection purposes, are called 'Disinfectants' (or Germicides). For example, phenol, cresol, bleaching powder, etc. Disinfectants being toxic, they are suitable only for disinfection of inanimate objects. A disinfectant destroys the organisms either by oxidation and burning of protoplasm or by coagulation of cytoplasm or by interfering with its metabolism.

Joseph Lister first used carbolic acid as an antiseptic in 1865 and published his work in 1867, which heralded the 'Antiseptic era'. This resulted in aseptic practices in patient care. Joseph Lister is called 'Father of Antiseptic surgery'.

Allied Terms

- **Sterilization:** It is the process of destruction of not only the vegetative forms of the bacteriae but also their spores, fungal spores and viruses. It also includes the process of elimination of all living organisms by mechanical means such as filtration (e.g. filtration of water using Katadyn

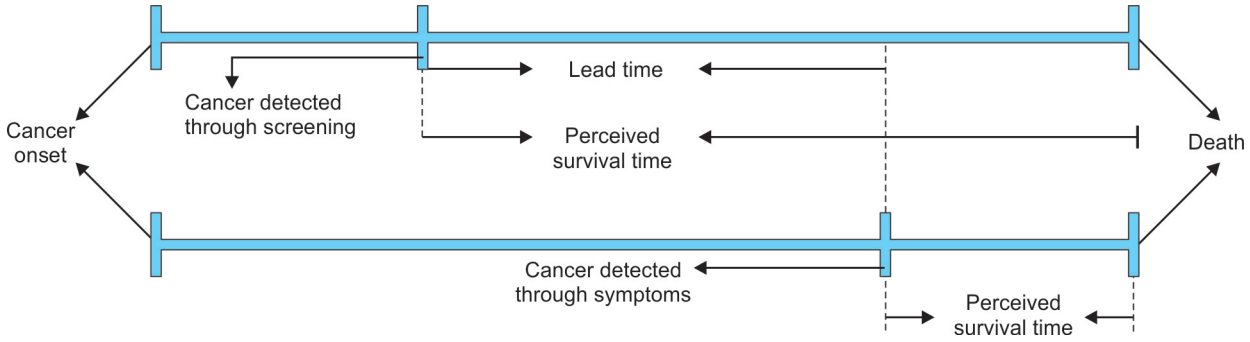


Fig. 19.9 Lead time

and Pasteur Chamberland Filters). In family Welfare services, sterilization refers to terminal/surgical method of contraception (viz vasectomy and tubectomy).

- **Antiseptic:** Disinfectants being toxic, are sufficiently diluted to suit human requirement, when they are called as 'antiseptics'. Thus, antiseptic is a disinfectant in lower concentration. An antiseptic either kills organisms or prevents (arrests) their growth. Being nontoxic and safe, antiseptics are recommended for superficial application on human tissues. For example, spirit, tincture iodine, etc.
- **Disinfestation:** It is a process of destruction of the ectoparasites such as lice, ticks, mites, etc.
- **Disinfestant:** It is a substance used for disinfestation, e.g. BHC.
- **Asepsis:** Consists of exclusion of all organisms from an area of skin.
- **Deodorant:** It is a substance, which eliminates foul smell, e.g. phenyl.
- **Detergent:** It is a surface cleaning agent. So they are also called 'surfactants'. It removes dirt, grease and bacteriae from the skin. It acts by reducing the surface tension.

Types of Disinfection

There are three types of disinfection as follows:
1. Prophylactic disinfection
2. Concurrent disinfection
3. Terminal disinfection.

Prophylactic Disinfection (Precurrent Disinfection)

This is carried out as a preventive measure, to prevent the onset of the disease, e.g. chlorination of water, pasteurization of milk, sterilization of the vaccines, scrubbing and washing the hands before surgery and after examining the patient, sterilization of the instruments before using for surgery.

Concurrent Disinfection (Concomitant Disinfection)

This consists of immediate destruction of the pathogens, as soon as they come out of the infected person's body, through the body fluids. It is undertaken to disinfect the infectious material of the patients and the infected articles used by them and the infected materials soiled by them during the course of their illness. This consists of disinfection of:

a. Infectious material like saliva, sputum, urine, vomitus, feces and other body discharges.
b. Linen, clothes, towels, dressings, utensils and bedding used by them and also.
c. Instruments, gloves, aprons, bowls and such others used during interaction with these patients.

This is done to prevent further spread of the disease and is carried out throughout the period of illness, i.e. as long as the patient is in the hospital.

Terminal Disinfection

This is carried out after the death or discharge of the infectious patients. In otherwords, it is complementary (a continuation) to the process of concurrent disinfection. This consists of disinfection of not only all the articles left behind in the ward by the patient, but also includes disinfection of floor, walls, furnitures, curtains, etc. of the ward.

The ultimate objective of the disinfection procedure is to prevent the onset of the disease and to prevent its further spread among the subsequent occupants.

Classification of Disinfectants

Disinfectants are grouped into three groups:
1. Natural
2. Physical
3. Chemical.

Natural Disinfectants

These are sunlight and air.

a. **Sunlight:** Sunlight acts as a disinfectant by its ultraviolet rays, which are lethal to bacteriae and some viruses. This is employed to disinfect articles like bedding (mattress), linen, furnitures, etc. by exposing to direct sunlight for several hours. UV rays act by coagulation of the protoplasm of the bacteriae.

b. **Air:** Air destroys the organisms by dessication or drying viz when the moisture content is evaporated, the pathogen dies.
However, these natural agencies are not reliable because they are less effective.

Physical Disinfectants

There are heat, radiation and filtration.

- **Heat:** This is employed in two forms—dry heat and moist heat.
  i. **Dry heat:** This has no power of penetration. It destroys the spores also. Therefore, dry heat can be employed for sterilization purposes also.
  Dry heat can be obtained in three ways:
  a. By burning
  b. By hot air
  c. By flaming.
  a. **By burning:** Burning is employed for disinfection and ultimate disposal of health care wastes such as bandages, swabs, rags, etc. This methods of

disposal of refuse is called 'Incineration', which is done in incinerator.

b. **By hot air:** Hot air is obtained from hot air ovens and there are three types of hot air ovens, employed for dry heat sterilization, namely conventional ovens, infrared ovens and microwave ovens.
   - **Conventional ovens:** The oven is preheated to a temperature of 160 to 180°C, then loaded with materials to be sterilized. The temp is maintained for at least one hour to kill spores. At the end of the time, the oven is allowed to cool before it is unloaded. (Sterilization time is calculated by adding penetration time to holding time; materials of bad conductors of heat take longer penetration time).

     This is very useful for sterilization of glassware articles, syringes, swabs, dressings, powders, oils, vaseline (petroleum jelly) and sharp instruments.

     The disadvantage is that it has minimal penetrating power and therefore not suitable for disinfection/sterilization of bulky articles like mattresses.
   - **Infrared ovens:** These are tunnel shaped chambers containing infrared heaters. They have openings at both ends guarded by flaps. These ovens have conveyor belts to carry articles for sterilization.
   - **Microwave ovens:** These produce electromagnetic waves and convert radiant energy into heat energy, which sterilizes the materials kept inside.

     This is useful in microbiological laboratories and dental units to sterilize culture medias and dental instruments.

c. **By flaming:** This is employed for sterilization of wire-loops, needles, etc. in microbiological laboratories, by holding them in flame of a Bunsen burner.

ii. **Moist heat:** This is obtained by heating or boiling the liquid. The temperature obtained by boiling is employed in three ways:

a. **A temperature below 100°C:** This is employed in pasteurization of milk, sterilization of vaccines (in vaccine bath), etc.

b. **At temperature of 100°C:** The water is heated to boil and rolling-boil is maintained for at least 20 minutes to destroy the spores also. This is employed in sterilization of syringes, needles, linen, utensils, gloves, surgical instruments, etc.

c. **At temperature above 100°C:** The moist heat above 100°C, is called steam, which is of two types namely saturated and superheated steam:
   - **Saturated steam:** It is the one collected in a boiler, in which the water is still boiling.
   - **Superheated steam:** It is the one collected in a boiler, in which all the water is converted into steam and heating of the boiler is still continued, so that the temperature of the steam is further raised.

   This method of sterilization by steam is employed by using 'autoclaves' in operation theaters, to sterilize the surgical instruments, OT garments, linen, gloves, masks, gowns, etc. However, it is not suitable for plastics.

   Autoclaves (steam sterilizers) hold both 'sensible heat' and 'latent heat'. Sensible heat is the one, which the steam has initially consumed to reach the boiling point. Latent heat is the one which it has absorbed for conversion into steam.

   Steam is the most effective sterilizing agent. It destroys all forms of life including spores. It has great power of penetration. It acts by giving off its latent heat.

- **Radiation:** Ionizing radiations like g-rays (gamma rays) have great power of penetration. Cobalt-60 is used as a source of radiation.

  This is employed for sterilization of bandages, condoms, dressings, catgut, plastic syringes, drip-sets, copper-T, catheters, etc. the material to be sterilized is prepacked in a plastic container and subjected for irradiation. They remain in a sterile condition until they are opened.

  This method is most effective but costly. However, it turns out to be economical in the long-run. HIV is not inactivated by ultra-violet and gamma radiation.
- **Filtration:** Liquids and solutions of heat labile substances can be sterilized by filtration. Four main types of filters have been used for bacteriological purposes—earthenware, asbestos, sintered glass and membrane of cellulose and other polymers. The first three types are usually satisfactory for retaining bacteriae but do not retain viruses. Membrane filters are available with pore size varying from 0.015 to 0.12 mm and can be used safely for sterilization of liquids and solutions.

Water for drinking purpose at household level can be disinfected by using domestic filters such as Berkefeld filter, Pausteur Chamberland filter and Katadyn filter.

Chemical Disinfectants

An ideal disinfectant is a one which fulfils the following criteria:

- Should be safe, cheap and effective
- Should kill all pathogens but not harmful to man
- Should be readily soluble (miscible with water), highly penetrable, consistently reliable, low in toxicity, rapid in its action
- Should neither corrode metals nor bleach or stain the articles
- Should be stable and not have unpleasant smell
- Should act in both acid and alkaline media
- Should not be influenced by the organic matter

An ideal disinfectant may be a distant dream but one that can fulfill a certain purpose and suit a certain situation can always be identified.

The action of a disinfectant depends upon its strength, nature of the solvent, nature and number of organisms, presence of organic matter, time given to act and temperature of the mixture.

Chemical disinfectants are grouped into four groups—namely, solid, liquid, gaseous and miscellaneous disinfectants.

Solid Disinfectants

For example, lime, bleaching powder, potassium permanganate, hypochlorites, halazone tabs, iodophors.

a. **Lime:** It is cheap and easily available. It is used in two forms:
   - *Dry lime (Quick-lime):* It is used to disinfect floor by spreading over it and also to disinfect water.
   - *Milk of lime (i.e. aqueous solution):* This is not only used to disinfect the walls by white-washing but also to disinfect excreta in the ratio of 2:1 and left for 2 hours.

b. **Bleaching powder:** It is chlorinated lime (i.e. when chlorine gas is passed into lime, it becomes bleaching powder—$CaOCl_2$). It is a white amorphous powder, having pungent smell of chlorine. The fresh bleaching powder contains 33.3 percent available chlorine. Bleaching powder is an unstable compound. So it looses its chlorine content on exposure to air and light. Therefore, it is always stored in brown colored bottle with air tight lid and kept in cool and dark place. Its unstability is the greatest disadvantage. As a disinfectant, its action is rapid but brief.

   Uses

   i. Bleaching powder is mainly used to disinfect water and also feces and urine because of Cl_2. Roughly 2.5 g of bleaching powder is required to disinfect 1000 liters of water. Presence of organic matter (feces) in the water reduces its efficacy. However, correct dose of bleaching powder requirement to the water can be estimated by using 'Horrock's apparatus.'

      Five percent solution of bleaching powder (3–4 tablespoons to 1 liter of water) is suitable for disinfection of excreta and urine, allowing for a period of one hour for disinfection.

   ii. It is used as a deodorant in bathrooms and latrines, because of the chlorine smell.

   iii. It is used as bleaching agent in paper and textile industries due to CaO.

   iv. Bleaching powder is also used as an oxidizing agent in oxidizing organic and ammoniacal substances present in the water, because of nascent oxygen in it.

c. **Hypochlorite:** Hypochlorites of sodium, calcium and lithium act in the same way as bleaching powder, even more stronger than that containing 80,000 to 1,80,000 ppm of available chlorine. It corrodes metals. Its solution called 'Hyposolution' containing 100 to 200 ppm of available chlorine is used to sterilize feeding bottles.

   Sodium hypochlorite (liquid bleach) has 5 percent available chlorine, calcium hypochlorite has 70 percent available Cl_2 and sodium dichloro-isocyanurate (NaDCC) has 70 percent Cl_2. Chloramine has 25 percent available Cl_2.

d. **Potassium permanganate:** It is a good oxidizing agent but a weak disinfectant. It is used to disinfect fruits and vegetables. Eventhough it can be used to disinfect water, it is not used because it results in reddish coloration of water and metallic taste. It is often recommended by dermatologists to treat eczema.

e. **Halazone tablets:** These are chlorine tablets containing 25 percent available chlorine. These are available in different strengths and are intended for domestic use. They are used for small-scale chlorination of drinking water. 1 such tablet containing 4 mg of halazone is sufficient to disinfect about 1 liter of water in about 30 to 60 minutes. Such tablets are also used for preparing chlorine solution for washing dishes, fruits and vegetables.

f. **Iodophors:** These are complexes of iodine, releasing free iodine. Iodine is a broad spectrum germicidal agent, possessing antibacterial, antifungal and antiviral properties. It acts by oxidizing microbial protoplasm and precipitating proteins. Iodophors are available as 'Solubilizers', e.g. povidone iodine (Betadin). Solubilizers contain carrier which helps in sustained release of iodine. They possess the same activity as iodine, but nonirritant and do not stain the skin. They are rapidly inactivated by organic matter.

(*Note:* Chemical disinfectants must not be used for disinfection of needles and syringes).

Liquid Disinfectants

For example, coaltar disinfectants, (phenol, cresol, izal, lysol, cyllin, hexachlorophane, chlorhexidine, chloroxylenol) quaternary ammonia compounds, iodine, hydrogen peroxide alcohols and formalin.

Coaltar Disinfectants

i. **Phenol:** Pure phenol (or Carbolic acid) is found as colorless crystals, which becomes pinkish and later dark red on exposure to air. Pure phenol is not an effective disinfectant. However, it has an injurious action against

pathogens and tissue cells by protoplasmic poisonous activity. Nevertheless, it is used as a standard to compare the germicidal activity of disinfectants.

Phenol has a caustic action and can produce skin burns. The presence of organic matter does not interfere with its action seriously but the presence of soap does reduce it. Thus, carbolic soaps have a questionable germicidal activity.

Because of its injurious property, phenol is not used as an antiseptic.

However, crude phenol (phenyl), which is a mixture of phenol and cresol is an effective disinfectant. It is a dark, brown colored oily liquid, having a characteristic smell. It is not readily inactivated by organic matter. Ten percent strength is used for disinfection of feces and 5 percent strength for mopping floors and cleaning drains.

ii. **Cresol:** It is an excellent coal tar disinfestant. It is 3 to 10 times more powerful than phenol, yet not toxic to tissues. It is also brown colored, oily liquid, which turns white on dilution with water.

In 5 to 10 percent strength, cresol is used to disinfect feces and urine (5% solution can be prepared by adding 50 ml to 1 liter of water).

Cresol doesnot loose its germicidal action in the presence of soap. On the other hand when cresol is saponified, becomes a powerful disinfectant (i.e. saponified cresol). Saponified cresol such as lysol, izal and cyllin are popular disinfectants in hospital use.

Lysol is five to ten times more powerful germicide than phenol, useful for disinfecting hands, clothes, excreta and hospital equipment.

Izal is eight times more powerful than phenol. It possesses a special action against coli-typhoid group of organisms. It is useful for disinfecting stools and urine of typhoid patients.

Cyllin is also a cresol emulsion, which is seventeen times more powerful than phenol. It is used mainly for disinfecting drains and latrines. It is popular for being a cheap and efficient germicide.

Chlorocresol, which is obtained by chlorinating metacresol, is used as a preservative for injections. It is more efficient than cresol.

iii. **Hexachlorophene:** It is a powerful chlorinated phenol. It is an efficient antiseptic for skin and a deodorizer. The presence of soap or organic matter does not interfere with its germicidal activity. Therefore, it is incorporated in soaps for its antiseptic and deodorizing action. It is also employed as an antiseptic for skin preparation in obstetric practices.

iv. **Chloroxylenol:** It is popularly known as 'Dettol'. It is 70 times more powerful germicide than phenol. But its potency is reduced by the presence of organic matter. It is active against streptococci but not so much against Gm negative bacteriae.

Being noncorrosive and nonirritating, it is widely used in clinical practice as a surgical antiseptic for wounds, as hand lotion and as a mouth-wash in dental practice. It is also incorporated in skin creams, lubricating obstetric creams and soaps.

v. **Chlorhexidine (Hibitane):** It is a nonirritating antiseptic that destroys bacteriae by disrupting the cell membranes. It is widely used as a general skin antiseptic. 0.5 percent aqueous solution is used as hand lotion. Creams and lotions containing 1 percent chlorhexidine is recommended for burns. It is also recommended for mouth wash and neonatal bath.

Quaternary Ammonia Compounds

For example, cetrimide, savlon, zephiran.

i. **Cetrimide:** It is marketed as 'Cetavlon'. It has a soapy feel. Thus it is an efficient surface cleansing-cum-disinfectant. It is used usually in 1 percent strength, popularly in the management of roadside wounds for removing dirt, grease, tar and blood. It is also used for disinfecting surgical instruments and gloves and also for sanitizing utensils.

ii. **Savlon:** It is a combination of cetavlon and chlorhexidine (hibitane). Like cetavlon, savlon is also a popular cleansing, disinfecting and sanitizing agent. It is also used for surgical toilet of roadside wounds. Savlon, 1 in 6 in spirit is a best disinfectant for clinical thermometers and plastic appliances.

iii. **Zephiran:** It is used as a preoperative skin disinfectant, for superficial wounds, as a douche for irrigation of mucous cavities, for storage of surgical instruments, etc. thus employed as an all purpose disinfectant and antiseptic. It is active against gram-positive cocci and less active against gram-negative bacteriae like cetavlon.

Iodine

Iodine is a broad-spectrum germicidal agent having antibacterial, antifungal and antiviral properties. It acts by oxidizing microbial protoplasm and precipitating proteins. Iodine is cheap, readily available and quick in its action. Iodine is irritating to the tissues particularly wound margins. It often causes sensitivity reactions and stains the skin. Iodine is employed in various forms, as:

- Tincture of iodine (2% solution in 70% alcohol) and Polyvidone iodine (PVI; betadine) as antiseptic for cuts and wounds
- Iodine paint as an antiseptic before giving injection
- Iodine solution applied over skin for preoperative antisepsis
- Mandle's paint applied on sore throat for germicidal action
- A drop of tincture iodine added to a liter of drinking water for disinfection during emergency situation.

Hydrogen Peroxide

It is an oxidizing liquid. It acts by releasing nascent oxygen. Solution of hydrogen peroxide has a poor penetrability and feeble germicidal action. Commonly it is used for cleansing the suppurative wounds and ulcers. By releasing gas, it removes pus, slough and loosens dead necrotic matter. It is also used for gargling the mouth. It is also used as a spray disinfectant for plastic goods and mechanical equipment.

Alcohol (Spirit)

Disinfectant alcohols are ethyl alcohol and isopropyl alcohol. Between 60 to 80 percent concentration, they act as disinfectant and below that (at 50% level) they act as bacteriostatic agents. Pure alcohol has no power of disinfection.

Ethyl-alcohol (methylated spirit) is used as skin antiseptic before giving parenteral injections and hand washing. But because of their volatile nature the alcohol does not possess sustained disinfectant action. Moreover, because of its toxic and irritant nature, these alcohols cannot be applied to mucous membranes.

Because of its cost and flammability, its use is limited to certain article disinfection such as thermometers, hospital trolleys and table tops in laboratories.

Alcoholic solution of chlorhexidine and iodine are effective antiseptics.

Formalin

Commercial formalin is 40 percent aqueous solution of formal-dehyde gas. It is used as spray for disinfection of the rooms, tents, huts and vehicles. It is also used for disinfection of delicate articles and jewelery items. It is also used as a preservative of tissues/organs in the anatomy and pathology museums and for sending the tissues for histopathology examination. Three percent strength is used to disinfect rooms in the form of spray.

Ten percent strength is used to disinfect excreta.

Formalin is irritating to the eyes and nose. It often causes contact dermatitis.

Gaseous Disinfectants

For example, formaldehyde, ethylene oxide, sulphur-dioxide.

a. **Formaldehyde:** This gas can be obtained either by boiling liquid formalin or by pouring formalin over potassium permanganate crystals, placed in a deep pan/bucket. This gas is also released by spraying formalin. The formaldehyde gas is highly inflammable, irritating, colorless and highly toxic gas.

   Formaldehyde gas possesses germicidal action against viruses, fungi, bacterial spores and acid fast bacteriae. It scores over chlorine in disinfecting hospital equipment and instruments in that it does not bleach textiles or damage metals.

   Formaldehyde gas is commonly employed for disinfection of the rooms, specially operation theaters. It also possesses insecticidal action against mosquitoes, fleas and lice, which is an added advantage. The gas is also employed for disinfection of books, clothes, blankets, bed, etc. which cannot be boiled.

   Its flammability, toxicity and potential carcinogenicity are the limitations.

b. **Ethylene oxide:** Ethylene oxide also is an extremely toxic, inflammable, irritating and explosive gas, highly lethal to all kinds of vegetative forms of pathogens, and viruses. It is directly obtained from its liquid form, which has a very low boiling point. Since it is explosive, it is mixed with 12 percent carbon dioxide. Water vapor increases its efficiency.

   It is used for disinfection of fabrics, rubber, plastic and synthetic materials. It is also employed for disinfecting a variety of hospital equipment, electronic equipment, anesthetic equipment, cardiac equipment, diathermic equipment and medical and dental equipment. However, the process is difficult to control. Therefore, ethylene oxide is not preferred when others are available.

c. **Sulphur dioxide:** This is also an irritating and highly poisonous gas, produced by burning sulfur. It possesses bleaching, tarnishing, discoloring the paints and inflammatory properties. Sulfur dioxide is practically inert when dry. It depends upon the presence of moisture for its disinfectant action. It is more effective as an insecticide and rodenticide. Water vapor increases the efficiency of the gas.

Standardization of Disinfectant

The bactericidal activity of a disinfectant is compared with that of phenol, using *Salmonella typhi* as the test organism and expressed in terms of a coefficient called 'Rideal walker coefficient' (or Carbolic coefficient).

If RW coefficient is 10, it denotes that the disinfectant is 10 times more potent than that of phenol, in its action on *Salmonella typhi*, under laboratory conditions, in the absence of organic matters or in the presence of other factors limiting the germicidal action of a particular disinfectant.

Now, there is an improvement on R-W test, called 'Chick-Martin' test which gives an estimate of the germicidal power of a disinfectant in the presence of organic material like yeast, excreta, etc.

Miscellaneous Disinfectants

These are certain metals and dyes.

a. **Metal disinfectants:** For example, silver, and mercury.
   - **Silver:** The germicidal action of silver nitrate is due to its caustic nature and the antiseptic (bacteriostatic) action is due to the release of silver ions by silver

proteinate formed by the interaction of silver with tissue proteins.

The caustic action is employed in silver nitrate 'touches' to hypertrophied tonsils and aphthous ulcers.

As an antiseptic it is employed in irrigation of bladder and urethra. Silver nitrate drops are used in the prophylaxis and treatment of ophthalmia neonatorum. Silver is also effective in gonococcal infections. The oligodynamic action of silver is employed in purification of water in Katadyn filters. The outer surface of the filter candle is covered by a coating of silver, which releases silver ions to disinfect water.

- **Mercury:** This acts as a disinfectant by releasing metallic ions which get adsorbed on the surface of bacteria and coagulate their protoplasm. Mercuric chloride (corrosive sublimate) is a powerful disinfectant, but its activity is impeded in the presence of albuminous matter. Mercurochrome is a poor antiseptic.

b. **Disinfectant dyes:** For example, acridine, roseline, fluorescein dyes.
   - **Acridine dyes:** The derivatives of acridine are acriflavine and proflavine. Their activity is not interfered by the presence of organic matter. Acriflavine vaseline bandages are used for dressing burn injuries.
   - **Roseline dyes:** The derivatives are gentian violet and brilliant green. They are effective not only against gram-positive bacteriae but also against fungi. Often acriflavine is added to them to make it more effective.
   - **Fluorescein dyes:** These include mercurochrome and sodium salt of fluorescein (i.e. fluorescenum sodium). The latter emits green fluorescence by reflected light and is used for detecting corneal ulcers and abrasions.

DISINFECTION PROCEDURES

For excreta, sputum, room (operation theater), clinical thermometer, purulent and other discharges, bed-linen, blankets.

1. **For feces and urine:** Excreta should be collected in impervious vessels and disinfected by adding equal quantity of, any of the following disinfectants. Feces are broken with sticks to allow proper disinfection and allowed to stand for 1 to 2 hours.
   a. 8 percent bleaching power solution (This is obtained by adding 50 g of fresh bleaching powder with 33.3 percent available chlorine to 1 liter of water).
   b. 10 percent crude phenol (prepared by adding 100 mL of phenol to 1 liter of water).
   c. 5 percent cresol (by adding 50 mL to 1 liter of water).
   d. 10 percent formalin (by adding 100 mL to 1 liter of water).

   If any of these disinfectants are not available, at least equal amount of milk of lime (1 part of lime to 4 parts of water) may be added, mixed well and left for 2 hours.

   If that is also not available, a bucket of boiling water may be added to the feces, it is then covered and allowed to cool.

   After disinfection, the excreta is emptied into a water closet or buried in the ground.

   Bed pans and urine cans should ideally be steam disinfected. They can be disinfected with 2.5 percent cresol for an hour after cleaning with boiling water.

   If none is available, they can as well be washed with soap and water.

   Burning a cotton ball soaked in spirit inside a bed pan is useful in a field/emergency situation.

   Workers attending to this should wash their hands thoroughly with soap and water after attending to this and before eating or drinking.
2. **For sputum (specially of tuberculosis patients):** This is received in the gauze or paper handkerchiefs and destroyed by burning or it is buried in the earth far from human habitation.

   Alternatively, sputum may be received in a cup half filled with 5 percent cresol and when full it is allowed to stand for one hour and the contents are emptied and disposed off.
3. **For room (operation theater/isolation ward):** The isolation ward need to be disinfected after discharge or death of the patient. The doors and windows are kept open for several hours for good aeriation. Then the room is disinfected usually by all the three methods—mopping, spraying and fumigation.

   Floors and hard surfaces may be mopped with formalin solution (10%) or cresol (2.5%) or phenol (5%) and washed after a contact period of 4 hours. Furniture items may also be mopped with 5 percent formalin solution.

   The room as a whole may be disinfected by fumigation with formaldehyde gas, when the doors and windows are kept closed for 10 to 12 hours. The gas is generated either by boiling liquid formalin in two volumes of water (i.e. 500 ml in one liter of water per 30 cu meter of space) or by pouring liquid formalin over crystals of potassium permanganate placed in a deep pan. On the other hand if potassium permanganate is added to formalin solution, it can result in violent explosion. (viz. 500 ml of formalin + 1 leter of water to about 200 g of $KMnO_4$ per 30 cu meter space). All the materials in the room get disinfected. Room is kept closed for 10 to 12 hrs (preferably 24 hours) as a contact period.

   Alternatively the room may be disinfected by spraying it with formalin solution. Care must be taken to spray the walls from below upwards to prevent running down of the liquid disinfectant along the walls of the rooms. The sprayer must use personal protective devices during the spraying operations.

4. Articles used by patients such as linen, clothes, etc. soiled with blood or dejecta, are disinfected before they are used by others. Such items are soaked in a solution of formalin (10.0%) or cresol (2.5%) or 5 percent phenol and then after the contact period, washed with soap and water followed by sun drying and ironing.

   Alternatively such linen and clothes are disinfected by boiling for half an hour or by steaming.
5. Damageable goods of far and leather and also woolen and silk fabrics may be disinfected by exposure to formaldehyde gas.
6. Clinical thermometer is disinfected either by keeping it in surgical spirit or dettol or savlon solution. Hot water swab should never be used to clean the bulb of thermometer because the temperature reading shoots up.
7. Paper, books and woolen materials can be disinfected with hot air. Wrist watches can be disinfected with spirit.
8. Utensils and crockery items can be disinfected by boiling for 5 to 10 minutes. Cutlery items specially knives, which may get blunt on boiling may be disinfected by immersion in 10 percent formalin or 2 percent lysol for 10 minutes before being washed and cleaned.
9. Disposable items like tissue paper, gauze pieces, cotton swabs and rags may be directly disposed of by burning or incineration.
10. **Disinfection of needles and syringes:** The following procedure is recommended after using the syringes and the needles but before disposal, till the facility of incineration or hot air oven becomes available.
    - Do not detach the needles from the syringes after use
    - Aspirate disinfectant fluid into the syringe
    - Immerse the syringe with attached needles in the disinfectant fluid horizontally in flat metal or glass tray or puncture proof plastic container
    - Keep them immersed in the disinfectant fluid for at least 30 minutes
    - The needles and syringes are then removed from the tray and destroyed mechanically before disposal.

Alternatively all the disposable material can be put in the hot air oven at a temperature of 160°C for 30 to 60 minutes. This will ensure that there will not be any possibility of its reuse.

If incineration is not available, the only next best alternative is 'deep burial' in controlled land fill sites. However, the needles and syringes must be destroyed mechanically before burial.

High Level of Disinfection

It is a process of destroying all microorganisms, however some spores may survive particularly if they are present in large numbers initially.

High level of disinfection can be achieved by continuous boiling for 20 to 30 minutes. This is simplest and most reliable method for freeing an article from most of the pathogenic organisms including HIV and HBV, in situations where sterilization by autoclaving is not possible.

High level of disinfection can also be achieved by exposure to vapors of ethylene oxide or formaldehyde or by soaking in chemical disinfectants like activated glutaraldehyde and carbolic acid for prolonged period.

Instruments and equipment like vaginal specula, proctoscope, laryngoscope, flexible, fibro-elastic endoscope, etc. which come in contact with intact mucous membrane but do not penetrate it, should ideally be sterilized. However, if sterilization is not possible they must be exposed to high level of disinfection.

Syringes and needles and other skin piercing instruments can also be used after high level of disinfection by boiling when autoclaving is not possible.

Chemical disinfectants must never be used for disinfection of syringes and needles.

HOSPITAL-ACQUIRED INFECTIONS (NOSOCOMIAL INFECTIONS)

(Nosos = Disease; Nosocomial = Relating to a hospital)
These are the cross-infections occurring in the hospitals.

Definition

Hospital-acquired infections (HAIs) is defined as acquiring an infection in the hospital by the patients or others during their stay and manifesting either during the hospital stay itself or after discharge.

The prevalence of HAI is expected to be about 7 to 12 percent in the developed countries and 25 to 40 percent in India.

Causes

Hospital-acquired infections is usually due to failure to observe aseptic precautions while carrying out the hospital procedures such as surgical operations, IV infusions, catheterization, dressings of the wounds, lumber puncture, giving injections, etc.

Predisposing factors:

- Development of the resistance by the organisms to the commonly used drugs
- Overcrowding of the hospitals
- Poor environment of the hospitals, both inside and outside
- Decreased resistance and increased susceptibility of the vulnerable groups of patients such as those suffering from tuberculosis, leprosy, diabetes, severe PEM, anemia, cardiac patients, old age of the patients, those who have undergone major surgery, those who are on steroids, cytotoxic drugs, etc.

Etiological agents: Fifty percent of HAIs are due to staphylococci and about 45 percent are due to gram-negative bacilli such as *E. coli*, *Klebsiella*, *Proteus*, *Pseudomonas*, *Salmonella*, *Shigella*, etc. Remaining 5 percent are caused by viruses, protozoa, rickettssiae, fungi, etc.

Among the viruses, emergence of HBV and HIV has worsened the situation.

Predominantly, there are four types of HAIs:

- Urinary tract infections, which may be symptomatic and asymptomatic
- Infections of the lower respiratory tract
- Postoperative infections—any surgical wound resulting in purulent discharge, is considered as HAI
- Systemic infections, revealed by positive blood culture.

Sources and Reservoirs of HAI

Hospital-acquired infections can be derived from:

1. **The patient's own flora:** Self-infection (autoinfection). Under normal conditions, the organisms concerned is not pathogenic. But due to the hospital procedure, non-pathogen assumes pathogenic property and results in an infection.
2. **The flora of another patient:** Cross-infection. In such cases the microorganism concerned is transmitted:
   a. By direct contact between patients (patient's hands, saliva droplets)
   b. By air (dust from fabrics carrying a patient's flora).
   c. By the staff:
      – Who collects the microorganisms directly on their hands or clothes and transmit them to another patient.
      – Who harbors the microorganisms on the mucosa of their own respiratory and intestinal tracts, where they are reproduced and transmitted (i.e. carriers).
3. **Environmental sources:**
   a. *Air:* Hospital air and dust usually harbors more bacteriae, which are often pathogenic and multidrug resistant.
   b. Surfaces contaminated by patient's secretions, excretions, blood and body-fluids, animals and insects.
   c. *Inanimate objects:*
      – *Contaminated by the patients:* Hospital equipment, such as thermometer, linen, bed, table, cot, sanitary installations, etc. medical equipment such as endoscopes, catheters, needles, lancets, spatula, vesical probes, etc.
      – Contaminated by the hands of any hospital staff in any part of the hospital (kitchen, laundry, treatment room, etc.)
      – Contaminated by visitors
      – Contaminated by staff who are ill or are carriers of microorganisms
      – Contaminated by food or contaminated water
      – Contaminated by animals and insects.

Thus, man occupies a central position:

a. As reservoir and source of microorganisms
b. As disseminator (communication routes)
c. As recipient or target, thus becoming a new reservoir.

All patients in the hospital are potential recipients of cross-infection. Those who are severely ill, chronically ill and on steroid therapy are all highly susceptible. So cross-infection is greater in intensive care units, postoperative wards, pediatric wards and geriatric wards.

Age incidence: HAI can occur in any age group. But it is high in pediatric and geriatric age groups.

Sex incidence: HAI is equal in both the sexes.

Mode of Transmission

Hospital-acquired infections spread by the various routes as follows:

a. *By contact:* Close physical contact among the patients themselves by touch or with the doctor or staff.
b. By droplet infection
c. *By infected dust:* Which are released and spread into the atmosphere while sweeping the wards or while bed-making, etc.
d. By fomites (inanimate objects mentioned already)
e. By parenteral or percutaneous route while carrying out the hospital procedures (Iatrogenic).

Prevention and Control of Nosocomial Infections

Elimination of the Reservoirs or Sources

1. **Care of the staff:** Hospital staff suffering from any infectious disease (respiratory or alimentary or any septic skin lesions) should not attend to their duties until complete recovery.
2. **Care of the patients:** All acute infectious cases must be admitted in the isolation ward only. There are three types of wards.
   i. **Chamber ward (cell ward):** This is a separate ward for separate (individual) patients. It is also called isolation ward. It has its own ventilation. The partition extends from floor to ceiling.
   ii. **Cubicle ward:** In this type, the partition extends from floor but does not reach ceiling, giving provision for cross-ventilation.
   iii. **Open wards:** These are general wards wherein many patients are admitted.
3. **Treatment:** This should be given correctly and completely with specific antibiotics.

4. **Nursing care:**
   i. **Barrier nursing:** This means that the hospital staff must act as barriers to prevent cross-infection by wearing gowns, gloves, masks, etc. while touching or examining certain acute infectious cases.
   ii. **Task nursing:** This means posting special nurses for special duties. For example, a nurse attending to feeding of a premature child should not attend to the toilet of the child. Such care is essential in intensive care unit, premature baby-ward, etc.

Breaking the Channel of Transmission

1. Contact transmission can be prevented or broken by disinfection of hands with soap and water or dettol lotion soon after touching the patient suffering from contagious diseases.
2. Isolation of the infectious cases in the isolation ward.
3. Concurrent disinfection of infectious patients' body discharges like urine, saliva, sputum, excreta, etc. and also his clothes, utensils and other fomites must be carried out as long as the patient is in the hospital.
4. Droplet mode of transmission can be prevented by:
   - Avoiding overcrowding in the wards
   - Enough bed spacing of at least 12' between the patients
   - Adequate lighting
   - Adequate ventilation, specially cross-ventilation in the wards
5. *Control of infected dust:* By vaccum cleaning of the floor followed by wet-mopping of the floor preferably with phenyl.
6. Transmission by various hospital procedures can be prevented by observing strict aseptic precautions. Post-operative dressings should be made by meticulous care, caution and technique.
7. Hospital refuse like waste bandage cloth, dressings, plaster, etc. are all best disposed off by incineration. However, the needles and syringes are disinfected before disposal.
8. Hospital premises should always be kept clean both inside and outside.

Protection of Susceptible Persons

1. Highly susceptible persons should be admitted preferably in the isolation wards.
2. They are protected with vaccinations, e.g. tetanus, hepatitis B, gas gangrene, etc.
3. Universal blood and body fluid precautions to be adopted by all the health care workers.

Administrative Measures

There should be a Hospital Infection Control Committee for surveillance of HAIs, to draw guidelines for different high-risk procedures, early detection and control of outbreak of HAI and also to formulate policies (regarding admission of infectious cases, isolation facilities, disinfection procedures, etc.) and to implement them.

The Hospital-acquired Infection Control Committee consists of the following administrative set-up:

Chairperson: Medical Superintendent

Member Secretary: Infection Control Officer (Microbiologist)

Members: Chiefs of all Clinical Units/Heads of Deptartment

Chief of Blood Bank Service

Microbiologist

Medical Record Officer

Chief of Nursing Services

Infection Control Sister

Invited members: Chiefs of all Supportive Services (OT, kitchen, laundry, etc.)

The Committee must meet at least once a month. Similarly there must be a 'Control Board' at the state level and national level.

EMPORIATRICS

In Greek, '*emporos*' means traveler and '*iatrike*' means medicine. Emporiatrics is that branch of medical science which deals with the study of health of international travelers.

Health Problems of Travelers

- Younger travelers are at a greater risk than older ones.
- The greater the climatic and cultural contrast between the native country and the destination country, higher the risk
- Most common health problems are diarrhea and vomiting.

Problems Faced by Travelers

- They are subject to disorders induced by travel such as motion sickness, nausea, indigestion, fatigue, insomnia and jet lag.
- They are exposed to diseases which are not covered by International Health Regulations, e.g. malaria, typhoid, AIDS, STDs, viral hepatitis, dengue fever, etc.
- They are separated from familiar and accessible sources of medical care.
- They are exposed to various forms of stress, which reduces their resistance and makes them susceptible. For example, overcrowding, long hours of waiting, disruption of eating habits, change in climate.

Jet lag: It is the term used for the symptoms caused by disruption of the body's internal clock and the approximate 24 hours (circadian) rhythms it controls. This occurs specially when multiple latitudes (time zones) are crossed while traveling from East to West or West to East.

The symptoms are indigestion, bowel disturbances, general malaise, day time sleepiness, difficulty in sleeping at night and reduced physical and mental performance. Symptoms gradually wear off as the body adapts to new time zone.

Jet lag cannot be prevented but its effects may be reduced by the following measures:

- Resting well before and during flight
- Eating light meals and limited consumption of alcohol
- Taking short acting sleeping pills may be helpful
- Exposure to day light at destination usually helps adaptation.

Health Advice to Travelers

They should:

- Use boiled and cooled water for drinking purposes. Bottled mineral water can also be used. This prevents all waterborne diseases.
- Avoid taking bath in polluted water. This prevents infections of the eyes and ears.
- Avoid contaminated food and drinks. They must use thoroughly and freshly cooked foods.
- Take chemoprophylaxis if they are traveling to malaria endemic areas. They must start taking the drugs on the day of arrival in the malarious area and continued for 4 to 6 weeks after leaving the malarious area. The drugs recommended are chloroquine, amodiaquine and sulphadoxine and pyrimethamine.
- Take human normal immunoglobulin to protect against viral hepatitis A, every 4 months, with a dose of 0.02 to 0.05 mg/kg body weight.
- Take 3 doses of hepatitis B vaccine with the schedule of 0, 1 and 6 months.
- Avoid sex with other partners or limit to a single, faithful uninfected partner.
- Use condom if the sexual partner is unknown.
- Use disposable syringe and needle whenever injection is essential.
- Produce valid certificate of vaccination against yellow fever.
- Take active immunization against tetanus also.
- Use mosquitonets while sleeping.
- Carry medical kit containing disinfectant, dressing cloth, ORS packets, sun cream, mosquito repellent and those drugs which are taken regularly.
- Carry 'Health card' with them.

INTERNATIONAL HEALTH REGULATIONS 2005

International Health Regulations (IHR) is an international law that is binding on 194 countries to enhance national, regional and global public health security. The aim is to help the international community prevent and respond to acute public health risks that have the potential to cross borders and threaten people worldwide.

The purpose and scope of these IHRs are 'to prevent, protect against, control and provide a public health response to the international spread of diseases in ways that are commensurate with and restricted to public health risks and which avoid unnecessary interference with international traffic and trade'.

All 194 States Parties have agreed to implement IHR 2005.

In the globalized world, diseases an spread for and wide via international travel and trade. A health crisis in one country can impact livelihoods and economics in many parts of the world. Such crises can result from emerging infections like severe acute respiratory syndrome (SARS) or a new human influenza pandemic. The IHR can also apply to other public health emergencies such as chemical spills, leaks and dumping or nuclear meltdowns. The IHR aims to limit interference with international trade and traffic while ensuring public health through the prevention of disease spread.

IHR require member countries to report certain disease outbreaks and public health events to WHO. IHRs define the rights and obligations of countries to report public health events and establish a number of procedures that WHO must follow in its work to uphold global public health security.

IHR also require countries to strength their existing capacities for public health surveillance and response. Timely and open reporting of public health events will help make the world more secure.

Evolution

1851: IHR was originated at Paris with International Sanitary Regulations (ISR)
1948: WHO came into existence.
1969: During 22nd World Health Assembly, ISR was renamed as International Health Regulations (IHR) and adopted. 34th World Health Assembly amended IHR to rule out smallpox from the list of notifiable diseases (Cholera, plaque and yellow fever).
1995: During 48th World Health Assembly, IHR was revised by WHO because of narrow scope of these three notifiable diseases and also because of emergence and re-emergence of infectious diseases.

IHR (2005) entered into force on 15th June 2007 binding on 194 countries. India entered into force on 8th August 2007.

The implementation of these Regulations shall be full respect for the dignity, human rights and fundamental freedom of persons.

The implementation of these Regulations shall be guided by the Charter of the United Nations and the Constitution of WHO.

IHR (2005) Second Edition has 10 parts. Part 5 has 4 Chapters dealing with Public Health Measures.

Chapter I. General Provisions

Article 23: Health Measures on Arrival and Departure

1. a. *With regard to travelers:*
   i. Information concerning traveller's destination, so that traveler may be contacted.
   ii. Information concerning the traveller's itinerary to ascertain if there was any travel in or near an affected area or other possible contact with infection or contamination prior to arrival, as well as review of the traveler's health documents if they are required under these Regulations; and/or.
   iii. A noninvasive medical examination which is the least intrusive examination that would achieve the public health objectives.
   b. Inspection of baggage, cargo, container, conveyances, goods, postal parcels and human remains.
2. On the basis of the evidence of a public health risk obtained, State Parties may apply additional health measures.
3. No medical examination, vaccination, prophylaxis or health measures under these regulations shall be carried out on travelers without their prior expressed informed consent or that of their parents or guardians (except as provided in paragraph 2 of Article 31) and in accordance with the law and international obligations of the State Party.
4. Travelers to be vaccinated or offered prophylaxis pursuant to these regulations or their parents or guardians shall be informed of any risk associated with the vaccination or with non-vaccination and with the use of or non-use of prophylaxis.
5. Any medical examination, medical procedure, vaccination or other prophylaxis which involves a risk of disease transmission shall only be performed on or administered to, a traveler in accordance with established national or international safety guidelines and standards so as to minimise such a risk.

Chapter III. Special Provisions for Travelers

Article 30: Travelers Under Public Health Observation

A suspect traveler who on arrival is placed under public health observation may continue an international voyage, if the traveler does not pose an imminent public health risk and the State Party informs the competent authority of the point of entry at destination, if known, of the traveller's expected arrival. On arrival, the traveler shall report to that authority.

Article 31: Health Measures Relating to Entry of Travelers

If a traveler refuses to provide the information or documents, the concerned State Party may deny entry to that traveler. If there is an evidence of imminent public health risk, the State Party may compel the traveler to undergo or advise the traveler to undergo:

a. The least invasive and intrusive medical examination.
b. Vaccination or other prophylaxis.
c. Additional established health measures such as isolation, quarantine or placing the traveler under public health observation.

Article 32: Treatment of Travelers

State Parties shall treat travelers with request for their dignity, human rights and fundamental freedoms including by:

a. Treating them with courtesy and respect.
b. Taking into consideration the gender, socio-cultural, ethnic or religious concerns of travelers
c. Providing appropriate accommodation, food, water, cloth and protection for their luggage, appropriate medical treatment, means of necessary communication in an understandable language and appropriate other assistances if necessary.

BIBLIOGRAPHY

1. Bres P. Public Health Action in Emergencies caused by Epidemics. WHO, Geneva 1986.
2. Government of India. National Child Survival and Safe Motherhood Programme: Manage the Cold Chain and Other Supplies. Ministry of Health and Family Welfare, New Delhi 1992.
3. Last John M. A Dictionary of Epidemiology. Oxford University Press, 1983.

4. Mathur JS. A Comprehensive Textbook of Community Medicine 1st edn, 2008.
5. Maxcy Rosenau. Public Health and Preventive Medicine, 11th edn, 1980.
6. NRHM Bulletin. 2012;7(4).
7. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.
8. Rothman, Greenland and Lash. Modern Epidemiology. Lippincot Wiliams and Wilkins—a Wolters Kluwer Business. Third Edn. 2010.
9. Srinivas. Hospital Acquired Infections: Guidelines for Control. Ministry of Health and Family Welfare, Government of India, New Delhi 1992.
10. Vipin M. Vashistha. Key statements of IAPCOI and IAP immunization time table for the year 2012. Pediatric infectious disease 2012;4(3):112-24.
11. WHO International Travel and Health; Vaccination Requirements and Health Advice 1996.
12. WHO Tech Rep Ser No 666, 1981.
13. WHO Tech Rep Ser No 682, 1983.
14. WHO. International Health Regulations (2005) 2nd edn. Geneva; 2006.
15. Wilson JMG, Jungner G. Principles and Practice for Screening for Disease. Public Health Paper No 34, WHO, Geneva, 1968.

CHAPTER 20

Epidemiology of Communicable Diseases

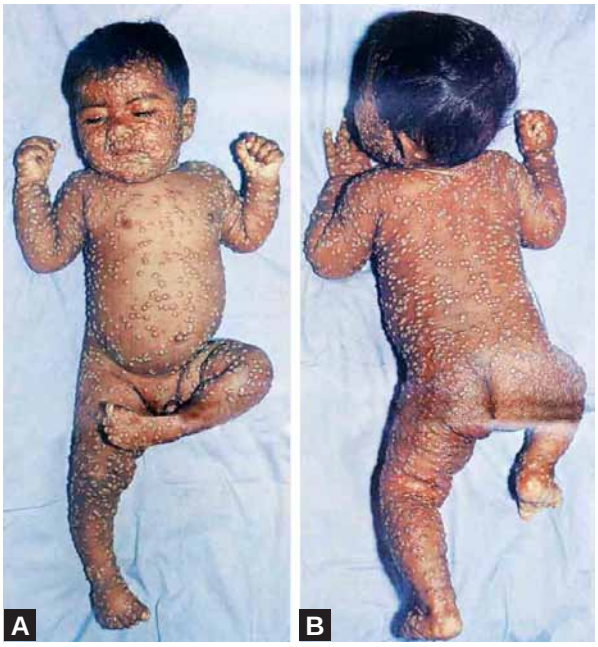
AIRBORNE DISEASES

STORY OF SMALLPOX (VARIOLA MAJOR) (OBITUARY)

Smallpox was an acute, highly infectious, exanthematous, major killer disease of children, caused by variola-virus, transmitted by droplet infection, often occurring in epidemics, clinically characterized by sudden onset of high fever, severe prodromal symptoms, followed by appearance of rashes on 3rd day, centrifugal in distribution, passing through the successive stages of mucule, papule, vesicle, pustule and scab formation, leaving behind deep seated, pock marks permanently, with a case fatality rate, varying from 20 to 50 percent **(Figs 20.1A and B)**.

In the early part of 20th century, smallpox was worldwide in distribution. By systematic vaccination and re-vaccination, it was eliminated from Western countries in the first half of the century. In 1962, Government of India launched National Smallpox Eradication Program. Till 1967, it was endemic in Africa, Asia and Indonesia. In 1967, WHO began an intensified Global Smallpox Eradication Program by intensive surveillance, systematic vaccination and re-vaccination. As a result, country after country achieved Smallpox free status.

In 1975, Government of India further intensified the program under the banner 'Operation Smallpox-Target Zero'. Within few months, the disease was eliminated. The last indigenous case in India occurred on 17th May 1975 in Bihar State (Pachera village of Katihar district). On 24th May 1975, another case was reported, but was imported from Bangladesh. The patient was a woman of 30 years old, namely Saiban Bibi, who got infected in Bangladesh but developed fever with rashes while living on the platform of Karimganj railway station, in Assam. Since then no cases were reported from India. After an arbitrary period of two years of intensive surveillance all over India, when not even a single case was detected, India was declared 'Smallpox free country' in April 1977 by the International Commission.



Figs 20.1A and B Baby with smallpox disease

World's last historic case of Smallpox, was reported from Somalia of Africa, on 26th October 1977. The world was

declared as Smallpox-free by WHO on 8th May 1980. It was a very great achievement to eradicate smallpox and indeed a historic milestone in the history of medicine.

The credit goes to the great 'Edward Jenner', who discovered the vaccine against Smallpox. He made a very observation that an attack of cowpox protected a milkmaid, namely Sarah Nelmes against smallpox. Later, he proved his observation by taking the cowpox matter from the lesions of the milkmaid and vaccinated James Phipps, who got protected from smallpox. Edward Jenner got Fellow of Royal College of Society (FRS) for his discovery. Since the vaccinia-virus (cowpox virus) was employed to protect against variola-virus (smallpox), the procedure was called as vaccination.

By 1982, all countries officially discontinued compulsory vaccination, so much so the vaccination against smallpox is considered as medical malpractice. Even though smallpox has been eradicated from the world, viruses are being maintained in living conditions only in two laboratories namely US laboratory in Atlanta, Georgia and Viral Research Institute, Moscow. This is because there are many animal pox viruses, specially monkey pox virus, which can affect human beings and it is not known whether these animal pox viruses, such as monkeypox, tanapox, cowpox, camelpox, rabbitpox, mousepox, buffalopox, sheeppox, goatpox, etc. can someday replace the eradicated smallpox virus.

The epidemiological factors, which favored the eradication of smallpox are:

- Absence of animal reservoir.
- Absence of subclinical cases.
- Absence of carrier state.
- Absence of second attacks.
- Easy recognition of the disease even by a nonmedical person.
- Availability of potent, freeze-dried vaccine.
- Successful cooperation from the public.
- Cooperation from the International Health Organization.

HUMAN MONKEYPOX

Monkeypox is a zoonotic disease, animal reservoir being unknown, affects the human beings accidentally. It is caused by monkeypox virus, belongs to orthopox-virus group. A person-to-person transmission is limited, thus not constituting a public health problem. Secondary attack rate is hardly 15 percent.

In 1970, it was first recognized as a human disease in Zaire, Africa. It is a sporadic disease. Hardly 165 cases were reported from the forest areas of Central and West Africa in a span of 15 years. These areas are under surveillance by WHO.

Clinically, it is characterized by 14 days of incubation period, localized (cervical ?) lymphadenopathy, indicating percutaneous route of entry of the virus, (probably vector-borne) followed by the appearance of cutaneous rashes. Among children, the rashes are extensive and associated with significant mortality.

Vaccination against smallpox, protects against monkeypox also, because of its close antigenic resemblance with smallpox virus. The differences between smallpox and monkeypox are shown in **Table 20.1**.

CHICKENPOX (VARICELLA; WATERPOX)

It is not clear how chicken got into chickenpox. It is an acute highly infectious disease, but a mild, exanthematous disease of children, caused by varicella-zoster virus (VZV), transmitted by droplet infection. Clinically characterized by fever, mild prodromal symptoms followed by the appearance of rashes. Not a fatal disease.

It is worldwide in distribution and occurs in both epidemic and endemic forms.

Table 20.1 Differences between smallpox and monkeypox

Smallpox	Monkeypox
Human disease	Zoonotic disease (Animal reservoir unknown)
Caused by variola-virus	Monkeypox virus
Epidemic disease	Sporadic disease
Not associated with lymphadenopathy	Associated with localized lymphadenopathy
Incubation period is 12 days	14 days
Secondary attack rate = 30–45%	15%
Transmitted by droplet infection	Vector-borne transmission (?)
Mortality is high	Low

Etiological agent: The causative agent is varicella-zoster virus. It is a DNA virus of human alpha herpes virus 3. The primary infection with this virus results in chickenpox. Recovery from the disease is followed by the establishment of latent infection in the body, especially in the dorsal root ganglia for decades. When the conditions are favorable such as suppression of cell-mediated immunity, the virus, which had dermatotropic effect in the primary infection, develops neurotropic effect and results in herpes-zoster (Shingles), characterized by painful, vesicular, pustular lesions all along the distribution of one or more sensory nerve roots.

Source of infection: Usually, a case of chickenpox is the source. Rarely, a case of herpes zoster may also be a source. There are no subclinical cases, no carrier state and no animal reservoir also.

Infective materials: These are the respiratory secretions, the cutaneous lesions and the vesicular fluid. However, scabs are not infective.

Period of infectivity: It is about one week, i.e. one or two days before the appearance of rashes to 4 to 5 days thereafter. Once the macular and papular lesions become pustules, the patient is no longer infectious, because the virus tend to disappear from the lesions.

Secondary attack rate: Chickenpox is highly infectious so much so, the secondary attack rate is 90 percent.

Host Factors

Age incidence: Chickenpox is common among young children below 10 years of age. However, it can occur among adults also. But when it occurs among adults, it is usually severe.

Sex incidence: It is equal in both the sexes.

Immunity: One attack confers lifelong immunity. Second attacks are rare. The infection induces both humoral and cell-mediated immunity. Cell-mediated immunity is the one which prevents the recurrence and also the reactivation of the latent infection.

Pregnancy

If the pregnant mother gets the infection during first trimester (organogenesis), in 3 percent cases, the fetus gets the intra-uterine infection resulting in severe damage, characterized by low birth weight, micro-ophthalmia, choroidoretinitis, cataract, hypotrophic limbs with hypotonicity, and zoster-like skin lesions or scars, a condition called 'congenital varicella syndrome'.

If the mother gets the infection during the last trimester, there will not be any developmental defects in the newborn, because fetus is already developed. On the other hand, it will have only rashes. Attack would be mild, because it would have received the maternal antibodies.

If the mother gets the infection during the last few days of pregnancy or just before delivery and has not yet developed antibodies, the newborn will develop signs of chickenpox during neonatal period and it will be very severe.

Environmental Factors

Chickenpox is more during summer and overcrowding favors transmission.

Modes of Transmission

Commonest route of transmission is by droplet and droplet nuclei. Transplacental transmission occurs in 3 percent of cases. Transmission through contaminated fomites is less likely.

Pathology and Pathogenesis

Having entered the body through the respiratory route, the viruses circulate in the blood, later affect the epidermis part of the skin, because of its dermatotropic property, resulting in balooning degeneration of the cells and outpouring of intercellular fluid, forming a vesicle. Very soon the polymorphs migrate from the clear fluid of the vesicle and fluid becomes turbid, the lesions are called pustules, which dry up rapidly resulting in scabs. The scabs separate within 8 to 10 days without leaving pock marks.

Incubation Period

It is about 15 days, but varies from 1 to 3 weeks.

Clinical Features

The clinical course occurs in two stages.

1. *Prodromal stage:* It is the pre-eruptive stage, characterized by mild fever, myalgia and malaise, lasting for about few hours to one day. These features are little more severe among adults and lasts for 2 to 3 days.
2. *Exanthematous stage:* This eruptive stage is characterized by appearance of rashes on the next day of fever or even on the day the fever starts.

The rashes are macular, quickly pass through the stages of papules, vesicles, pustules and crusting stage within 3 to 4 days. Lesions are centripetal in distribution, i.e. more on the closed parts of the body (chest, abdomen, axilla), unlike in smallpox. Rashes are pruritic. New lesions continue to

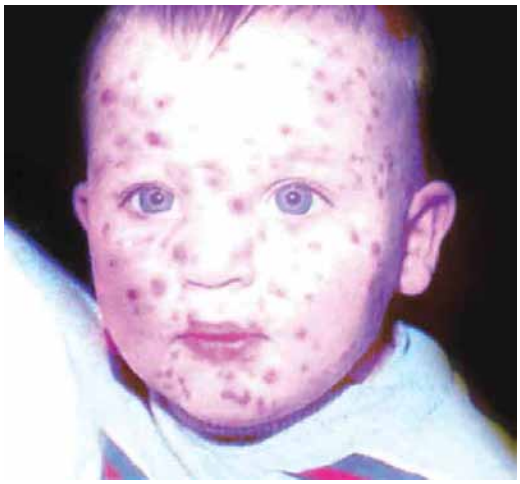


Fig. 20.2 Varicella—typical multiple lesions in different stages of development

Fig. 20.3 Varicella vaccine

appear daily. Fresh crops of lesions are associated with rise of temperature. The vesicles look like 'water drops' on the skin. Rashes appear daily for 4 to 5 days.

Pleomorphism of lesions is characteristic of chickenpox. That is, all stages, of the lesions (macules, papules, vesicles, and pustules) are seen simultaneously at one time **(Fig. 20.2)**.

Lesions can occur in the mouth, forming ulcers. They can also be seen on cornea, tympanic membrane and vagina.

Crusts (Scabs) over the lesions may remain from 1 to 3 weeks and fall off, not leaving pock mark. However, there may be slight discoloration lasting for few weeks before skin becomes normal.

Usually, it is observed that if the prodromal symptoms are mild, rashes will be less.

Complications

Chickenpox is a mild self-limiting disease. However, on occasions, it can prove fatal especially among newborn babies of mothers with varicella, among those on long-term steroid therapy and immunocompromised.

Complications are known to occur in 5 percent of cases. These are sepsis (due to secondary infection following itching), varicella-pneumonia, encephalitis and hemorrhages (varicella-hemorrhagica). Other rare complications are Reye's syndrome (encephalopathy associated with fatty degeneration of liver) and congenital varicella syndrome.

Management

Since there is no treatment, patients have to be isolated and managed symptomatically with analgesics, antipyretics and soothing ointments. However, concurrent disinfection has to be carried out.

Prevention

Prevention is by active and passive immunization.

Active Immunization

A live attenuated, freeze dried, varicella-vaccine (VARIVAX) has been developed, by using Oka-strain of the virus in Japan, grown on human diploid cells which has been proved effective and safe. It is supplied with diluent. It is recommended for the children between 12 months and 12 years (Not for infants). Dose is 0.5 mL subcutaneously. Efficacy is more than 90 percent. Immunity lasts for 10 to 15 years. Indian Academy of Pediatrics recommends second dose during 5th year. For primary immunization in adults, 2 doses are recommended with 4 to 8 weeks interval **(Fig. 20.3)**.

Contraindications: Contraindications are pregnancy, immunocompromised conditions like malignancy, AIDS, long-term steroid therapy, etc.

Question that has arised is about the need for a vaccine against chickenpox, because varicella being a mild disease, is postponed to adulthood by vaccination and when it occurs among adults, results in a severe condition. Another objection is whether the vaccine virus establishes latent infection, producing zoster in later years. Vaccine-associated complications can also occur resulting in sequelae. Because of all these limitations, many do not consider the need for the vaccine.

Passive Immunization

This is done by using varicella zoster immunoglobulin (VZIG). It is given for those, who are at risk such as young close contacts. It is effective only when given within 3 to 4 days of exposure. High risk contacts are those with impaired immunity, malignant disease, newborn and pregnant mother contacts.

The VZIG is hyperimmune serum obtained from those who have recovered from chickenpox or immunized against chickenpox.

Dose is 20 units per kg body weight.

ACUTE RESPIRATORY INFECTIONS

Acute respiratory infections (ARIs) is sudden onset of infection of any part of the respiratory system from nose to alveoli, including paranasal sinuses, middle ear and pleural cavity. Thus, the ARIs constitute a complex and heterogeneous group of diseases, caused by a great number of etiological agents. It is common among under-five, infants being hit hardest. Thus contributing significantly for increased morbidity and mortality among infants, more so in the developing countries, (about 50 times higher than developed countries) because of increased prevalence of malnutrition, low birth weight and indoor air pollution, due to poor living condition and overcrowding.

Magnitude of the Problem

It has been estimated that 20 percent of infants born in developing countries fail to survive their fifth birthday and 30 percent of child mortality is attributable to acute respiratory infection as an underlying or a contributing cause.

In India, in absolute numbers, it is about 2 million deaths among under-five children every year, i.e. 2000 deaths per day or 80 per hour or 1 per minute.

The ARI constitutes about 40 percent of total pediatric out patients and 20 percent of hospital admissions. About 25 percent can be managed at home by the mother herself and another 50 percent can be managed by trained health worker. However negligence can result in complications.

Thus, the ARI is a public health problem in India. Timely intervention and correct treatment and referral service can save many deaths, particularly pneumonia.

Classification

Etiological Classification

Viral (adenovirus, coronavirus, rhinovirus, influenza-V, respiratory, syncytial virus, etc.), bacterial (*Streptococcus pneumoniae*, *Haemophilus influnzae* (common causes of community-acquired pneumonia), fungal, parasitic and allergic.

Anatomical Classification

- *First group:* Rhinitis, coryza, sinusitis, otitis media, pharyngitis, tonsillitis, quinsy (peritonsillar abscess).
- *Second group:* Epiglottitis, laryngitis, tracheitis, bronchitis, bronchiolitis, pneumonia, pleurisy.

WHO Classification

- Acute upper respiratory infections (AURI)—includes anatomical first group.
- Acute lower respiratory infections (ALRI)—includes anatomical second group.

Etiology

Respiratory tract may be invaded by one pathogen or a variety of pathogens such as viruses, bacteria, fungi, parasites or allergens, simultaneously or one prepares the way for another to invade, i.e. primary infection leading onto secondary infection. Usually viruses cause mild upper respiratory infections and bacteria cause severe lower respiratory infections.

Host Factors

Age: Incidence of ARI is very high among under-five children, infants being hit hardest in the developing countries.

Sex: Incidence of ARI is more among male children than among female children in the ratio of 1.7:1. The difference may partly be due to preferential treatment to male children.

Risk factors related to host are:

1. *Low birth weight:* A LBW child is highly susceptible for any infection, more so for ARI and when ARI occurs in a LBW baby, the infection becomes more severe suddenly than in the healthy counterpart, resulting in increased morbidity and mortality. In addition to increased susceptibility, LBW babies, have poor respiratory mechanism.
2. *Failure of breastfeeding:* This deprives the child of maternal antibodies, more so from colostrum, predisposing the child for a great risk of many communicable diseases including ARI. Studies have shown that the incidence of ARI is high among artificially fed and bottle fed babies than breastfed babies.
3. *Undernutrition:* This in general decreases the immune mechanism and vitamin-A deficiency in particular decreases the integrity of respiratory epithelium predisposing the child for ARI which becomes severe and persistent (chronic) predisposing the child for complications and death.

The synergistic action of malnutrition and infection is well recognized. Presence of one predisposes and aggravates the other. The mortality rate of ARI is about 20 times more among malnourished children than among healthy counterpart. Such adverse effect of undernutrition can best be seen in measles.

4. *Lack of primary immunization:* Lack of routine primary immunization as per the schedule constitutes a major risk factor for acquiring the respiratory diseases such as tuberculosis, measles, diphtheria and whooping cough; Pneumonia being the commonest complication. These are major killer diseases of children in our country.
5. *Young infant age (i.e. neonatal period):* During the first one or two months after birth the newborn is extremely vulnerable to ARI. Poor standard of living worsens the situation.
6. *Vitamin A deficiency:* This not only decreases the integrity of respiratory mucous membrane but also reduces the secretion of mucus in the respiratory tract, predisposing the bacteriae to stick to the mucous membrane easily resulting in the disease.
7. *Antecedent viral infection:* Antecedent viral infection of respiratory tract not only predisposes the bacteria of oropharynx to invade down resulting in secondary bacterial infection, but also impairs the child's immune status and damages the bronchial epithelium as in measles.

Environmental Factors

1. *Air pollution:* Air pollution following industrialization and urbanization, predisposes the people for respiratory infections. Thus ARI incidence is more among urban children than among rural children.
2. *Smoking:* Both active and passive smoking predisposes the people for ARI. Thus, the children of cigarette and *beedi* smokers are more prone for ARI.
3. *Season:* The incidence of ARI is more in winter season because of indoor living and overcrowding.

Social Factors

There are many social factors, responsible for the prevalence of ARI in the community, such as poverty, illiteracy, ignorance, lack of personal hygiene, overcrowding, poor standard of living, lack of sanitation, nonutilization of health services, etc. These are all predisposing factors.

Epidemicity of a disease: Most ARI are endemic. However, some ARI such as measles, pertussis, influenza have potentiality of occurring in epidemics, when the case fatality rate will be very high.

Mode of transmission: ARI is primarily transmitted by droplet infection. Epidemics and pandemics occur through airborne route, i.e. by droplet nuclei.

Incubation period: This varies according to etiological agents.

Neonatal pneumonia: This deserves special mention because it is highly fatal and differs from pneumonia of older infants and children in its etiological agents, mode of transmission and nonspecific features.

The causative organisms isolated are *E. coli*, Strep-agalactiae (group-B), *Pseudomonas, Pneumocystis carinii, Klebsiella pneumoniae, Streptococcus pneumoniae* and *Staphylococcus aureus.*

The newborn may get infection either transplacentally from the mother during fetal life or by aspiration of amniotic fluid during birth or by droplet infection from others after birth.

The clinical features of ARI are not the routine type of cough and fever but will have signs of toxemia and respiratory distress such as tachycardia, tachypnea and hepatomegaly.

Neonatal pneumonia is very common among LBW babies, because of their poor respiratory mechanism.

Prevention and Control

The measures can be implemented at first three levels of prevention, namely health promotion, specific protection and early diagnosis and treatment. The other two levels of prevention are not implemented because ARI is an acute condition and not a chronic condition.

Health Promotion

- Efficient antenatal care to reduce the incidence of LBW.
- Essential care of the newborn and special care of LBW newborn.
- Promotion of exclusive breastfeeding up to the first six months of life.
- Promotion of adequate nutrition of the growing children.
- Improvement in the living conditions (Housing and sanitation).
- Reduction of parental smoking and smoke pollution indoors.
- Limiting the size of the family to prevent overcrowding.
- Health education of mothers about correct ARI case management at home with the following points.
  - To increase feeding and to keep the child warm.
  - To clear the nose by instillation of breastmilk, if runny nose interferes with feeding.
  - To relieve the cough with home made decoctions like tea, ginger, lime juice, etc.
  - To recognize danger signs such as fast breathing (increased respiratory rate) and difficult breathing. (Chest in drawing).

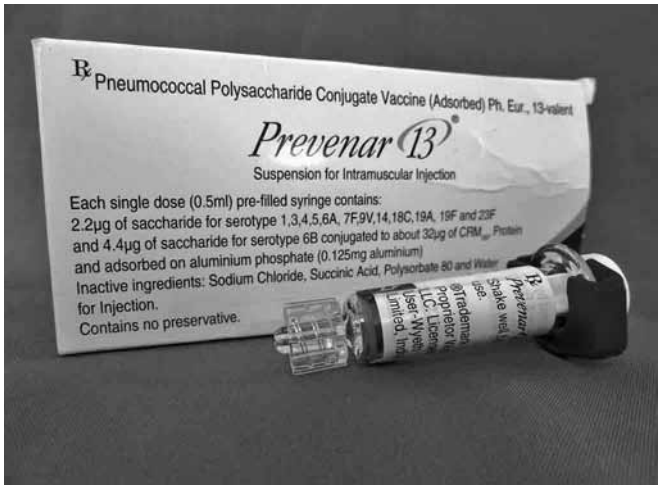


Fig. 20.4 Pneumococcal vaccine

Specific Protection

- Strengthening the existing routine primary immunization.
- Oral vitamin A concentrate, 5 mega doses for children between 9 months and 3 years.
- Other vaccines which can be given are pneumococcal vaccine **(Fig. 20.4)** and *Haemophilus-B influenzae* vaccine.

Early Diagnosis and Prompt Treatment

(Correct case management) WHO has recommended the following steps.

1. Assessment of the child from the following information by asking the mother and by looking and listening to the child for the following features.
   - Age of the child, duration of cough, wheezing, chest-in-drawing, stridor, fast breathing, infant stopped feeding well (below 2 months of age), ability to drink (in a child between 2 months up to 5 years of age), antecedent illness, (such as measles), fever, malnutrition, excessive drowsiness, convulsions, irregular breathing, cyanosis and any history of treatment.

Wheezing is a whistling noise heard during expiration, due to narrowing of air passage.

Chest-indrawing is lower chest wall moving in during inspiration.

Stridor is the harsh noise produced during inspiration, due to narrowing of larynx and trachea (This is also called croup).

Malnutrition is a risk factor and case fatality rate is higher.

Cyanosis is a sign of hypoxia.

Fast breathing: This is considered to be present when the respiratory rate is as follows.

- 60 per minute or more, in a child below 2 months of age
- 50 per minute or more, in a child between 2 and 12 months of age
- 40 per minute or more, in a child between 1 and 5 years of age.

2. *Classification of illness*—as mild, moderate, severe and very severe.

Mild ARI cases (No pneumonia): Characterized by cough, cold (runny nose), sore throat, otitis media with or without fever, no chest indrawing and no fast breathing.

Moderate cases (Pneumonia): Characterized by cough, fast breathing and no chest indrawing, with or without fever.

Severe cases (Severe pneumonia): Characterized by cough, fever, chest indrawing, fast breathing, (fast breathing may be absent if the child is exhausted) flaring of alae-nasi, grunting (sound made with the voice) and cyanosis.

Very severe cases (Very severe pneumonia): Characterized by all features of pneumonia associated with danger signs such as inability to drink, convulsions, abnormally sleepy, stridor, and severe malnutrition.

3. *Management (Standard Treatment):*
   a. *Mild cases (No pneumonia):* These can be treated at home by the home remedies like ginger, tea, lime juice.

      These cases do not require antibiotics. Most of such cases are self limiting.
   b. *Moderate cases (Pneunomia):* These cases require antibiotics orally and can be treated as outpatients. Drug of choice is cotrimoxazole. It is as effective as ampicillin or penicillin with high cure rates and few side effects and less expensive. This can be used safely by health workers in the field and by the mothers at home. Cotrimoxazole is available in both pediatric tablet and syrup forms.

Composition of each tablet	Each spoon (5 mL) syrup
Sulphamethoxazole = 100 mg	200 mg
Trimethoprim = 20 mg	40 mg

Dose schedule

< 2 months – 1 tab twice a day or half spoon twice a day.
2–12 months – 2 tabs twice a day or one spoon twice a day.
1–5 years – 3 tabs twice a day or one and half spoon twice a day.

Duration of treatment is for 5 days. However, reassessment of the condition of the child should be done after 48 hours. If there is improvement, cotrimoxazole is continued for 3 more days. If there is neither improvement nor worsening of the condition, change the antibiotic and reassessed after 48 hours. If there is worsening of the condition, the child is referred for hospitalization.

Along with the antibiotic the child is also given antipyretic and bronchodilator.

Note: For children below 2 months, cotrimoxazole is not recommended routinely. They are treated as severe pneumonia with parenteral antibiotics. However cotrimoxazole can be initiated before referral. Cotrimoxazole should not be given to premature babies and cases of neonatal jaundice.

c. *Severe cases (Severe pneumonia)*
   - Immediate hospitalization.
   - Parenteral antibiotics (Benzyl penicillin is the drug of choice 5 L units/kg, 6 hourly, IV).
   - Antipyretics.
   - Bronchodilators.
   - Monitored everyday and reviewed after 48 hours for antibiotic therapy.
   - If no improvement, then change the antibiotic.
   - If there is improvement, continue the same treatment for 3 more days.
   - If there is worsening, treated as very severe illness.

d. *Very severe cases (Very severe pneumonia):* These cases constitute acute medical emergency.
   - Hospitalization in intensive care unit.
   - Oxygen.
   - Broad spectrum antibiotics.
   - Maintenance of fluids and electrolytes.
   - Steroids as an emergency drug.

Supportive Treatment at Primary Health Care Level

This is provided by the community health workers. They are trained in making an early diagnosis and giving treatment with cotrimoxazole. They encourage continuation of breast feeding and intake of liquids to prevent malnutrition. They should refer the following types of ARI cases to the hospital early.

- Neonatal pneumonia (Pneumonia below 2 months of age).
- Very severe pneumonia.
- Pneumonia among LBW babies.
- Pneumonia with measles or following measles.
- Children who do not show signs of improvement after 2 days of treatment with cotrimoxazole.

MEASLES (MORBILLI; RUBEOLA)

It was so named as morbilli, to differentiate from 'Ill-morbo' which means plague. Rubeola means red spots (Rubor = redness, Ola = spots). The word 'Measles' is an Anglo-saxon word, derived from the word 'maseles', which means spots.

History

During 9th century, Abu Bacr, an Arab physician described the disease. For a long time, it was confused to be a separate form of Smallpox. It was Sydenham who first distinguished from smallpox during 17th century. In 1846, Panum studied the epidemiology. In 1954, Enders isolated the virus. In 1958, clinical trial was conducted with Measles vaccine. In 1963, the vaccine was licensed for use. In 1985, it was included under Universal Immunization program.

Measles is an acute infectious exanthematous disease, caused by a specific virus of paramyxovirus group, common among young children, transmitted by droplets, clinically characterized by fever, catarrhal symptoms followed by typical rashes. Case fatality rate is 5 percent which increases to 15 percent during epidemics.

Extent of the Problem

Measles is a global problem. In developing countries, it constitutes a 'Pediatric priority' (David Moorley). In India, it is the third most common cause of death among under fives, thus constituting a major killer disease. Repeated episodes result in malnutrition. During 1985 about 2.5 Lakh cases were reported. After including measles vaccine under UIP, the incidence started declining, so much so that during the year 2000, hardly 25,000 cases were reported. However if unrecorded cases are also included, it will be much higher. Measles is known for its epidemicity in cyclic trend.

Agent Factors

Measles virus is a single stranded RNA virus that belongs to paramyxovirus group. It cannot survive outside the human body. It can easily be destroyed by heat, acid and drying. It survives for a long time at sub-zero temperature. Lower the temperature, longer is its duration of life. At 4° to 6°C, as in the refrigerator it can survive up to 6 months and at –20°C as in Deep freezers/ILR, it can survive for 2 to 3 years. This property is utilized to prepare live vaccine against measles and to store it in cold-chain.

Reservoir of Infection

Measles is a disease of human beings only, because humans are the only natural host to measles virus. Hence, the only reservoir of infection is a case of measles. There is no carrier state. Subclinical cases may occur. There is no animal reservoir.

Infective material: Respiratory secretions of a case of measles.

Period of communicability: 4 days before and 5 days after the appearance of rashes. Measles is highly infectious during this period .

Secondary attack rate: SAR is about 80 percent among the susceptible contacts.

Mode of transmission: It is by droplet infection and droplet nuclei. Controversial statement is whether it is transmitted by conjunctival route also.

Host Factors

Age: Incidence is high among children between 6 months and 3 years in the developing countries. Infants below 6 months escape because of maternal antibodies they get through milk.

In the developed countries, there is a shift in the age incidence because of high immunization coverage.

Sex: Incidence is equal in both the sexes.

Immunity: One attack of measles confers life long immunity. Second attacks are rare. Immunity after vaccination is quite solid and long lasting.

Nutritional status: Malnutrition increases the susceptibility of the child. Measles becomes more severe in malnourished children. Mortality is about 400 times higher in a malnourished child compared to healthy counterpart. This is due to poor cell mediated immunity due to malnutrition. In addition, measles precipitates even a healthy child into malnutrition.

Environmental Factors

In temperate climates, measles is common during winter season and early spring (Jan to April) because of overcrowding indoors. Poor environmental conditions, poor housing, and overcrowding favor the disease transmission.

Pathogenesis

Having entered the body through the respiratory tract by droplet infection, the viruses quickly pass to the nearest lymph nodes, multiply there and then leak into the bloodstream in small amounts to reach reticuloendothelial cells in liver, spleen and bone-marrow, where they multiply, destroy those cells and flow again into the bloodstream in sufficient numbers as to affect many tissues in the body, mainly respiratory mucosa (i.e. nose, throat and bronchial tree), alimentary mucosa, conjunctiva and skin. Therefore, the symptoms are mainly due to inflammatory reactions in these areas.

Incubation Period

It is 10 days between the onset of infection and the onset of fever and it is 14 days between the infection and the appearance of rash.

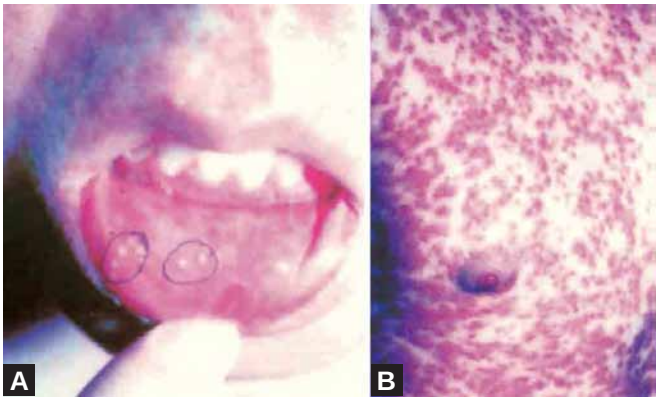
Clinical Features

The features occur in two stages – Prodromal stage and Exanthematous stage.

1. *Prodromal stage:* This is also called as Pre-eruptive stage or Catarrhal stage. This is characterized by fever, anorexia, cough, conjunctival congestion, photophobia, swelling of lower lids, runny nose, flushing of the face, lacrimation, giving the child the appealing woebegone expression of the face, characteristic of measles. The child is irritable. Nausea and vomiting may be associated. Oral and throat mucosa is congested. There may be associated dry cough and photophobia.

   One or two days before the appearance of rashes, Koplik's spots appear on the buccal mucous membrane, by the side of the second molar tooth, around the orifice of the Stenson's duct. They are small, blush-white spots on a red base, smaller than the head of a pin, looking like grains of salt on the red background, innumerable in number, lasting for about 3 to 4 days. Koplik's spots are pathognomonic of measles (**Fig. 20.5A**).

   Often cervical lymphadenopathy and febrile convulsions occur. Prodromal stage lasts for about 3 days.
2. *Exanthematous stage (Eruptive stage):* Rashes appear on 4th day of fever, first behind the ears, then on the forehead, face and down the trunk slowly taking 2 to 3 days to progress to the hands and lower extremities. Rashes are pink colored (or dull red), velvety and maculopapular (**Fig. 20.5B**). They remain discrete but often become confluent and blotchy. At this stage, temperature will



Figs 20.5A and B (A) Rubeola-Koplik spots: tiny white papules on oral mucosa; (B) Rubeola—intense morbilliform eruption

be very high, about 104°F. Within another 1 or 2 days, antibodies appear and the symptoms of viremia subside.

From the 5th or 6th day, rashes begin to disappear in the same order they had appeared. Lesions disappear completely from the face, but on the trunk, they leave behind brownish discoloration which may persist for about 6 to 8 weeks. No permanent pock marks are left behind. CFR varies from 5 to 30 percent depending upon the nutritional status and development of complications.

Complications

Postmeasles complications are grouped into the following groups.

Respiratory Complications

These are croup, pneumonia and otitis-media.

Croup: The cough is metallic and there may be laryngeal stridor. The crouping cough is described as 'wet' in measles and 'dry' in diphtheria. There will be respiratory distress.

Pneumonia: Post measles bronchopneumonia caused by the bacteria as secondary infection often constitutes medical emergency. If there is latent infection of primary complex, it is often flared up into active tuberculosis.

Otitis media: This also occurs as a secondary infection.

Gastrointestinal Complications

The commonest and dreadful complication is acute gastroenteritis, often associated with severe dehydration and malnutrition.

Neurological Complications

- Febrile convulsions occur when the temperature is very high.
- Encephalitis is 1 in 1000 and mortality is about 40 percent.
- *Subacute sclerosing panencephalitis* (SSPE): This is a rare complication, which develops many years after the initial measles infection. It is said that the virus is trapped in the brain and exists as latent infection which is reactivated after about 7 years resulting in progressive mental deterioration leading to paralysis, blindness, decerebrate rigidity and death. Incidence is about 7 per million cases of measles.
- Other rare complications are multiple sclerosis, retrobulbar neuritis, toxic encephalopathy, etc.

Ophthalmic Complications

- *Conjunctivitis:* This is common in all cases of measles. It becomes more severe, when there is secondary bacterial invasion.
- Corneal ulceration can occur among malnourished children.

The recognized postmeasles complications are gastroenteritis, pneumonia and encephalitis.

Management with Nursing Care

- Isolation in a well ventilated room.
- Concurrent disinfection of nasal and throat secretions.
- TPR chart to be maintained 4th hourly.
- Tepid sponge both is given to relieve irritation of skin and to reduce temperature.
- Light and clean clothes.
- Eyes are washed with sterile normal saline.
- Antipyretics to control fever.
- Attendants to use gown and mask.
- Prophylactic antibiotics may be given.
- Plenty of water and fruit juice because of loss of appetite.
- Watch for the complications.
- Terminal disinfection of the room.

Prevention and Control

This is done by active and passive immunization.

Active immunization: This is done by using live attenuated vaccines.

They are grouped into 2 groups:

Measles vaccine of single antigen: They are of 2 types.

- Aerosolized vaccine (Edmonston Zagreb (EZ)—Chick Embryo vaccine; EZ Human Diploid cell vaccine)
- Heat stable vaccine (containing either Schwartz strain or Moraten strain)

Measles vaccine of multiple antigens: MMR-Vaccine (Measles, Mumps, Rubella vaccine).

All are tissue culture live attenuated, freeze dried vaccines. They are safe and effective.

Fig. 20.6 Measles vaccine

Measles Vaccine

Nature

It is a live virus vaccine of single antigen and is a freeze dried vaccine **(Fig. 20.6)**.

Indication

For active immunization of infants against measles.

Composition

Each dose of 0.5 mL contains not less than 1000 TCID 50 (Tissue culture infective dose) live attenuated, Edmonston Zagreb strain of measles virus, propagated on Human Diploid cells.

Diluent: Sterile distilled water.

Dose: 0.5 mL.

Route: Subcutaneously in the upper arm or anterolateral surface of the thigh.

Schedule: Only one dose during 9th month of infancy.

Directions for use: Diluent is to be added along the side wall of the vial and then rolled between the palms but not shaken because shaking the vial results in formation of foam. Reconstituted vaccine must be used immediately.

Immunity: Develops 10 to 12 days after vaccination and lasts lifelong.

Protective value: One dose confers 95 percent protection (5% failure).

Reaction: In 15 to 20 percent of the vaccinees, the attenuated virus multiplies and induces 'mild measles illness' about 8 to 10 days after vaccination, characterized by mild fever, lasting for 1 or 2 days followed by mild rashes lasting for 2 to 3 days, followed by recovery.

The virus does not spread from vaccinees to contacts.

Contacts: Young susceptible children coming in contact with an active case of measles can be protected from measles by the vaccine if given within 3 days of exposure, because the incubation period in artificial infection is 7 days whereas in natural infection, it is 10 days.

Contraindications: Acute febrile illness, diseases of the nervous system, convulsions, decompensated heart disease, steroid therapy, radiation and immunosuppressive drugs. However, mild illness is not a contraindication.

Malnourished children deserve immunization most.

Storage: Cold chain must always be maintained. Vaccine retains its potency for more than 2 years at 2 to 8°C.

Age: Immunization is not recommended for children before 9 months of age because the vaccine will be rendered ineffective by the maternal antibodies, which will protect the child up to 9 months. If vaccine is given after 9 months, it runs the risk of contracting measles. Therefore immunization is recommended at 9th month of age. But under the situation of epidemic of measles or history of contact with case of measles, measles vaccine can be given as early as 6th month of age. However, such children require a second dose during 15th to 18th month of age.

Adverse Effects

- Mild measles illness in 15 to 20 percent of the recipients.
- Encephalitis 1 in 1 million vaccinees (Subacute sclerosing panencephalitis).
- Anaphylactic shock is very rare.
- Most dreadful complication is toxic shock syndrome (TSS), which occurs due to contamination of the vaccine by staphylococci. Contamination is likely to occur if there is delay in using the vaccine after opening the vial. Clinically TSS is characterized by sudden onset of high fever, vomiting and severe watery diarrhea within few hours of vaccination. Death may occur within 48 hours. Case fatality rate is high. It is preventable. Occurrence of TSS reflects the poor quality of immunization services.

Vaccine of Multiple Antigen (Combined Vaccine)

MMR vaccine not only protects the child against measles, but also against mumps and rubella-simultaneously. It is also a live, viral, freeze dried vaccine. It contains per dose of 0.5 mL, following concentration of live attenuated viruses of not less than 1000 $TCID_{50}$ of EZ strain of measles virus propagated on HDC, 5000 $TCID_{50}$ of LZ strain of mumps virus propagated

Fig. 20.7 MMR vaccine

on chick embryo fibroblast cells and 1000 $TCID_{50}$ of Wistar RA 27/3 of Rubella virus propagated on Human Diploid cells (HDC). Diluent is sterile distilled water **(Fig. 20.7)**.

It is recommended at 15th month of age, subcutaneously and storage temperature is 2 to 8°C.

Passive Immunization

This is done by human normal immunoglobulin. It is gamma globulin. It is nonspecific immunoglobulin. It is given for those young children who have come in contact with a case of measles and are not immunized. It either prevents or modifies the attack of measles, if given within 1 week of exposure. *Dose* = 0.25 to 0.5 mL per kg body weight (Approximately 250 mg for infants and 500 mg for children above 1 year). Given intramuscularly. Immunity lasts for about 3 weeks. Afterwards the contact is immunized actively. Just like active immunization, passive immunization is also generally not required for infants below 6 months of age, because of presence of maternal antibodies.

Other Points

- Measles is one of the diseases taken up for control by the Government of India under Universal Immunization Program (UIP) during 1985-86.
- 16th March is observed as 'Measles Immunization Day' to focus attention on the problem and to provide thrust and urgency for the control of measles.
- Measles is amenable for eradication because of the following reasons:
  - It is a disease of human beings only.
  - There is no animal reservoir.
  - There is neither subclinical state nor carrier state.
  - Potent, live, vaccine is available
  - Single dose administration.
  - The only two limitations for the eradication are:
    - 95 percent of infant population must be immunized
    - Immunization must be a continuous ongoing program.

Global Eradication of Measles by 2020

In May 2009, the Executive Board of WHO at its 125th session reviewed an initial assessment of global elimination of measles and requested a more comprehensive report in 2010. This report presents information on the feasibility of achieving a goal of measles eradication. It provides an assessment of programmatic challenges to achieve measles elimination in each of WHO region.

The Strategic Advisory Group of Experts advised that the term 'Eradication' should be used to describe worldwide interruption of measles transmission (i.e. simultaneous elimination of measles in all regions).

Progress

Global mortality due to measles has been reduced by 78 percent from 7,33,000 deaths in 2000 to 1,64,000 deaths in 2008. All WHO regions have already achieved this goal except South East Asia Region, specially India. In 2008, the immunization coverage with measles vaccine was 83 percent.

Requirements for Measles Eradication

- Biological feasibility
- Programmatic operational feasibility
- Supply of high quality of vaccines
- Cost effectiveness
- Political commitment by Member States.

Regional Measles Elimination

- *Regions of America:* In 1994, the regions of America established the goal of measles elimination by 2000. Eight years later, in November 2002, elimination was achieved by well-defined vaccination activities and sensitive disease surveillance.
- *African region:* This region attained the goal of 90 percent measles mortality reduction as compared to 2000 estimates by the end of 2006—three years earlier than its regional target years of 2009. In 2008, however 27 percent of birth cohort (about 7.7 million infants) did not receive their first dose. In 2009, the Regional Committee for Africa adopted a regional measles elimination goal for 2020 by sustained political commitment as well as financial support.
- *Eastern Mediterranean region:* In 1997, the member states resolved to eliminate measles by 2010. Of the 21 countries in the region, 7 countries achieved elimination, 10 countries would achieve by 2015 and 4 countries by 2020.
- *European region:* In 1998, this region set the goal of elimination of measles and German measles by 2010. Since 1998, the incidence of measles declined. However, in 2008, there was resurgence of measles in Western European Region Countries. With appropriate action and commitment, the region expects to be able to eliminate measles before 2015.
- *Western Pacific region:* In 2003, this region resolved to eliminate measles. By 2008, the immunization coverage increased to 93 percent. Of the 37 countries, 25 have eliminated. 6 countries are likely to eliminate by 2012 and remaining 6 countries by 2015.
- *South East Asia region:* This region adopted Global immunization vision and global goal for mortality reduction. Routine immunization coverage for measles in the region increased from 61 percent in 2000 to 75 percent

in 2008 and reported incidence of measles declined from 50 to 43 cases per million population over the same period. Deaths was reduced by 46 percent. All member states except India, achieved or exceeded the 90 percent mortality reduction target. Achievement of global goal unit is expected by India by 2013.

Key challenges include the need to vaccinate more than 1000 million more children than are currently receiving routine immunization.

Next Steps

Measles eradication is achievable. One WHO region has sustained measles elimination for the past seven years and four of the five remaining WHO regions have set an elimination goal to be achieved by 2020 or earlier.

A major obstacle in many countries is the inadequacy of routine immunization and surveillance system. These must be strengthened.

The targets for 2015 are proposed as milestones towards the goal of eradication of measles. These include:

- Less than 90 percent coverage with first dose of measles vaccine.
- Reduce annual measles incidence to less than 5 cases per million population and maintain at that level.
- Reduce measles mortality by 95 percent or more compared to 2000 estimates.

German Measles (Rubella)

The term 'German' is probably of literary rather than geographical significance. Rubella is simply the plural of the Latin word 'rubellus' meaning red spots.

German measles is an acute, infectious, viral disease, usually of older children and young adults, clinically characterized by mild prodromal symptoms, typical rashes and painful cervical lymphadenopathy. It is mildest of all exanthematous (eruptive) diseases. It is so mild that it causes much less inconvenience to the patient than common cold. Eventhough it is such a mild disease, the importance lies in the fact that it can cause damage to the growing fetus, when a woman contracts the disease during pregnancy. Thus rubella maims fetus for life.

Disease is worldwide in distribution, occurring sporadically, often in epidemics, once in 6 to 8 years in a cyclic trend.

History

In 1938, the viral etiology was established by Hiro and Tasaka.

In 1941, Normal Gregg, an Australian, reported the teratogenic property of the virus. He noticed an unusual number of congenital cataract associated with congenital heart disease among the newborns. Then he sensed that it was an epidemiological phenomenon and not a genetic phenomenon. He made a retrospective study among 78 cases of congenital cataract and found that 68 of their mothers had suffered from rubella in their early months of pregnancy.

In 1962, the virus was isolated.

In 1966, the virus was attenuated.

In 1967, live attenuated vaccine was prepared.

Rubella epidemic occurred in USA during 1964 to 65, when nearly 12.5 million cases had occurred resulting in nearly 1.5 lakhs arthritis, about 11,000 abortions, 20,000 congenital rubella syndrome and 2000 deaths.

Agent Factors

It is a RNA virus belonging to togavirus group readily inactivated by heat and chemical agents.

The rubella virus is known by its teratogenic effects rather than by its composition.

Reservoir: Humans are the only known reservoirs and the source of infections is usually a case. Large number of subclinical infections also act as a source of infection. There is no known carrier state. Infants born with congenital rubella are also infectious.

Infective material: This is the respiratory and throat secretions.

Period of communicability: Rubella is less communicable than Rubeola because of absence of cough. However, it is infectious 1 week before and 1 week after the appearance of rashes. Infectivity is greatest at the time of cutaneous rashes.

Age and sex incidence: It is a disease of older children and adolescents.

Maximum incidence is in the age group of 5 to 10 years. However, people of all the age group and both the sexes are susceptible to infection.

Immunity: One attack confers life long immunity. Infants born to immune mothers are protected only for about 6 months. Many acquire immunity as a result of subclinical infection. However, about 40 percent of the population escape infection and remain susceptible. This includes women of child-bearing age also.

Environmental Factors

In temperate zones, the disease occurs in late winter season.

Mode of transmission: It is mainly by droplet route. The disease is also transmitted transplacentally from the mother to the fetus.

Pathology and pathogenesis: Having entered the body through the respiratory route, the viruses reach the cervical group of lymph nodes, where they multiply, reach an optimum number and enter circulation (viremia) and ultimately lodge in the skin, resulting in the development of rashes.

But when the virus enters the fetus via the placenta, damages many organs because of organogenesis of the fetus.

Incubation period: It is about 15 to 20 days.

Clinical Features

1. *Prodromal stage:* Usually the symptoms are mild, characterized by mild fever, coryza, sore-throat, dry cough lasting for a day or two. This stage indicates the onset of viremia.
2. *Lymphadenopathy:* In most of the cases, the postauricular and posterior group of cervical lymph nodes enlarge slightly one week before the appearance of rashes and persist for about 10 to 15 days after the disappearance of the rashes. They are not tender among children but often tender among adults.

   A faint suffusion of conjunctivitis may occur among adults.
3. *Exanthematous stage:* Fine maculopapular rashes appear first on the face within 24 hours of the onset of prodromal symptoms. They are small, pale, pinkish and discrete (not confluent as in measles). They spread rapidly to trunk on second day and extremities on 3rd day. By the time, they appear on extremities, they will disappear over the face, thus lasting for 3 days only. So it is also called as 3-day measles.

   Rash is an inconsistent feature. It does not appear in about 25 percent of cases and subclinical cases.

   If the rash is atypical, cervical lymphadenopathy is often a helpful diagnostic sign.

Complications

Arthritis and arthralgia is a common complication particularly among women. Encephalitis is very rare. Thrombocytopenic purpura may occur. Common dreadful complication is congenital malformation of the fetus in a pregnant mother.

Diagnosis

The disease goes unrecognized, unless it is an epidemic. Definitive diagnosis is only by virus isolation from throat swab.

However, serological confirmation can be done by hemagglutination inhibition test of a paired sample of sera, the first sample drawn within 5 days of onset of illness and second sample 2 weeks later. A four-fold rise in IgG antibody liter (HI) in the second sample or detection of IgM antibody in the second sample is diagnostic. Sensitive serological tests are ELISA and radioimmune assay.

Congenital Rubella (Rubella Syndrome)

This refers to infants born with a number of defects due to intrauterine infection with rubella virus, occurring in the early part of its fetal life, the primary infection being occurring in the mother during early pregnancy.

Since the fetus is in the stage of organogenesis, the rubella infection inhibits cell division, resulting in multiple structural defects. Thus congenital rubella is a chronic infection while acquired rubella is an acute infection. The fetus remains infected throughout the period of gestation and for many months or years after birth. The gestational age at which maternal infection occurs is a major determinant for the extent of fetal damage. In other words, the earlier the infection during pregnancy, greater will be the damage to the fetus.

Thus, the first trimester of pregnancy is the most disatrous time for the fetus, because it is in the stage organogenesis.

The risk and severity of damage varies with the time of infection in pregnancy.

Stage of gestation	Risk of damage to the fetus (%)
4 to 8 weeks	80
8 to 12 weeks	25
12 to 16 weeks	10
> 17 weeks	00

If the infection is serious, spontaneous abortion and still-birth may occur. If the child is born alive, it will have developed minimum multiple defects such as the classical triad of patent ductus arteriosus, cataract and deafness. Infection in the second trimester may cause only deafness, but infection after 16 weeks, suffers no major abnormalities.

The damages of the heart, eyes and ears together constitute 'Rubella Syndrome' or 'Congenital Rubella'. When other organs are also affected, the condition is often referred to as 'Expanded Rubella Syndrome'. The associated features are hepatosplenomegaly, thrombocytopenic purpura, lymphadenopathy, pigmentary retinopathy, hypospadias, cryptorchidism, LBW, anemia, microcephaly, mental retardation, jaundice, pneumonitis, myocarditis, dental defects, etc.

Prevention

Prevention of rubella really means prevention of congenital rubella, because acquired rubella is of minor clinical significance, except when it affects pregnant mothers. Prevention is by active and passive immunization.

Active immunization: The vaccines available are Mono valent vaccines and Combined vaccines. All are freeze dried vaccines, supplied along with diluent, i.e. sterile distilled water. They are live attenuated vaccines. *Dose*—0.5 mL, given subcutaneously, preferably in left upper arm. Storage temperature is 2 to 8°C.

Monovalent rubella vaccines:

- *Wistar RA 27/3 vaccine:* The virus is propagated on human diploid fibroblasts. This is commonly used. This is marketted as R-Vac **(Fig. 20.8)**.
- *Cendehill vaccine:* Rabbit kidney cells are employed for propagation of virus.

Fig. 20.8 Rubella vaccine

- *HPV-77; DE-5 vaccine:* Duck embryo cells are employed.
- *Japanes* to 336 vaccine
- *Leningard* 8/23 vaccine.

Efficacy rate is 95 percent. Immunity lasts for at least 15 years, probably life long. Infants under one-year should not be vaccinated due to possible interference from persisting rubella antibody, obtained from immune mother. Therefore, preferred age for immunization with rubella-vaccine is 15 to 18 months.

Pregnancy is an absolute contraindication, because the vaccine is attenuated to only adult cells and not to fetal cells. So if given to pregnant mother, the vaccine may induce the disease in the fetus. However, if the girls of marriageable age have received the vaccine, they should be advised not to become pregnant over the next 3 months. Immunization of all the school girls with rubella-vaccine is practiced in the developed countries.

Combined vaccine: It is available as MMR vaccine, which simultaneously protects the child against measles, mumps and rubella. It is also recommended at the same age of 15 to 18 months.

Passive immunization: This is done by using human normal immunoglobulin. It is given to those who are at risk, such as young close contacts and infected pregnant mothers, preferably within 2 to 3 days of exposure. Since it is not a specific antibody preparation, either it prevents or modifies the course of illness in an infected individual. However, its efficacy has not been established. *Dose*—20 mL intramuscularly. Its use is optional.

Therapeutic abortion is a better way of prevention of congenital rubella. But, it involves human, ethical and religious issues.

MUMPS

It is an acute infectious self-limiting disease, caused by an RNA virus, transmitted by droplet route, common among children and adolescents, clinically characterized by fever and nonsupportive enlargement of one or both the parotid glands. Other salivary gland may be affected. Mortality rate is minimal.

Agent factors: Causative agent is an RNA virus belonging to Myxovirus group. Myxovirus parotids is the only serotype known in this family.

Reservoir: Human beings are the only reservoirs known (Natural hosts). Cases may be both clinical and subclinical. Subclinical cases constitute a constant source of infection and maintain the cycle of infection.

Infective material: It is the salivary secretion of the reservoirs.

Period of communicability: Usually 5 to 6 days before and 6 to 8 days after the clinical onset of the disease, i.e. after enlargement of parotid gland. Secondary attack rate is about 80 to 90 percent.

Route of transmission: It is by droplet infection.

Host Factors

Age incidence: Mumps is common among school children (5–15 years) and often among adults. However, no age is bar from the disease. In the older age, the disease becomes more severe.

Sex incidence: It is equal in both the sexes.

Immunity: One attack confers life-long immunity. Infants below 6 months are immune because of maternal antibodies.

Environment Factors

Incidence of mumps is high during winter season because of indoor living and overcrowding, predisposed by poor living conditions.

It is an endemic disease often results in epidemics.

Incubation period is 2 to 3 weeks.

Clinical Features

There is sudden onset of fever, associated with headache, bodyache, malaise, lasting for 1 or 2 days followed by painful enlargement of one or both parotid glands, associated with earache, difficulty in opening the mouth, and tenderness in the parotid region.

Sublingual and submandibular gland may also be affected.

Complications

Occur when other glands are affected. These are orchitis, oophoritis, myocarditis, which are all very rare.

Prevention and Control

Monovalent mumps vaccine is a live, attenuated, highly potent and effective to the tune of 90 to 95 percent. *Dose*—0.5 mL subcutaneously or intramuscularly.

A combined vaccine is also available as MMR vaccine. Dose and route of administration is same.

Control: Control of mumps is difficult because of occurrence of subclinical cases. However, cases should be isolated and concurrent disinfection is carried out.

INFLUENZA

Influenza is an acute, highly infectious, febrile, respiratory disease caused by influenza virus, characterized by sudden onset of fever/chills, headache, bodyache, prostration and non-specific respiratory symptoms like sore throat, cough, coryza, often associated with vomiting and diarrhea among children and elderly persons. It is followed by post influenza asthenia (weakness). Pneumonia is the most common complication due to secondary infection.

History

Pfeiffer was the first person to investigate the etiology of influenza. He studied the cases during 19th century (1889-92) and isolated *Hemophilus influenzae* bacilli and so it was thought to be a bacterial disease. However, studies made in the first pandemic during 20th century (1918) showed that influenza was a viral disease and *H. influenzae* were only the secondary invaders. The virus was isolated during 1933.

Agent Factors

The influenza virus is an enveloped, spherical, single stranded RNA virus, belonging to the family Orthomyxoviridae measuring about 50 to 120 nm in diameter and exists in three types A, B and C, which are all morphologically similar but antigenically different and therefore they do not provide cross imunity. It is the internal ribonucleoprotein of the virus which determines the type specificity.

The types A and B cause significant disease among humans. Type A causes severe disease. It affects not only humans but also animals including birds (poultry) and result in epidemics and even pandemics, because of frequent antigenic variations (changes). The large pool of viruses among animals and birds, creates a reservoir state for the emergence of new viruses, which when affect human beings, results in havoc. Type B causes milder epidemics (not pandemics) among humans only (chiefly among children) because of infrequent antigenic variations. Whereas Type C, even though limited to humans, it does not cause significant disease, because it is antigenically stable. It is not a cause of worry. Therefore it is not important.

Morphology of the Virus

Influenza A virus has two surface antigens (proteins) called Hemagglutinin (H) antigen and Neuraminidase (N) antigen, looking like spikes. About 500 spikes are present over the surface. H and N antigens are in the ratio of 5:1. H antigen enables the attachment of the virus to the susceptible host cell and N antigen (an enzyme) releases the newly formed virus from the infected host cell. Then the new virus can go on infecting other cells in the respiratory system **(Fig. 20.9)**.

There are 16 known H-antigens and 9 known N-antigens for type A viruses. Each hemagglutinin subtype is codified as 'H' followed by a number sequentially, as H1, H2 ..... H16. Similarly each neuraminidase antigen subtype is codified as 'N' followed by a number N1, N2 ..... N9. H antigen is the most important protein for stimulating protective immunity. Many different combinations of H-Ag and N-Ag are possible giving rise to different subtypes of A viruses, e.g. H1N1 – H1N2, H2N2 – H2N3, H3N1 – H3N2 – H3N8 – H5N1 – H5N2 – H5N3 – H5N8 – H5N9 – H7N1 – H7N2 – H7N2 – H7N3 – H7N4 – H9N2 – H10N7.

Type A	Type B	Type C
• Causes significant disease • Associated with epidemics and pandemics • Associated with high morbidity and mortality • Infects both humans and other species like pigs, horses and birds • Shows antigenic variations frequently	• Causes significant disease • Associated with milder epidemics • Associated with less morbidity and mortality • Limited to only humans (mainly children) • Shows antigenic variations infrequently	• Does not cause significant disease but only inapparent cases • Limited to humans • Shows no antigenic variations (stable virus)

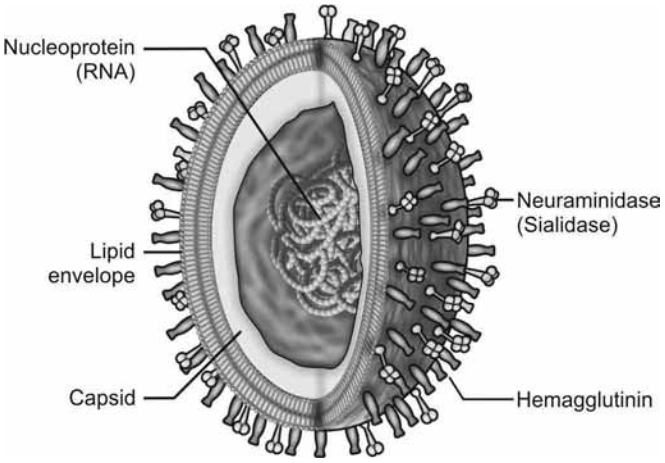


Fig. 20.9 Influenza virus anatomy

Three H antigen (H1,H2 and H3) and two N antigens (N1 and N2) have been recovered from humans.

Different species infected by influenza A subtypes, is shown in **Figure 20.10**.

The species affected by H antigen are listed on the left and species affected by N antigen are listed on the right. It is to be noted that the wild migratory waterfowl are infected with all subtypes.

The genome of influenza virus contains RNA, which has an imperfect replication mechanism by which it mutates at a high rate. In addition, the genome occurs in eight segments, that can easily break apart from one another and trade segments with genome of human, avian or animal influenza virus, if they are infecting the same cell (i.e. genetic recombination), leading to development of 'Novel subtype' of virus (H1N1) differing from both parent viruses. If the novel subtype has sufficient genes from human influenza viruses, it makes it readily transmissible from person to person by droplets, causing even pandemics, because people are not immune to new virus. After the pandemic is over, the pandemic virus strain becomes a seasonal virus and circulates among the human population.

The strains endemic in swine is called swine influenza virus (SIV). This can live outside the body for 3 to 5 hours. It is a zoonotic disease.

Avian influenza virus (H5N1) is said to have emerged as a result of genetic reassortment of human and avian strains of the virus in the body of pigs. Eventhough this can affect human beings because of very close contact with the poultry in the farms, it has not acquired the ability for efficient human to human transmission. But still cases are documented among prolonged, close family contacts, through infected droplets. As on today, there is no evidence of human-to-human transmission.

Pandemic influenza virus H1N1 is said to have emerged as a result of genetic reassortment of human, avian and swine

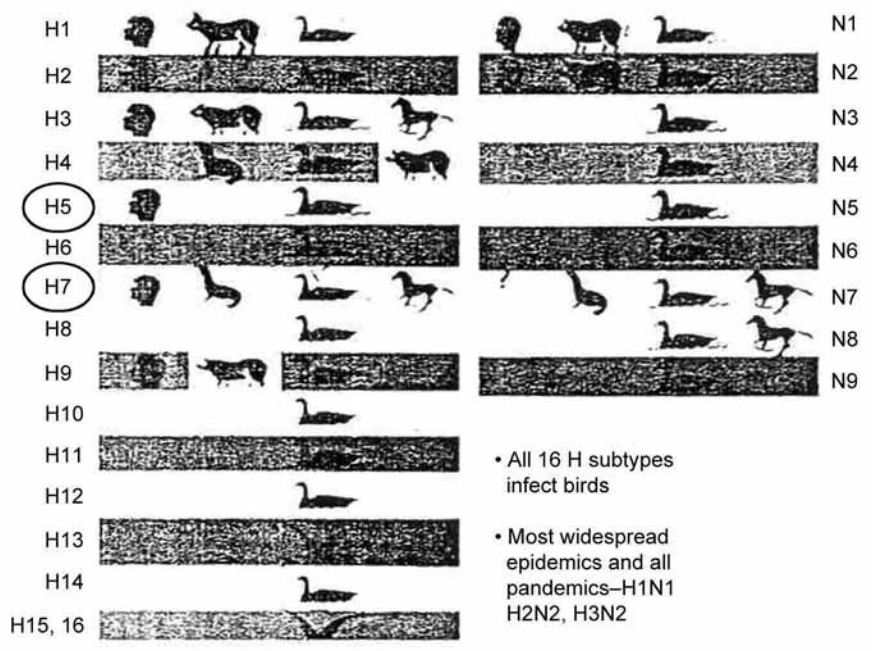


Fig. 20.10 Different species infected by influenza A subtypes

viruses in the body of pigs. Pigs are distinct from other species in that their cells possess receptors that can bind human and avian viruses. Thus pigs act as excellent 'melting pot' and produce a new novel virus.

Antigenic Variations

The type A virus undergoes frequent antigenic variations (changes), which is readily described as antigenic shift and antigenic drift.

Antigenic shift: It is the sudden, complete and major change in the surface antigen of the virus.

- The results from the genetic recombination of human virus with animal or avian virus, especially avian virus.
- It leads to the development of 'Novel subtype' of virus, which is different from both parent viruses.
- If the novel subtype has sufficient genes from human influenza viruses, it makes it readily transmissible from person to person, resulting in pandemics.
- Antigenic shift is facilitated by the segmented nature of the RNA genome.
- Evidence suggests that human influenza viruses responsible for the recent 2009 pandemic, caused by H1N1, contained gene segments closely related to avian influenza viruses. This was of low virulence.
- Antigenic shift was responsible for 'Spanish flu' pandemic during 1918, 'Asian flu' pandemic during 1957 and 'Hong Kong flu' during 1968 **(Table 20.2)**. It was the only time in the demographic history of India that the country had a negative population growth rate during 1918-19.

In 2009, pandemic started from Mexico to USA from 17 April 2009, then via some European countries and ultimately 168 countries of the world, including India were affected. This is swine flu, more correctly known as pandemic H1N1 2009 influenza, H1N1 flu, hog flu, pig flu. According to Center for Disease Control and Prevention (CDC), US, the 2009 virus H1N1 is not from swine but derived from a strain originally, lived in swines, underwent genetic recombination, developed into novel virus and now transmitted from person to person **(Fig. 20.11)**. So the term 'swine flu' is a misnomer and it is so called because of its genetic source. The correct terminology is 'H1N1 flu.'

Antigenic drift: It is the gradual, incomplete and minor change in the antigenic nature of the virus, over a period of time, resulting from 'point mutations' in the genes owing to selection pressure by immunity in host population. It is responsible for frequent influenza epidemics (i.e. seasonal influenza); necessitates reformulations of seasonal influenza vaccines.

Table 20.2 20th century flu pandemic

Pandemic	Year	A-virus subtype	No. of people affected (approx)	Age group	Deaths estimated	Attack rate	Case fatality rate
Spanish flu (Swine flu very severe)	1918-19	A(H1N1)	>50 million	20-40 years	>20 million (about 6 million in India)	2.8%	>2.5%
Asian flu (moderately severe)	1957-58	A(H2N2)	1000 million	<30 years	2 million (767 in India)	1.2%	<0.1%
Hong Kong flu (mild)	1968-69	A(H3N2)	–	Children	1 million	–	<0.1%
Swine flu	2009	A(H1N1)	1,62,380 (959 cases in India)	04-54 years	1154 (6 death in India)	–	<0.01%

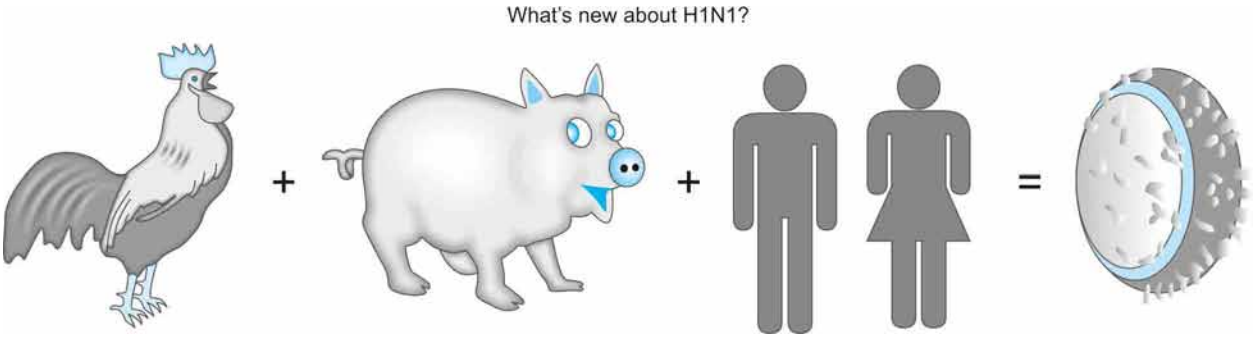


Fig. 20.11 Production of new novel virus

Influenza Terminology

- Human seasonal influenza
- Avian influenza
- Pandemic influenza.

Human Seasonal Influenza

This is endemic and seen every year at regular intervals. The same AH type circulates around the globe mutating (antigenic drift) as it spreads, resulting in seasonal epidemics (usually in winter season), affecting about 10 to 20 percent of population, resulting in 3 to 5 million cases and 2 to 5 lakh deaths annually, globally. The outbreaks in closed communities such as hostels, prisons, old age homes, crèches, ships, etc. are explosive. The morbidity and mortality burden due to seasonal influenza in India is not clearly known. Vaccination is needed on a regular basis to protect oneself from the diseases, as there is constant antigenic drift in the virus.

Avian Influenza (Bird Flu)

This is a disease of birds, caused by A (H5N1) virus that can occasionally infect humans having significant exposure to infected birds/poultry. The viruses affecting the poultry can have variable pathogenicity (low and high). Highly pathogenic avian influenza (HPAI) viruses cause large scale economic loss in the poultry sector. H5N1 virus is a HPAI virus and results in epornithic disease (outbreak among birds). The avian virus rarely jumps from birds to humans. This H5N1 virus is still evolving and close watch needs to be kept on this virus, which can evolve into a pandemic strain.

Pandemic Influenza

This occurs when there is antigenic shift of the virus as a result of genetic reassortment/recombination of human virus with the avian virus and the animal virus, in the body of the swine (pigs), leading to 'novel subtype' (H1N1) for which human population have no immunity. If it has sufficient genes from human influenza viruses, it becomes readily transmissible from person to person resulting in pandemics. Best example is that of 2009. There is generally a gap of 10 to 30 years between the pandemics.

The pandemic influenza virus H1N1 started in March 2009 in Mexico, lurched towards India in May 2009. By September 2009, it spread in 22 cities in India very fast, killing more than 300 people. Initially caused a large number of deaths in Mexico also. Since then it has become milder. However, there is a fear that this virus may become more virulent in the second wave of the pandemic.

The differences between seasonal and pandemic influenza are as follows:

Seasonal influenza	Pandemic influenza
• A public health problem each year	• Appears in the human population rarely and unpredictably
• Usually some immunity is built up from previous exposures to the same subtype	• Human population lacks any immunity. Virulence and mortality not entirely linked to immunity
• Infants and elderly are at most risk because of lack of immunity. However adults have some immunity	• People of all the age groups, including healthy adults may be at risk of complications However, the elderly may be spared due to some level of partial cross immunity from the past influenza illness
• Result of antigenic drift	• Result of antigenic shift

Epidemiology

Magnitude of Seasonal Influenza

This is worldwide in distribution. Sporadic cases occur every season/year round. Outbreaks occur every year. Major epidemic occurs at interval of 2 to 3 years. Pandemics are rare. Attack rate during epidemic is 20 to 30 percent in the general community and greater than 50 percent in the closed communities like hostels, schools, etc. Epidemics generally last for 3 to 6 weeks.

Magnitude of Pandemic Influenza

Explained under antigenic shift.

Magnitude of Avian Influenza

No human case of avian influenza has been reported in India so far, although our neighboring countries have reported human cases. In India during 2009, the avian influenza cases that occurred in poultry in Assam, West Bengal and Tripura—all occurred in winter season. **Table 20.3** shows the list of neighboring countries with confirmed human cases of H5N1. Person-to-person transmission has so far not reported. However H5N1 is a potential candidate for the next pandemic.

Avian influenza A (H5N1) was first detected in poultry in the Republic of Korea on 12th December, 2003. Then it spread to adjacent countries like Vietnam, Japan, Thailand, Cambodia, China and Indonesia through migratory birds. As on 1st November, 2005, a total of confirmed 122 human cases with 62 deaths was reported. Thus, there is concern because the number of cases in birds and human beings is increasing.

According to current information, the infection does not spread easily from birds to humans and also from person to person. But this may change due to genetic reassortment

Table 20.3 Recent human infections: Avian Influenza

Year	Place	Subtype	Cases	Deaths
1997	Hong Kong	H5N1	18	6
1999	Hong Kong	H9N2	02	0
2003	Hong Kong	H5N1	02	1
2003	Netherlands	H7N7	83	1
2003	Hong Kong	H9N2	01	0
2003-09	China, Cambodia, Egypt, Indonesia, Iraq, Myanmar, Nigeria Pakistan, Thailand, Turkey, Bangladesh, Vietnam	H5N1	436	262

(with human and swine, influenza genes in the body of pigs) thus increasing the possibility of emerging a pandemic virus in future, affecting humans and transmitting from human to human, proving devastating. Thus H5N1 is a potential candidate for next pandemic.

The disease spreads from country to country as a result of trade in birds or through migratory birds infected with virus. Migratory birds like waterfowl, wild ducks, carry the virus, but do not suffer from disease (or may have only a mild illness) and spread to domestic birds like chickens or turkeys when they come in contact.

During 2004, eight Asian countries reported the outbreak of Avian influenza. Only Vietnam and Thailand reported human infection. Out of 43 cases, 31 dead.

Though cases occur almost round the year, peaks are seen during winter months, associated with H5N1 poultry outbreaks during winter. Overall case fatality ratio is 63 percent, highest among 18 to 19 years, lowest among persons above 50 years.

Reservoir of Infection

Human cases or subclinical cases are the primary reservoirs for seasonal human infections. Major reservoirs are animals (swine, horses, dogs, cats) and birds (domestic poultry, water birds, wild birds, etc.). Migratory waterfowl (wild ducks) are the natural reservoir of avian influenza viruses. Domestic poultry are particularly susceptible to epidemics of avian influenza.

Source of Infection

Usually a case or a subclinical case.

Communicability

It is 3 to 5 days among adults and 7 days among children from the date of clinical onset. Infected person may shed the virus even before the onset of symptoms. Infectivity is highest on the first day of illness. Therefore, the clinical specimens for virus isolation should be collected on the day one of illness or as early as possible. If illness persists for more than 7 days, the chances of communicability may persist till resolution of symptoms. Immunosuppressed persons can shed the virus for months.

Host Factors

Age and sex incidence: People of all the age group and both the sexes are susceptible for influenza. Case fatality rate (CFR) is high during epidemics among high-risk people such as young children, old people, diabetics and persons suffering from chronic renal, respiratory and heart diseases. However in avian influenza H5N1 and in the pandemic influenza 2009 H1N1, the disease is more common among young adults.

Immunity: Antibodies appear in 7 days after an attack, reach maximum level in 2 weeks and drops to preinfection level in 8 to 12 months. Antibodies to H antigen neutralizes the virus and antibodies to N antigen modifies the infection.

Environmental Factors

Seasonality: In temperate zones, epidemics occur in winter season and in tropical countries, epidemics occur in rainy season. Sporadic cases occur throughout the year.

Overcrowding: Overcrowding enhances transmission. Attack rates are higher in closed populations like schools, hostels, ships, prisons, etc.

Modes of Transmission

Human influenza (seasonal and pandemic) being a respiratory tract infection and the virus being very contagious, the disease is transmitted easily by droplet infection and droplet nuclei from person to person. Transmission from contaminated objects, like surface or clothing, is also possible. Viremia has rarely been reported. Pandemic flu (Swine flu) is not transmitted by eating pork or pork products because cooking at 160°C destroys the viruses.

Avian influenza (H5N1) on the other hand is transmitted feco-orally (infected birds excrete a large amount of virus in saliva and feces) among birds and to those persons who are in close contact with infected poultry, such as direct contact with sick or dead poultry by touching, slaughtering, cleaning, defeathering, preparing for cooking, handling untreated poultry feces as fertilizer, ingestion of virus by under cooked meat or uncooked duck blood. Indirect transmission can also occur through infected poultry products or contact with surfaces, contaminated with secretions or excretions from infected birds.

Eventhough this can affect human beings, it has not acquired ability for human-to-human transmission. As on today, there is no evidence of sustained human-to-human transmission of avian influenza.

Clinical Presentation

Incubation period is 1 to 4 days/2 to 5 days.

Seasonal influenza, avian influenza and pandemic influenza, all present initially with influenza-like illness with subtle differences.

Seasonal Influenza

This condition generally presents as a febrile illness with symptoms of respiratory tract infection. However, the symptoms vary depending upon the age group.

- *Infants and young children:* Only high fever or fever with nasal congestion, rhinorrhea, diarrhea occurs. Flushing of face, watering of eyes, dry and hot skin, often cervical lymphadenopathy are also observed.
- *School age children and adults:* Sudden onset of fever with chills, nasal congestion, runny nose, sore throat, cough with or without expectoration, chest discomfort, abdominal pain, myalgia, vomiting and diarrhea.
- *Elderly:* Same symptoms of adults occur among elderly also, but often associated with anorexia, malaise, headache, myalgia and fatigue.

Thus young children and elderly persons constitute high risk group.

Since the features are nonspecific in nature, epidemiological linkage is essential to arrive at a diagnosis.

Thus, the clinical features of seasonal influenza are similar to common cold. The differences are as follows **(Table 20.4)**.

Thus fever and constitutional symptoms are more severe in influenza, compared to common cold. Resolution of major symptoms is complete within 7 days time in majority of individuals.

Complications: Secondary bacterial infection results in pneumonia. Reye's syndrome (a combination of liver disease and noninflammatory encephalopathy) occurs mainly due to previous influenza B infection or chickenpox and in those on aspirin therapy. It carries 50 percent mortality, common among children below 18 years of age.

Table 20.4 Influenza versus common cold—physical findings

Features	Influenza	Common cold
Fever	Unusually high lasts for 3–4 days	Unusual
Headache	Yes	Unusual
Fatigue/Weakness	Can last up to 2–3 weeks	Mild
Pain, aches	Usual and often severe	Slight
Exhaustion	Early and sometimes severe	Never
Stuffy nose	Sometimes	Common
Sore throat	Sometimes	Common
Cough	Yes	Unusual
Chest discomfort	Common, often severe	Mild/Moderate
Complications	Bronchitis, pneumonia	Sinus congestion

Avian Influenza

- **Clinical features in birds:** The features are ruffled feathers, soft shelled eggs, off feeds, droopiness, sudden drop in egg production, inability to walk, staggering gait, fever, watery diarrhea, cyanosis, fast breathing, swelling of eyelids and head, blood tinged discharge from the nostrils, pin point hemorrhages, increased number of deaths in a flock within 24 hours. Mortality is greater than 5 percent within a few days.
- **Clinical features in humans:** The incubation period is generally 2 to 5 days but may be as high as 9 days.

The predominant symptom is high grade fever of 40°C (104°F), associated with cough, shortness of breath and diarrhea. The features differ from seasonal and pandemic influenza, in that the signs are of lower respiratory tract infection predominantly. So the mortality rate is also higher. Diarrhea occurs in 20 percent of the cases. There is often leukopenia, thrombocytopenia and lymphopenia. Disease progresses to bilateral pneumonia within about 8 to 10 days, leading onto hypoxia, later respiratory failure, needing ventilatory management.

X-ray chest may show widespread collapse, consolidation and interstitial shadowing.

The fatality is very high with the currently circulating HPAI virus H5N1 infection. The disease is mild with low pathogenic avian influenza virus like H7N7 and H9N2. Thus, the features vary depending the virus.

Factors associated with severity of disease are old age, delay in hospitalization, lower respiratory involvement, and leukopenia or lymphopenia at admission. Viral replication

seems to trigger a burst of cytokine production resulting in multiorgan failure.

Pandemic Influenza

Earlier called 'Swine Flu.' Synonyms are H1N1 flu, hog flu, pig flu. This is caused by H1N1 virus, responsible for 2009 pandemic. Basically, it is a zoonotic disease, endemic among swine and rare in humans. According to CDC, US, the virus of the pandemic 2009 is not from swine but derived from a strain originally lived in swine, undergone genetic reassortment with human, avian and swine strains of the virus, in the body of pigs, resulting in antigenic shift, to produce a new mutant, referred to as 'Novel H1N1' virus, which was transmitted from pigs to pig handlers, several months before the onset of pandemic and later spread among human population. So the term 'Swine flu' is a misnomer and it is called so because of its genetic source. The correct terminology is 'H1N1 flu.'

Clinical features among pigs: It is characterized by barking (cough), nasal discharge, sneezing, breathing difficulty and going off feed. Death rate is very low among pigs.

Clinical features among humans: They are of classic flu like symptoms such as fever/chills, sore throat, runny nose, cough, headache and myalgia. Vomiting and diarrhea are also common **(Fig. 20.12)**.

Complications may occur similar to seasonal influenza, such as sinusitis, otitis media, cramps, pneumonia, bronchiolitis, myocarditis, pericarditis, myositis, encephalitis, seizures and toxic shock syndrome. Individuals at extremes of age and with pre-existing medical conditions are at a higher risk of complications including exacerbation of underlying conditions.

Laboratory Diagnosis

Influenza can be confirmed only through laboratory tests. With large scale community spread, there may not be need to test all cases. Then testing would be done: (i) to establish geographic spread to new areas and (ii) to detect change in the character of the virus.

The virus titer in clinical specimens (throat swab) would be significant only on first two days of illness. So specimens should be collected within first 24 to 48 hours of onset of illness. However adults shed virus for 4 to 6 days and children for longer period. Viral RNA may be detected in blood for a period of two weeks after the onset of illness. From this period, antibodies to the virus appear. Detection of viral RNA by conventional or Real time—polymerase chain reaction (RT-PCR) is the best method for initial diagnosis of H5N1 virus.

For seasonal and H1N1 influenza, nasal and oropharyngeal swabs are the recommended specimens. Both the swabs can be collected into the same viral transport medium to increase the viral yield.

For detection of avian influenza virus H5N1, throat swabs are more useful. However, the preference of sample is in the following order:

- Endotracheal aspirate if the patient is intubated.
- Oropharyngeal swab.
- Nasopharyngeal swab/secretions.

All samples should be transported in cold chain at 0-4°C, to the designated laboratory quickly, after proper packing using the standard triple packaging system (WHO) **(Fig. 20.13)**. The samples should accompany with the clinical details and the identification data of the case, attaching a certificate that it is for research purposes only and not hazardous to the

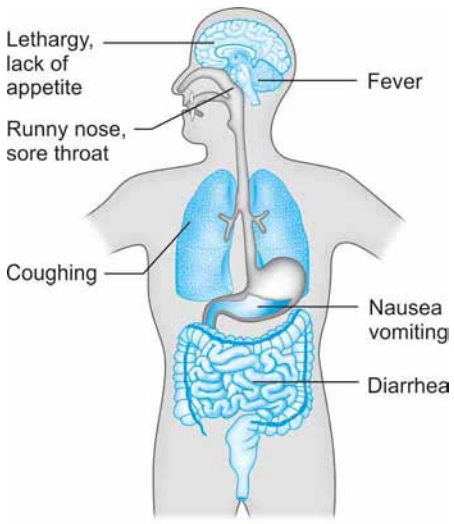


Fig. 20.12 Symptoms of respiratory tract infections

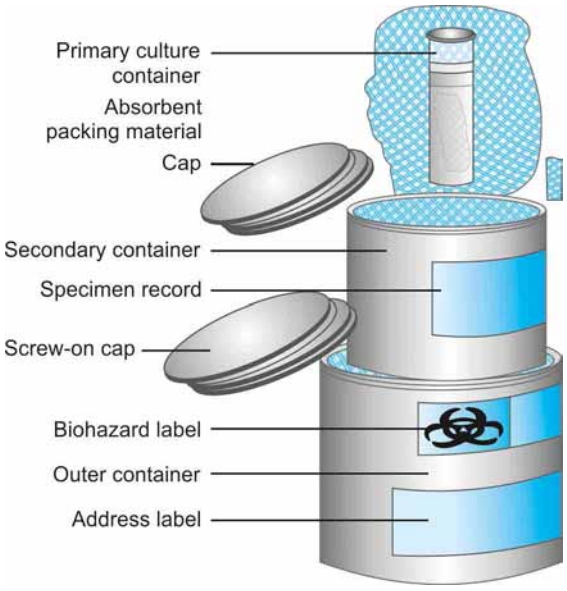


Fig. 20.13 Triple packaging system

community. The two designated laboratories in India are National Institute of Communicable Diseases (NICD), New Delhi and National Institute of Virology, Pune, which have Bio Safety Level (BSL-3) laboratories.

Biosafety Measures

- Clinical specimens should be collected by hospital staff only (and not by laboratory staff), wearing Personal Protective Equipment (PPE) such as head cover, goggles, N-95 mask, disposable gloves and disposable apron.
- Personnel must wash their hands after handling the materials and before leaving the laboratory.

Tests

Viral culture is the 'Gold standard' for diagnosis of influenza. Seasonal influenza viruses grow best in egg culture.

Viral antigen can be detected by rapid tests using kits. It is 80 percent specific. A positive test can be taken as such but a negative test needs to be repeated. Hemagglutination test, Hemagglutination inhibition test and immunofluorescence assay are cumbersome and are not generally done for H5N1 and novel H1N1 virus.

Viral nucleic acid can be detected (molecular detection) by RT-PCR test. If RT-PCR test is positive for avian/novel influenza, then these specimens need to be tested in WHO reference laboratories like NICD, Delhi/NIV Pune, for further tests and confirmation.

Case Definitions for Avian and Pandemic Influenza

Case definitions for influenza are very vital for surveillance. It gives vital epidemiological information for tackling the pandemic as well as vaccine production.

Case definition are followed at three levels, from most sensitive definitions to most specific (accurate) definitions.

- A suspected case is defined at field/health worker level. It is a more sensitive definition, to minimize the number of missing cases, based on symptoms. So also called 'syndrome based' definitions.
- A probable case is defined at medical officers' level, based on a combination of symptoms and signs. This is more specific than suspected case definition but are not confirmatory.
- A confirmed case definition includes evidence from not only symptoms and signs but also from epidemiological factors and confirmed laboratory results for the disease in question. This is the most specific definition.

Case Definition for Avian Influenza

- **Person under investigation (PUI):** In an outbreak of avian influenza, a person with cough and fever is said to be under investigation/observation, who is residing in the 'infected zone' i.e. within 3 km from the epicenter of outbreak among birds. Such a person is followed up to know the outcome of the disease (recovery/deterioration) for early detection of human cases/human to human transmission and also to investigate for possible H5N1/H1N1 infection.
- Suspected case of avian influenza

  A person with an acute respiratory illness with cough, fever, breathlessness.

  and

  One or more of the following exposures within seven days prior to the onset of symptoms:
  a. Close contact with a human or animal (pig, cat) case of H5N1,

     or

  b. Exposure to poultry farm or consumption of under cooked poultry in an area, where the outbreak of avian influenza has occurred in the last month
- Probable case of avian influenza

  A suspected case with one of the following additional criteria
  a. Evidence of acute pneumonia on chest radiograph plus evidence of respiratory failure

     or

  b. Limited laboratory evidence for H5N1 infection

     or

  c. A person dying of an unexplained acute respiratory illness and is linked by time, place and exposure to a case of H5N1.
- Confirmed case of avian influenza

  A suspected or a probable case

  and

  Positive, laboratory test result, conducted in WHO accredited laboratory, as follows:
  - Isolation of H5N1 virus,
  - Positive RT-PCR result or IF-test or ELISA test,
  - A four-fold rise in neutralization antibody titer between acute and convalescent serum samples.

Case Definition for Pandemic Influenza

- Suspected case of pandemic influenza

  A person with an acute respiratory febrile illness with a history of close contact with a confirmed case of novel H1N1 virus infection within 7 days of onset.

  or

  Residing/travel to an area where there are one or more confirmed cases of H1N1.
- Probable case of pandemic influenza

  A suspected case
  - Who is positive for influenza A but unsubtypable for H1 and H3,

    or
  - Who is positive for influenza A by influenza rapid test or IFA test,

or

  - Who died of unexplained acute respiratory illness and considered to be epidemiologically linked to a probable or confirmed case.
- Confirmed case of pandemic influenza

  A suspected or a probable case of H1N1, with a positive test result for Novel H1N1 virus infection at WHO approved laboratory by one or more of the following tests:
  - RT-PCR
  - Viral culture
  - Four-fold rise in neutralizing antibodies between acute and convalescent serum samples.

Case Management

Seasonal influenza cases are treated symptomatically because of low severity. However, cases of avian influenza and pandemic influenza are admitted and managed in well-ventilated isolation wards. They are treated with antiviral drugs. Pandemic influenza cases also require supportive care. Concurrent disinfection is a must. Contact of H1N1 cases are given chemoprophylaxis.

Antivirals: There are mainly two categories of drugs for the treatment of influenza. One is M_2 inhibitors (amantidine group of drugs) like amantidine and rimantidine, both given orally. The other group is neuraminidase inhibitors comprising oseltamivir (Tami flu) and zanamivir (Relenza). A third anti viral drug, Ribavirin, is effective only in very high doses and is costly, hence not used.

1. **M_2 inhibitors:** Dose of both Amantadine and Rimantadine is same, i.e. 100 mg, orally, twice daily for 3 to 5 days. They are absorbed rapidly and block the penetration of the virus into the cells, thereby prevents multiplication of viruses and also damage to the respiratory epithelial cells. They reduce the severity and duration of illness.
2. **Neuraminidase inhibitors:** They are superior to M_2 inhibitors and so are the drugs of choice for avian (H5N1) and pandemic (H1N1) influenza. Oseltamivir (Tami flu) is available in the form of capsule of 75 mg and pediatric suspension (12 mg/mL when reconstituted). It is given orally. Early treatment within two days of onset of illness improves survival. Recommended doses for different age group are described in **Table 20.5**.

Zanamivir (Relenza) can be tried in case of resistance to oseltamivir. It is used in the inhalation form. Dose—10 mg (2 inhalations), two times a day for five days for therapeutic purpose and 10 mg once a day for 7 to 10 days for prophylaxis. It may cause bronchospasm.

Supportive Treatment

This is needed in seriously ill cases of influenza. Oxygen therapy is needed in patients showing signs of hypoxia such as drowsiness, tachypnea, etc. Oxygen is not given openly as it would generate aerosols. So oxygen is given by positive pressure ventilation or by intubation. Antibiotics are given if there is bacterial infection. Steroids are given for those, who are in shock. Immunomodulators are not necessary. Mechanical ventilation may be needed for respiratory failure. Other measures like maintenance of fluid and electrolyte balance, bowel care, etc. need to be given.

Table 20.5 Recommended doses for different age group

Infants	
Age	**Dose**
0–3 months	15 mg
3–6 months	20 mg
6–11 months	25 mg
Children above 1 year	
Weight	**Dose**
< 15 kg	30 mg
15–23 kg	45 mg
23–40 kg	60 mg
>40 kg	75 mg
Adults	75 mg

Note: All doses are given twice daily for 5 days. Higher doses with 150 mg twice daily for 10 days are given, if there is complications like pneumonia. Prophylactic dose is half of therapeutic dose, i.e. same dose, but once a day for 7 to 10 days for contacts

Discharge Policy

This is different for different types of influenza.

For seasonal influenza

- Adults are discharged on 7th day of illness, if they have been afebrile for the last 24 hours.
- Children are discharged 2 weeks after the onset of illness.

For avian influenza

- Adults are discharged if remain afebrile for 7 days and X-ray chest is normal.
- Children below 12 years are discharged 21 days after the onset of illness.

For H1N1 pandemic influenza

- Patients who respond to treatment and become totally asymptomatic, are discharged after 5 days of treatment. No need for a repeat test.
- Those who continue to have symptoms of fever, sore throat, etc. even on the 5th day should continue treatment for 5 more days. If the patient becomes asymptomatic during the course of the treatment, there is no need to test further.
- Those who continue to be symptomatic even after 10 days of treatment or those cases with respiratory distress and

in whom secondary infection is taken care of and if the patient continues to shed the virus, then resistance of the patients to antiviral drugs would be tested. Then the dose of the drugs may be adjusted on case to case basis.

If laboratory tests are negative, the patient would be discharged after giving full course of oseltamivir and are followed up.

General Precautions against Avian Flu

In areas affected by avian influenza, individuals should avoid contact with poultry and frequently was their hands with soap and water. Poultry, including eggs, should be cooked thoroughly.

Immunization

Vaccines are of three kinds: (1) Killed vaccines, (2) Live vaccines and (3) Newer vaccines, for seasonal influenza.

1. **Killed vaccines (Inactivated influenza vaccines):** These are of two types namely saline (Acqueous) vaccine and oil adjuvant vaccine:
   i. *Saline (Acqueous) vaccine:* Each dose of 0.5 mL contains 15 µg of H-antigen. Two doses are given with an interval of four weeks, subcutaneously. Immunity lasts for 6 months. Revaccination is recommended every year. Since the vaccine is prepared by growing in allantoic cavity of chick embryo and killed by formalin or beta propiolactone, hypersensitivity reaction may occur.
   ii. *Oil adjuvant vaccine:* Since this is an oil emulsified preparation, the advantages are that the dose is less, i.e. 0.2 mL and is more effective in producing antibodies. Immunity also lasts longer, i.e. for about one year. But the disadvantage is that it may result in sterile abscess because of oil content. It may also result in painful nodules. So not recommended for general use.

   Both the saline and oil adjuvant vaccine are 'whole virus vaccines'. They are more immunogenic and reactogenic than newer vaccines.
2. **Live attenuated vaccine:** It is a live, attenuated, freeze dried vaccine, supplied along with the diluent sterile distilled water. It is administered intranasally as 'Nose spray/Nose drops'. It mimics natural infection. It induces both local and systemic immunity, mainly local immunity with IgA. This is widely used in Russia. Immunity is developed within 3 to 4 weeks and lasts for about one year.
3. **Newer vaccines:** These are of three types.
   i. *Split virus vaccine:* It contains split virus particles.
   ii. *Surface antigen vaccine:* It is a refinement of split virus vaccine, in which only the surface antigens H and N are included.
   iii. *Recombinant vaccine:* In this type, genetic recombination is done between the human and the avian strains. These are also found to be effective.

Immunization against Pandemic Flu (Swine Flu)

There are two types of Swine flu vaccines, namely intranasal and injectable. The intranasal vaccine is a live attenuated, freeze dried, human (H_1N_1) pandemic influenza vaccine, marketed as 'Nasovac', indicated among children over three years of age and adults **(Fig. 20.14)**. Diluent is sterile distilled water.

The injectable vaccine is a split virion, inactivated, monovalent, vaccine, produces only systemic immunity. There is no local immunity in the nose. Eventhough the person is protected, he/she may spread the disease in the initial period if the virus enters the nose.

Dosage schedule

- Children of 6 months to 35 months, should receive two doses of 0.25 mL, IM, with one month apart.
- Children of 36 months to 9 years, should receive two doses of 0.5 mL, IM with one month apart.
- Children above 10 years and older, should receive a single dose of 0.5 mL IM.
- Preferred site for intramuscular injection is anterolateral aspect of thigh among children and deltoid region among adults and older and not in gluteal region.

The effectiveness of the vaccine has not been established among infants below 6 months of age and also among pregnant and lactating mothers.

The pandemic influenza vaccine H1N1 is marketed as 'Panenza'. Storage temperature is 2° to 8°C.

Fig. 20.14 Human, live attenuated, H1N1, intranasal influenza vaccine

Chemoprophylaxis

This is a prophylactic treatment with rimantadine and amantadine, recommended for those who are at high risk such as young, close contacts and elderly, debilitated persons.

Dose—4 to 8 mg per kg body weight per day, continued till the epidemic subsides, because the person becomes susceptible again, when the drug is stopped. For prophylaxis against avian influenza, Oseltamivir should be administered to individual within 48 hours of exposure to H5N1 avian influenza.

Control Measures of Avian Flu

Since the direct or indirect contact of domestic flocks with migratory waterfowl has been implicated as a frequent cause of epidemic avian flu, all the poultry birds of the infected farm and those within a radius of 3 km of the infected farm should be culled. This will prevent the spread to other farms.

All the farms within a radius of 10 km of the infected farm must be tested for the virus.

Stringent sanitary measures on farms should be implemented. This will confer some degree of protection as avian influenza viruses are readily transmitted from farm to farm by mechanical means, such as equipment, feed, cages, vehicles or clothing.

Widespread vaccination of birds is not advisable as the vaccinated birds will have avian influenza antibodies and an epidemic of bird flu will not be suspected until humans start dying of bird flu.

Infection Control in Health Care Facility

Infection control precautions are the activities aimed at preventing the spread of pathogens between patients, from health care workers to patients and from patients to health care workers in the health care settings.

Precaution Levels

- Hand hygiene
- Standard precautions using personal protective equipment.

Hand hygiene: This is the critical component of all the precautions and is the corner stone of infection control. Proper hand washing provides 60 to 70 percent protection from influenza. One must always remember to wash hands in between contact with every new patient.

Hand washing method:

- Wet hands with clean (not hot) water
- Apply soap
- Rub hands together for at least 20 seconds
- Rinse with clean water
- Dry with disposable towel or air dry
- Use towel to turn off faucet (Alcohol may also be used for hand washing).

Personal protective equipment: This is to protect one from self-exposure to infectious agents. The equipment consists of gloves, gowns, masks and respirators, boots and eye protection.

- **Gloves:** Clean, disposable, patient care gloves should be used for contact with the patient. Thick gloves are used for cleaning and house keeping purposes and sterile gloves are used for collecting specimens and for conducting medical procedure on the patient. Change the gloves after use on each patient.
- **Gowns:** These are made from 3 GSM cloth with long sleeves and elastic cuffs.
- **Masks and respirators:** Surgical masks of triple layer should cover nose and mouth. Head should be covered with scarf. Recommended respirator is N95 respirator, which excludes particles less than 5 microns in diameter.
- **Boots:** Disposable or washable boots are used to prevent contamination of foot gear.
- **Eye protection:** Eyes can be protected by using goggles. However face shield can also be used.

Once PPE is removed, it is not reused but disposed properly.

Contact Precautions

- Isolation of the patient.
- Another patient having the same infection status can be admitted in the same room but with at least one meter apart (this is known as 'Cohorting').
- Those entering the patient's room, should wear PPE and remove it after the contact is completed before leaving the room followed by washing hands.
- Patient's room must be disinfected daily by using household bleach.
- Other precautionary measures are shown in the **Figure 20.15**.

Case Management during Pandemic

The components of case management in pandemic settings include triage, hospital surge capacity, criticare and domestic care.

Triage: This is a system of screening the population to identify the serious cases of pneumonia and referred to hospital to provide them critical care.

Screening tool for triage: The screening tool developed by British Thoracic Society is 'CURB-65' i.e. C = conscious level (confusion), U = Urea level in the blood, R = Respiratory rate, B = Blood pressure and 65 stands for those aged above 65 years.

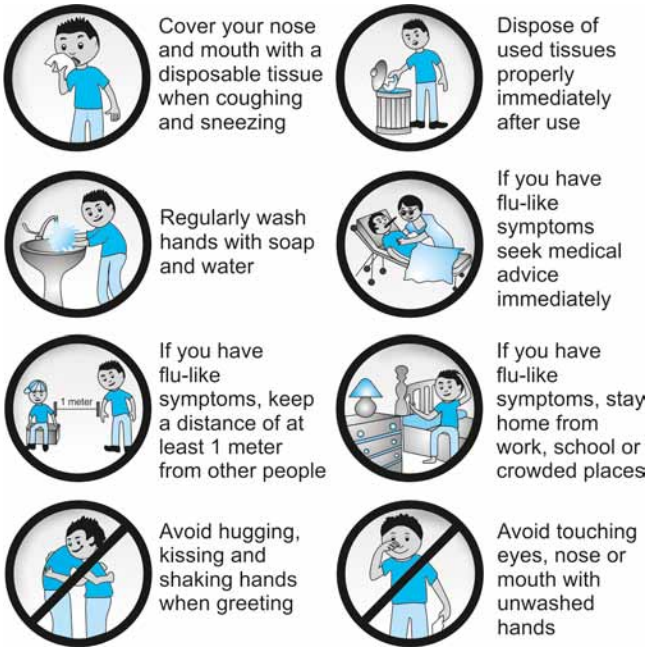


Fig. 20.15 Precautions

When this screening system is used at field level, urea level criteria is excluded and only CRB-65 is used to triage pneumonia cases **(Table 20.6)**.

If the patient's score is 0 or 1, needs only outpatient treatment. If the person scores 2, needs treatment in a hospital through supervised OPD treatment and those scoring 3 and above, needs admission and even ICU treatment.

Hospital surge capacity: If the number of admission exceed the capacity of the hospital, then community buildings like schools, dharmshalas, temples, etc. are all converted to temporary hospitals.

Nonpharmaceutical Interventions

Nonpharmaceutical interventions are the measures other than drugs and vaccines, undertaken to contain a pandemic or to mitigate its impact. These measures play a key role in delaying and/or reducing the impact of a pandemic, giving time to prepare and implement pandemic mitigation measures, because of the nonavailability of the vaccines and limited availability of anti-viral drugs.

Levels of application of NPIs: NPIs can be applied at various levels—individual, community, national and international levels.

Individual level: This consists of personal protective measures, such as proper hand washing, keeping at least an arm's length from others, and use of PPE.

Community level: This is mainly to reduce interpersonnel contact. This consists of measures to increase 'social distance', such as closure of schools, markets, cinema theaters and cancellation of events like marriages, funerals, festivals, sporting events, etc.

National/international level: This is mainly to prevent international spread of the disease. This consists of deferring nonessential travel, providing health information to international travelers, quarantine measures entry/exist screening in airport and seaport and cases detected by using thermal imaging cameras and in extreme cases ban of flights and ships originating from the affected area.

Revised Guidelines by Ministry of Health and Family Welfare

These are recommended for the containment of the outbreak. All the individuals seeking consultations for flu-like symptoms should be screened at health care facilities and categorized as under.

Category-A

- Pateints with **mild fever plus cough/sore throat**, with or without bodyache, headache, diarrhea and vomiting will be categorized as Category-A. **They do not require** oseltamivir and should be treated for the symptoms mentioned above. They should be monitored for their progress and reassessed at 24 to 48 hours by the doctor.

Table 20.6 Screening tool for triage

Field settings (CRB 65)		Health care settings (CURB-65)	
Components	**Score**	**Components**	**Score**
Confusion	1	Confusion	1
Respiratory rate (>30/min)	1	Urea (>70 mol/L)	1
Blood pressure (Systolic <90, Diastolic<70)	1	Respiratory rate (>30/min)	1
65 years or more	1	Blood pressure (Systolic <90, Diastolic<70)	1
		65 years or more	1
Total	4	Total	5

- **No testing of the patient for H1N1 is required.**
- Patients should confine themselves at home and avoid mixing up with public and high risk members in the family.

Category-B

i. In addition to all the signs and symptoms mentioned under Category A, if the patient has high grade fever and severe sore throat, may require home isolation and oseltamivir.
ii. In addition to all the signs and symptoms mentioned under Category A, individuals having one or more of the following high risk conditions shall be treated with oseltamivir.
   - Children less than 5 years of age.
   - Pregnant women.
   - Persons aged 65 years or older.
   - Patients with underlying systemic diseases including cancer and HIV.
   - Patients in long term steroid therapy.

iii. **No tests for H1N1 are required for Category-B (i) and (ii)**.
iv. All patients of Category-B (i) and (ii) should confine themselves at home and avoid mixing with public and high risk members in the family.

Category-C

In addition to the above signs and symptoms of Category-A and B, if the patient has one or more of the following:

- Breathlessness, chest pain, drowsiness, fall in BP, sputum mixed with blood, bluish discoloration of nails.
- Irritability among small children, refusal to accept feed.
- Worsening of underlying chronic conditions.

All these patients mentioned above in Category-C require immediate hospitalization and treatment.

WHO Phasing of Pandemic Influenza

Preparedness and Response

Since the timings of occurrence of pandemic influenza cannot be predicted, WHO has recommended six phased approach based on epidemiological evidence for formulation of strategic responses to prevent its emergence or mitigate its impact, under international Health Regulations to aid countries in pandemic preparedness and response planning **(Fig. 20.16)**.

Phase Descriptions

Phases 1–3 are the phases, wherein the infection is predominantly among animals and there may be few human cases. Occurrence of sustained human-to-human transmission moves the pandemic to phase 4. Effective response at this phase can prevent the pandemic.

When the outbreak is restricted to one WHO region, it indicates phase 5 and when it has spread across at least two WHO regions, it is phase 6 **(Fig. 20.17 and Table 20.7)**.

When the peak of the pandemic has been crossed, it is called post pandemic period. This period facilitates recovery activities in terms of health, societal and economic impacts of the pandemic. Vaccine for the pandemic influenza virus is generally developed in this period because it takes around six months to prepare a pandemic vaccine.

The recommended actions of phase wise approach for strategic interventions are summarized in **Table 20.8**.

The thematic areas and their tools for pandemic influenza preparedness and response and the society approach to pandemic preparedness is shown in **Figure 20.18**.

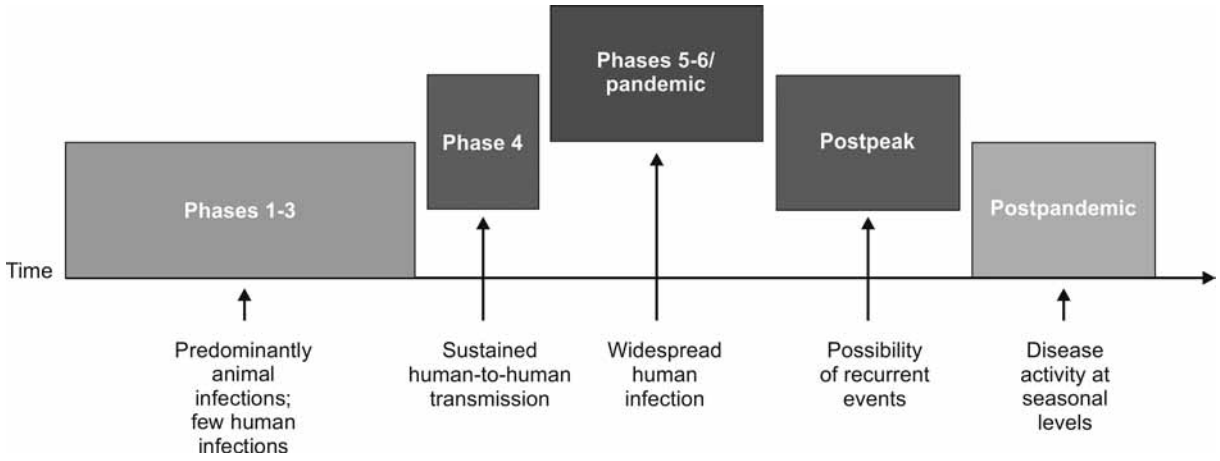


Fig. 20.16 Pandemic influenza phases (2009)

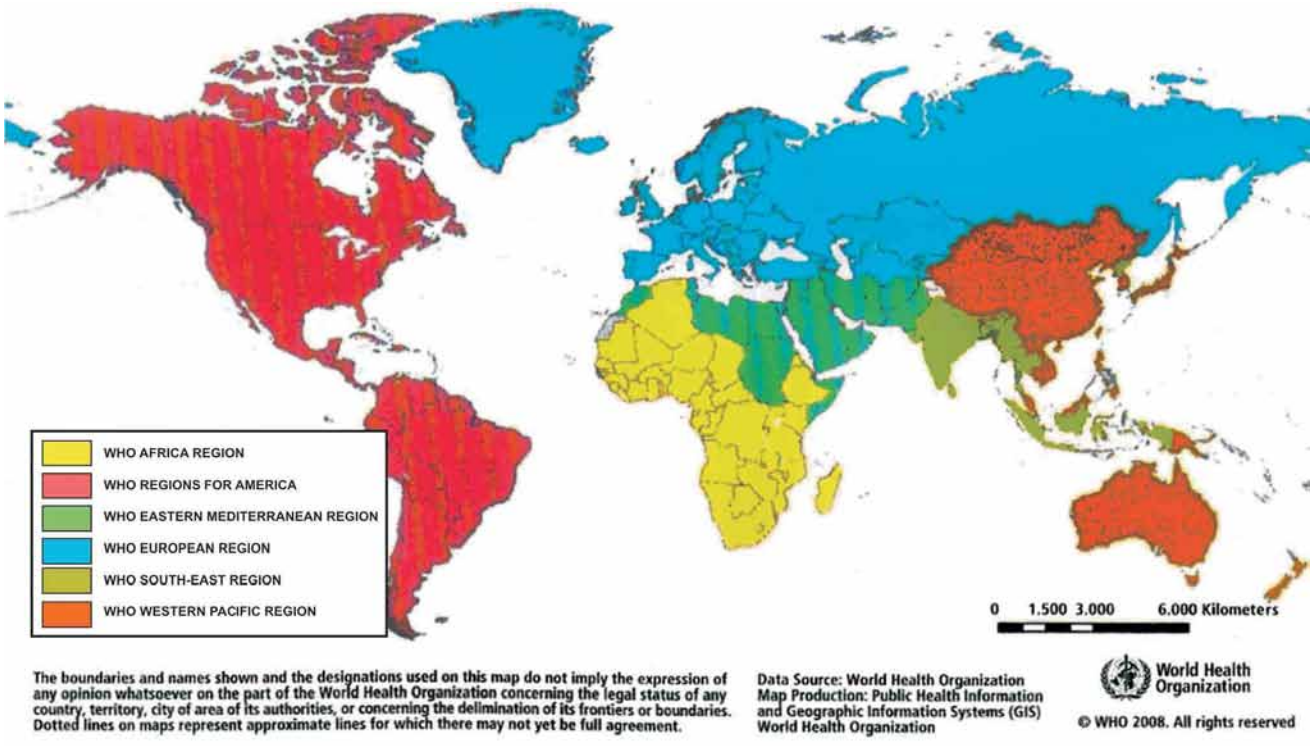


Fig. 20.17 WHO regions

Table 20.7 WHO pandemic phase descriptions and main actions by phase

	Estimated probability of pandemic	Description	Main actions in affected countries	Main actions in not-yet-affected countries
Phase I		No animal influenza virus circulating among animals has been reported 10 cause infection in humans		
Phase 2	Uncertain	An animal influenza virus circulating in domestic or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat	Producing, implementing, exercising, and harmonizing national pandemic influenza preparedness and response plans with national emergency preparedness and response plans	
Phase 3		An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks		
Phase 4	Medium to high	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level outbreaks has been verified	Rapid containment	Readiness for pandemic response
Phase 5	High to certain	The same identified virus has caused sustained community level outbreaks in at least two countries in one WHO region **(Fig. 20.17)**.	Pandemic response: Each country to implement actions as called for in their national plans	Readiness for imminent response

Contd…

Contd…

	Estimated probability of pandemic	Description	Main actions in affected countries	Main actions in not-yet-affected countries
Phase 6	Pandemic in progress	In addition to the criteria defined in phase 5, the same virus has caused sustained community level outbreaks in at least one other country in another WHO region		
Postpeak period		Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels	Evaluation of response: recovery; preparation for possible second wave	
Possible new wave		Level of pandemic influenza activity in most countries with adequate surveillance is rising again	Response	
Postpandemic period		Levels of influenza have returned to the levels seen for seasonal influenza in most countries with adequate surveillance	Evaluation of response; revision of plans; recovery	

Table 20.8 Summary table of recommended actions

Preparedness components	Phases			Postpeak	Postpandemic
	1–3	4	5–6		
Planning and coordination	Develop, exercise, and periodically revise national influenza pandemic preparedness and response plans	Direct and coordinate rapid pandemic containment activities in collaboration with WHO to limit or delay the spread of infection	Provide leadership and coordination to multi-sectoral resources to mitigate the societal and economic impacts **(Fig. 20.19)**	Plan and coordinate for additional resources and capacities during possible future waves	Review lessons learned and share experiences with the international community. Replenish resources
Situation monitoring and assessment	Develop robust national surveillance systems in collaboration with national animal health authorities, and other relevant sectors	Increase surveillance. Monitor containment operations. Share findings with WHO and the international community	Actively monitor and assess the evolving pandemic and its impacts and mitigation measures	Continue surveillance to detect subsequent waves	Evaluate the pandemic characteristics and situation monitoring and assessment tools for the next pandemic and other public health emergencies
Communications	Complete communications planning and initiate communications activities to communicate real and potential risks	Promote and communicate recommended interventions to prevent and reduce population and individual risk	Continue providing updates to general public and all stakeholders on the slate of pandemic and measures to mitigate risk	Regularly update the public and other stakeholders on any changes to the status of the pandemic	Publicly acknowledge contributions of all communities and sectors and communicate the lessons learned, incorporate lessons learned into communications activities and planning for the next major public health crisis
Reducing the spread of disease	Promote beneficial behaviors in individuals for self protection. Plan for use of pharmaceuticals and vaccines	Implement rapid pandemic containment operations and other activities; collaborate with WHO and the international community as necessary	Implement individual, societal, and pharmaceutical measures	Evaluate the effectiveness of the measures used to update guidelines, protocols, and algorithms	Conduct a through evaluation of all interventions implemented
Continuity of health care provision	Prepare the health system to scale up	Activate contigency plans	Implement contingency plans for health systems at all levels	Rest, restock resources, revise plans, and rebuild essential services	Evaluate the response of the health system to the pandemic and share the lessons learned

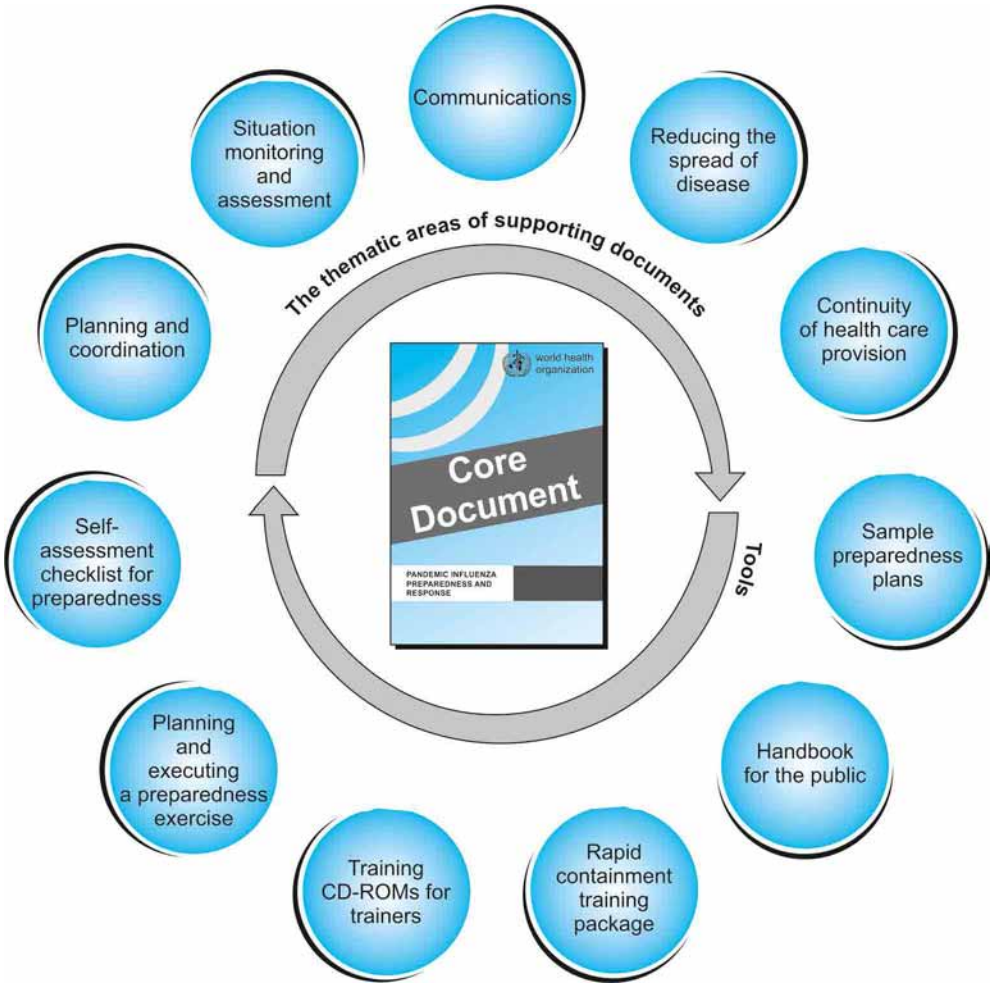


Fig. 20.18 The WHO guidance package for pandemic influenza preparedness and response

Hurdles in the Control of Influenza

- Mass immunization to be given at least two months before the expected epidemic.
- Sudden antigenic change or mutability of the virus.
- Short incubation period.
- Rapid spread by droplet infection.
- Presence of subclinical cases.
- Universal susceptibility.

Because of these limitations, it is difficult to prepare a particular vaccine and cost effectiveness is not in favor of immunization. The traditional method of control like isolation, quarantine, etc. are also ineffective. Mass chemoprophylaxis with amantidine and rimantidine is also not advisable.

The practice of mass destruction of infected poultry birds suspected to be suffering from influenza (bird flu) with potential human spread has proved to be a very effective measure of controlling transmission of new strains of influenza virus to human population. Apparently this practice has prevented the emergence of several pandemics of influenza in recent years. Recently in February 2013, an epornithic disease outbreak occurred in Shanghai Eastern China, caused by the emergence of a new and deadly strain of the virus, H7N9. It has killed nine persons, out of 33 confirmed cases. This virus has been found for the first time and the exact source of infection has remained unknown.

Some samples of blood has been tested positive in some birds in poultry markets of China.

This new virus H7N9 is severe in most humans, leading to fears that if it becomes easily transmissible, it could cause a deadly influenza pandemic. Since this new strain has not been demonstrated to be transmitted between humans it is not going to be pandemic like H1N1 strain.

This outbreak among poultry birds is not related to death of nearly 16,000 pigs, which occurred at the same time.

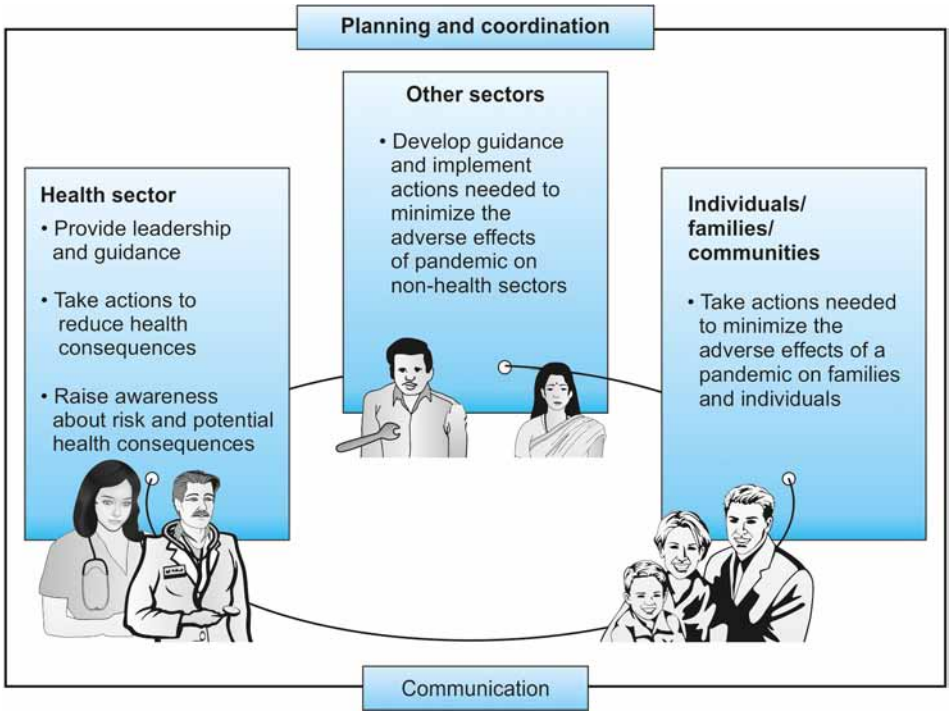


Fig. 20.19 Whole of society approach to pandemic preparedness

A vaccine against H7N9 is expected to be introduced shortly.

This virus is also susceptible to antiviral drugs like Tamiflu and Relenza.

To control the situation, tons of thousands of poultry birds have been culled in China and the persons concerned have been monitored.

DIPHTHERIA

In Greek language Diphtheria means leather.

Diphtheria is an acute highly infectious disease of pre-school children, caused by the *Corynebacterium diphtheriae*. Clinically, it is characterized by quiet beginning of gradual rise of temperature, signs and symptoms of toxemia and formation of a grayish-yellow membrane at the site of implantation in the throat, over the tonsils, pharynx or larynx with associated lymphadenopathy. Case fatality rate is about 10 percent.

The disease is one of the major killer diseases of under-five children, known to be existing even much before Christ was born. During third century it was described under the name 'Ulcera – Syriaca,' (by Arateus).

- In 1576, Baillou described the membrane.
- In 1826, Bretonneau gave the name Diphtheria.
- In 1883, Klebs was the first person to identify the bacilli.
- In 1884-85, Loeffler differentiated the diphtheria bacilli form diphtheroids, which are pseudo-diphtheritic organisms. He established the relation between diphtheria bacilli and the disease. Hence, the pathogens are named as Klebs-Loeffler bacilli.
- In 1913, Schick introduced an intradermal test to find out the susceptibility of an individual and that test is named after him as Schick test.

Magnitude of the problem: Diphtheria, by and large, has been eliminated from the developed countries of the world mainly by mass immunization campaigns but the endemicity has been continued in developing countries including India, due to lack of adequate immunization coverage. Recent outbreaks occurred in Ukraine (1990), Thailand and Laos (1996) showed a shift in the age incidence between 5 and 15 years. WHO reported about 5000 deaths due to diphtheria during the year 2002 and in India, the annual incidence has been brought down from 25000 to less than 1000 under the pressure of universal immunization program. However sporadic diphtheria has potential for epidemic flare ups if the immunization effort of the country slackens down.

Agent Factors

- *Agent:* The causative agent is *Corynebacterium diphtheriae* (Klebs-Loefflers bacillus). It is gram-positive, noncapsulated, nonspore forming, nonfilamentous, nonflagellated and nonmotile bacillus. The bacilli exhibit a pleomorphic appearance under the microscope in

varying sizes and shapes. Some are long, thin, curved with swollen ends giving clubbed shape and some are short and stout. The bacilli always tend to appear in pairs, lying at an angle, giving the characteristic appearance of Chinese letters. An important characteristic feature is that they contain 'metachromatic granules', which are absent in diphtheroid bacilli like *Corynebacterium hofmannii*, *Corynebacterium xerosis*, etc.

The organisms have no invasive power but produce a powerful toxin. Antigenically, there are three biotypes– gravis, intermedius and mitis. Generally, the former tends to be more severe and the latter to be least pathogenic. Now, it is learnt that there is no relation between the type and the pathogenicity.

There are both virulent and avirulent strains of the bacilli. The avirulent strain becomes virulent when exposed to bacteriophage – the beta phage. The virulent strain produces a powerful exotoxin, which has 2 factors A and B. A fragment is the lethal factor, which enters the target cells. It will act only when B-fragment is present in sufficient quantity. B-fragment is a spreading factor. It makes attachment with the cell membrane allowing the A-fragment to enter in the target cell. The exotoxin causes local tissue necrosis.

The diphtheria bacilli are easily destroyed by heat at 58°C and by drugs like penicillin and also by routine disinfectants like 10 percent cresol. They survive freezing and desiccation (drying). They can remain alive for several months at room temperature, in the dust of premises.

- *Reservoir of infection:* Man is the only reservoir and the source. A human reservoir may be a case or a carrier. A carrier may be temporary (incubatory, healthy or convalescent) carrier or chronic carrier. Nose and throat are the most common sites of carriage. However, the cutaneous carriers are more infectious than the respiratory carriers. For every clinical case there are about 8 to 10 carriers.

  Since the cutaneous carriers can spread the disease to the teats of the udder of the cattle resulting in sores, the cattle thus becomes the reservoir. However, the animals do not suffer from the disease. Thus, the ultimate source is the man only. Transmission of diphtheria through animal milk is extremely rare and is of epidemiological curiosity only.

  Immunization of the children does not prevent the carrier state.
- *Infective materials:* Nasopharyngeal secretions, discharges from cutaneous lesions and possibly the infected dust and contaminated fomites constitute the infective materials.
- *Period of infectivity:* This varies from 2 to 4 weeks. However chronic carriers remain infectious for several months to one year.

Host Factors

- *Age incidence:* Incidence of diphtheria is high between 1 to 5 years. It is almost nil in an infant below 6 months because of maternal antibodies through milk. In countries, where immunization coverage is very good, a shift in the age incidence has been observed from preschool age to school age.
- *Sex:* Incidence is equal in both boys and girls.
- *Immunity:* Breastfed infants are relatively immune. About 70 percent of children develop immunity through subclinical infection. More than 85 percent of immunization coverage helps in the development of herd immunity.

Environmental Factors

Incidence of diphtheria is high in winter season because of indoor life and overcrowding.

Modes of Transmission

- Droplet mode is the commonest way of transmission.
- Direct contact transmission is possible from a case of cutaneous diphtheria to a susceptible person.
- Indirect transmission is possible from recently contaminated fomites such as clinical thermometer, tongue depressor, handkerchiefs, pen, pencils, toothbrushes, cups and plates used by the patient.
- Transplacental transmission is not proved.
- Transmission through animal milk is of epidemiological curiosity.

Portal of Entry

Commonest portal of entry is the respiratory tract. Occasionally, these pathogens may enter through abraded skin (like cuts and wounds) and mucous membrane (conjunctiva, genitals).

Pathology and Pathogenesis

Having entered the body through the respiratory route by inhalation, the bacilli implant (because they do not move) in the upper respiratory passage either in the tonsils, nasopharynx or larynx and multiply there causing inflammatory reaction at the site. They do not have the invasive power and so the pathogens do not enter the circulation. However, the exotoxin enters the circulation resulting in toxemia. Because of severe inflammatory reaction the superficial epithelial cells undergo necrosis. The outpouring exudate containing fibrin clots and entangles the necrosed cells, dead or living bacilli, leukocytes and forms a dense coagulum or pseudo-

membrane which is grayish-yellow in color and is firmly adherent to the underlying tissue. It is about 1 to 3 mm thick. An attempt to peel the membrane results in bleeding, which is confirmative of diphtheria.

Eventhough the pathogens do not enter the blood circulation, they are drained to regional lymph nodes, which become enlarged and tender.

The exotoxin, after circulation, gets fixed up in the target organs especially the heart (myocardium) and the cranial nerves specially glossopharyngeal nerve. When heart is affected it results in myocarditis and heart failure and when 9th cranial nerve is affected, it results in palatal paralysis, nasal twang, nasal regurgitation, etc. Once the toxin gets fixed up into the tissues, no amount of antitoxin will be helpful to neutralize it. The toxin looses its toxicity gradually by itself after several months.

Clinical Features

The incubation period varies from 2 to 6 days. The disease begins quietly. There is gradual rise of temperature and associated features like headache, bodyache, malaise, loss of appetite, etc. Specific features depend upon the type of diphtheria.

a. *Nasal diphtheria:* Usually anterior part of the nose is affected. There is streaming of the nose. It is thin and watery to start with, later becomes purulent and blood stained. On examination, a yellowish membrane is often seen inside the nose. Usually, there will not be features of toxemia and so the child is ambulatory and is spreading the disease. The nasal discharge may produce denudation of external nares and upper lip.
b. *Tonsillar diphtheria:* The child will have pain in the throat, difficulty in swallowing. On examination of the throat, foul smell comes from patient's mouth as he opens and a yellowish membrane is seen on either of the tonsils or both the tonsils. Surrounding tissue is edematous and congested. An attempt to peel the membrane results in bleeding, which is confirmative of diphtheria and differentiates from acute tonsillitis. Regional cervical group of lymph nodes are enlarged and tender. The child will also have mild to moderate degree of toxemia.
c. *Pharyngeal diphtheria (Faucial diphtheria):* The child will have dry, disturbing, cough, sore throat and pain in the throat. As the child opens mouth, foul smell (foetor oris) comes from the mouth. There is congestion and edema in the pharynx. The pseudomembrane may extend anteriorly towards the palate, posteriorly upwards towards the nose or posteriorly downwards towards the larynx. Thus, the membrane is often spreading in nature. Such a membrane is black in the center and yellowish towards the periphery. Throat is congested. Regional lymph nodes are enlarged. The child will have severe degree of toxemia. Fever is high, the child is restless, irritable, looks pale, drowsy, the skin is dry and hot, pulse is rapid and thready.

   Sometimes all the cervical group of lymph nodes are enlarged which alongwith the involvement of soft tissues in the neck gives rise to a 'bulk-neck' appearance. This is the extreme form and is often called as 'Malignant diphtheria', because of its high fatality.
d. *Laryngeal diphtheria:* This may start as a primary response to infection or may be secondary to downward extension of pharyngeal diphtheria. Laryngeal diphtheria is characterized by hoarseness of voice, cough, dyspnea and respiratory distress. The child becomes restless, frightened, develops fear of death due to breathlessness, becomes cyanosed. Respiratory distress is due to the spasm of laryngeal muscles (laryngeal stridor). The child struggles to get more air which reflexly induces spasm, resulting in worsening of the situation. If not relieved by tracheostomy, the child may die very soon.
e. *Other rare forms of diphtheria are as follows*
   - Cutaneous diphtheria—characterized by punched ulcer on the skin and absence of features of toxemia.
   - Conjunctival diphtheria,
   - Gastrointestinal diphtheria,
   - Genital diphtheria—glans or vulva is affected.
   - Endocardiac diphtheria—subacute bacterial endocarditis due to diphtheria bacilli.

Complications of diphtheria

a. *Laryngeal diphtheria:* Secondary to extending pharyngeal diphtheria.
b. *Cardiovascular complication (postdiphtheritic myocarditis):* Due to fixation of exotoxin in the myocardium resulting in feeble heart sounds, triple (gallop) rhythm, soft murmur, tachycardia, tachypnea and hepatomegaly. Prognosis is poor. Child may recover after the toxins loose their toxicity in the natural way, which requires about 8 to 9 months.
c. *Neurological complications:* Commonest being the paralysis of glossopharyngeal nerve. There may be oculomotor paralysis or facial paralysis. Child may recover after several months.
d. Miscellaneous complications are bronchopneumonia, otitis media, etc.

Schick Test

This is an intradermal test done to find out the susceptibility or immunity of the child for diphtheria and also to find out hypersensitivity of the child for diphtheria toxin. The test materials are diluted toxin and detoxified toxin (detoxified by heat inactivation).

Procedure

The test is performed by injecting 0.2 mL of diluted toxin (1/50 MLD) intradermally in the left forearm (test arm) and same dose of detoxified toxin in the right forearm (control arm) for the purposes of comparison.

Interpretation

Following four types of reactions may be observed:

1. *Positive reaction:* The reaction is said to have become 'positive' if there is development of erythema of more than 10 mm diameter within 24 to 48 hours, reaching its maximum on 4th or 5th day and then fades slowly by 7th day in the test arm and no such changes in the control arm. Schick positive means the child is not having antibodies because it was not infected before and develops antibodies to the antigen injected. That means the child is 'susceptible' and requires immunization (Schick positive and Tuberculin negative are the indications for immunization).
2. *Negative reaction:* The reaction is said to have become 'negative' when there is no erythema in both the arms. That means the child is already having antibodies and therefore it has not allowed the injected toxin (antigen) to react. That means the child is immune and therefore does not require immunization.
3. *Pseudo-positive reaction:* The reaction is said to have become 'pseudo-positive' if there is transient erythema of <10 mm diameter in both the arms, seen on 2nd day, becomes maximum on 3rd day and fades on 4th day. This reaction is hypersensitive reaction to an allergen in the test materials. Since it is not a true positive reaction, it is considered as a negative reaction. That means the child is immune and hypersensitive and therefore it does not require immunization.
4. *Combined reaction:* The reaction is said to be 'combined', when there is true positive reaction in the test arm and pseudo-positive reaction in the control arm. Since there is positive reaction it is considered as susceptible and since there is pseudo-positive reaction in control arm, it is hypersensitive. Therefore, it requires immunization, but under great caution by decreasing the dose of the vaccine and increasing the number of injections.

Since direct immunization is practiced under universal immunization program, Schick test has lost its significance.

Treatment

- Isolation of the patient in isolation ward till 2 to 3 throat swab culture reports are negative consecutively, which will take about 15 to 20 days.
- Absolute bed rest, so that fixation of circulating toxins into the tissues can be minimized.
- Concurrent disinfection of throat secretions, sputum, utensils, clothes, is a must by using 10 percent cresol.
- Antidiphtheritic serum (ADS) is administered, following the test dose, in order to neutralize the circulating toxin.
  Dose—20,000 IU if one tonsil is affected. 50,000 to 1 Lakh IU if both the tonsils are affected. If the patient is sensitive to ADS, desensitization is done with diluted preparation. ADS should be given as early as possible because every moment of delay increases the risk to the child.
- *Antibiotics:* This is given to destroy the diphtheria bacilli. Penicillin is the drug of choice. Crystalline (Benzyl) penicillin 10 L 6th hourly is given for about 2 to 4 days to control toxemia followed by Procaine penicillin, 4 L daily for about one week. If the patient is sensitive to penicillin, erythromycin is next best.
- Analgesics and antipyretics are also given to control fever and pain.
- Fluid and electrolyte balance is also maintained.

Prevention and Control

i. *Elimination of reservoirs:* This consists of making the infectious persons (cases and carriers) noninfectious. Cases are eliminated by giving appropriate treatment. Carriers are detected by throat swab culture and treated with antibiotics.

ii. *Breaking the channel of communication:*
- By isolation of the cases
- By carrying out the concurrent disinfection of the sputum, linen, clothes of the patient and also other fomites such as tongue depressor, nasal speculum, clinical thermometer, etc.

iii. *Protection of susceptibles in the community (including contacts):* Young close contacts are under close medical supervision (Surveillance) for the maximum incubation period. They should be put on antimicrobial prophylaxis using penicillin. Their immunization status should be updated with diphtheria toxoid.

Among other children in the community, routine immunization coverage must be improved.

Immunization

There are two methods—active and passive.

A. *Active immunization:* This is done by using diphtheria vaccines, which are of the following types.
   a. *Vaccines of single antigen:*
      i. *Plain vaccine:* These are plain toxoid vaccines, quickly absorbed and rapid in action. However they contain protein fraction derived from meat, peptone and diphtheria bacilli, which produce adverse reactions.
      For example, formal toxoid (FT); toxoid antitoxin floccules (TAF) alum precipitated toxoid (APT).
      ii. *Adsorbed vaccines (Adjuvant toxoid vaccines):* These vaccines eliminate the protein fraction in the vaccine making it safer. For example, purified toxoid adsorbed on aluminum phosphate (PTAP); purified toxoid adsorbed on aluminum hydroxide (PTAH). The adjuvant or adsorbant

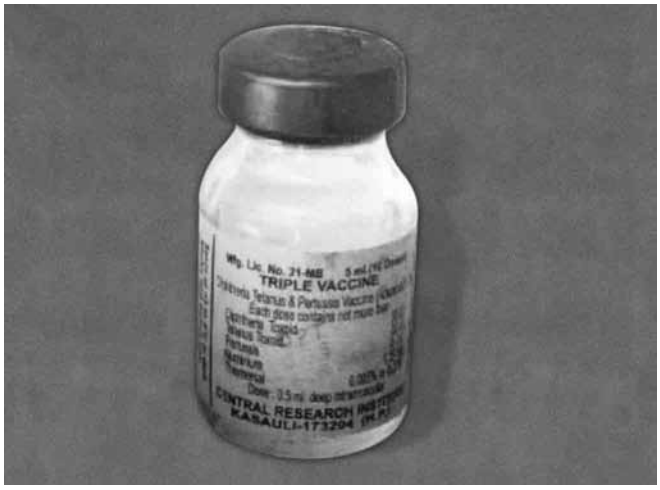


Fig. 20.20 DPT vaccine (Triple antigen)

increases the immunological effectiveness of vaccine.

b. Vaccines of multiple antigen (Combined vaccines): These are of the following types:
   i. *Bivalent vaccine (Td and DT):* Td vaccine contains a smaller dose of diphtheria toxoid and is indicated for children above 7 years of age. DT is pediatric type, recommended for children between 3 and 5 years.
   ii. *Trivalent vaccine (DPT):* This is also called as Triple antigen **(Fig. 20.20)**.
   iii. *Quadruple vaccine (DPT + IPV):* This consists of Triple antigen and Inactivated polio vaccine.
   iv. *Easy four vaccine (DPT + Hib):* It is a tetravalent liquid vaccine containing diphtheria toxoid, tetanus toxoid, whole cell pertussis vaccine and conjugated *Haemophilus influenzae* type *b* vaccine, absorbed on aluminum phosphate and suspended in isotonic saline solution, using thiomersal as preservative **(Fig. 20.21)**.
   Indications: 'Easy Four' is indicated for simultaneous active immunization against Diphtheria, tetanus, pertussis (whooping cough) and *Haemophilus influenzae* meningitis (Hib) among infants from 6 weeks onwards.
   Dosage schedule: Primary course consists of three doses, each of 0.5 mL, IM by on lateral aspect of thigh, during 6, 10 and 14 weeks of birth, followed by a Booster dose during 15th to 18th month of age. The vial is shaken well before use to get an uniform suspension.
   Contraindications:
   - Acute febrile illness (immunization is postponed).
   - History of sensitivity reaction to previous dose of DPT/DPT+Hib.
   - History of any disorder affecting central nervous system is a contraindication for pertussis vaccine.

   Note: Under such circumstances, the immunization must be continued with DT and Hib vaccines.
   Storage temperature: 4° to 8°C.
   v. *Easy five vaccine (DPT + Hib + HBsAg):* It is a fully liquid pentavalent vaccine, consisting of diphtheria toxoid, tetanus toxoid, whole cell pertussis vaccine, conjugated *Haemophilus influenzae* type b vaccine and Hepatitis B surface antigen, adsorbed on aluminum phosphate, suspended in isotonic saline solution, using thiomersal as preservative **(Fig. 20.22)**.

Fig. 20.21 Tetravalent vaccine (Easy four)

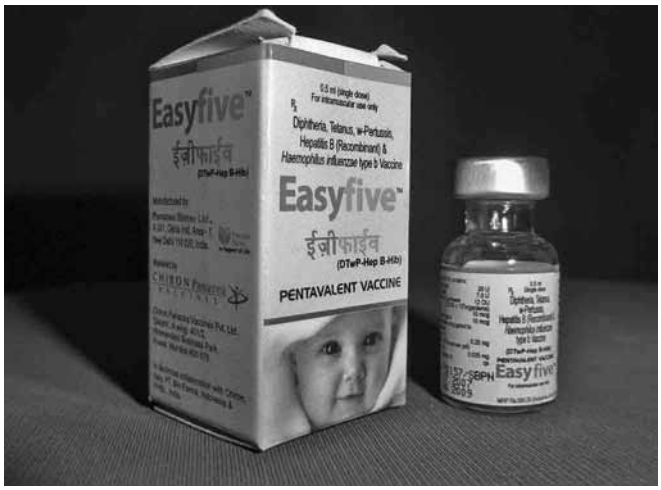


Fig. 20.22 Pentavalent vaccine (Easy five)

Indications: 'Easy Five' is indicated for simultaneous, active immunization against diphtheria, tetanus, pertussis (whooping cough), *Haemophilus influenzae* type b (Hib) and Hepatitis B among infants.

Dosage schedule: Primary course consists of three doses, each of 0.5 mL, IM by on lateral aspect of thigh, during 6 and 10 weeks and 14th weeks of birth followed by a Booster Dose during 15th to 18th month, with tetravalent (Easy Four) vaccine and not with pentavalent (Easy Five) vaccine. The vial is shaken well before use to get an uniform suspension.

Contraindications:

- Acute febrile illness (Immunization is postponed).
- History of hypersensitivity reaction to previous dose of DPT or Easy Four or Easy Five.
- History of any disorder affecting central nervous system is a contraindication for pertussis vaccine (under such circumstances the immunization must be continued with DT or Hib vaccines).

Storage temperature: 4° to 8°C.

vi. *Hexavalent vaccine:* DTPa – HBV – IPV – Hib (Diphtheria, tetanus, pertussis acellular vaccine, hepatitis B vaccine, inactivated polio vaccine and *Haemophilus influenzae* type b vaccine).

DPT Vaccine (Triple Antigen)

Nature	:	It is a killed bacterial, liquid vaccine
Indication	:	For active immunization of infants against diphtheria, pertussis and tetanus simultaneously.
Composition (per 0.5 mL)	:	Diphtheria toxoid—20 Lf. Tetanus toxoid—05 Lf. Pertussis bacilli (killed)—20000 million Aluminum phosphate—1.5 mg Thiomersal (preservative)—0.01%
Dose	:	0.5 mL
Route	:	Deep intramuscularly, preferably in lateral aspect of thigh.
Schedule	:	Primary course consists of three doses, at 6th week, 10th week and 14th week respectively followed by first booster dose at 18th month and second booster dose at 5th year with DT and not DPT because 'Pertussis component' is not necessary after 2 years of age.
Reactions	:	Usually pain and fever on the next day. It is because of toxoid component. Rarely anaphylactic shock and convulsions (Reye's syndrome). Very rarely provocative reaction.
Contra-indications	:	Acute febrile illness, history of convulsions, history of reaction to previous dose. However mild illness is not a contraindication. Malnourished children require immunization most.
Storage temperature	:	2 to 8°C
Precautions	:	Cold chain to be maintained. Vial to be shaken before use. If turbidity or floccules are seen it should not be used (Shake test). Date of expiry should be looked at. A frozen vial should not be used.

Instructions to the Parents

- To report if the child develops reactions
- To report for the next dose
- To complete the schedule positively.

Note: If the child has not received primary immunization with DPT during infancy and is already more than 2 years old, requires primary immunization with DT (and not DPT) only two doses with 4 weeks interval followed by booster dose with DT during 5th year.

B. *Passive immunization:* This is done with Antidiphtheritic serum (ADS). It is given for those who are at high-risk such as young close contacts of the patient's family, who are not immunized before.

Dose—1000 to 2000 IU. It is given after the test dose. It gives immediate protection and lasts for about 6 weeks. ADS is also used for therapeutic purposes, i.e. to treat cases of diphtheria, in order to neutralize the circulating toxins.

Community Diagnosis of Diphtheria

All the under-five children of the area are subjected for 2 screening tests namely Schick test and throat swab culture tests and results are interpreted as shown in **Table 20.9**.

WHOOPING COUGH (PERTUSSIS)

It is an acute, highly infectious disease of the respiratory tract, caused by *Bordetella pertussis*. Common among young children, transmitted by droplet infection. Clinically characterized by mild fever, attacks of cough with a characteristic whoop, due to sharp indrawing of breath, terminated by vomiting. Attack rate is about 70 to 80 percent and the case fatality rate is 5 to 15 percent. Chinese call it a 'Hundred day cough.'

Pertussis continued to be a major killer disease until a vaccine was discovered in 1950. Following widespread immunization, it is totally controlled in all the developed countries but in the developing countries, it is still an endemic disease with often epidemics.

Table 20.9 Community diagnosis of diphtheria

Sl. No	Schick test	Throat swab culture report	Interpretation	Remarks
1.	+	+	Susceptible child having the organisms in throat. It is an incubatory carrier. If features are present, it is a case	Requires both passive and active immunization. If it is a case, it requires treatment also.
2.	+	–	Susceptible child	Immunization
3.	–	+	Immune but carrier (Healthy carrier)	Only treatment. No immunization
4.	–	–	Immune and healthy child	Nothing required
5.	Pseudopositive	+	Healthy carrier and hypersensitive to vaccine	Treatment and antihistamine
6.	Pseudopositive	–	Immune and healthy; Hypersensitive to vaccine	Only antihistamine
7.	Combined reaction	+	Susceptible but allergic to vaccine and carrier	Immunization is given under caution and also treatment
8.	Combined reaction	–	Susceptible but allergic to vaccine	Immunization given carefully

In India, there has been a marked decline with the launching of UIP in 1985, when the incidence was about 1.85 lakh cases (1,85,000 cases) and in 2000 about 20000 cases were reported, showing a decline of about 84 percent.

Agent Factors

The causative agent is *Bordetella pertussis*. It is a gram-negative, Cocco-bacillus. They appear in both capsulated and non-capsulated forms. They produce an exotoxin (pertussigen). Capsulated, phase 1 strain results in severe clinical illness. *Bordetella para-pertussis* often affects older children but results in minor illness. The toxin is not only an important virulence factor but also acts as a mediator for attachment to the respiratory cells. The organisms survive for very short period outside the human body.

Reservoir

Human beings are the sole reservoirs. Mild undetected cases are responsible for the prevalence of the disease. There is no carrier state.

Infective Material

Nasopharyngeal secretions (droplets) contain the organisms.

Period of Infectivity

Maximum infectivity is during the first week of the illness (i.e. Catarrhal stage) and lasts for about another 3 weeks during the paroxysmal stage.

Host Factors

Age incidence: Pertussis is a disease of preschool children. Infants are hit hardest, constituting a pediatric priority. Morbidity and mortality is highest among infants below 6 months of age.

Sex incidence: It occurs more frequently and seriously among female children.

Immunity: The child is susceptible from birth-itself, because maternal antibodies do not appear to protect the infant. One clinical illness or active immunization confers 80 to 90 percent immunity. Second attack may be seen in 10 percent of cases. There is no cross immunity against Bordetella para-pertussis.

Environmental Factors

It is an endemic disease occurring throughout the year, but is highest during winter season because of indoor living and overcrowding, predisposed by poor socioeconomic condition, poor living condition, ill ventilation; malnutrition, large families, etc.

Modes of Transmission

The disease is transmitted mainly by droplet infection. The intermingling of children while playing in creches, day care schools offer more chances for transmission. Since the pathogens survive for very short period outside the human body, the transmission through fomites is minimum.

Incubation Period

1 to 2 weeks.

Pathology and Pathogenesis

Since the organisms are not invasive, they cause inflammation and necrosis of the respiratory epithelium leading to secondary bacterial infection. They produce toxin.

Clinical Features

Course of illness occurs in three stages:

Catarrhal Stage

This is characterized by insidious onset of fever, cold, dry hacking irritant cough associated with malaise and anorexia, lasting for about 10 days.

Paroxysmal Stage (Spasmodic Stage)

The dry irritating cough progresses resulting in episodic, paroxysmal cough. Violent cough occurs in bouts after bouts without gap throwing the air out of the lungs leaving nearly empty. The glottis is however closed. After the bouts of cough, glottis relaxes and the air from outside rushes inside the lungs during inspiration. This gush of air through the glottis creates a classical 'a deep high pitched inspiratory whoop', characteristic of this disease and hence the name whooping cough. During this paroxysm the face of the child becomes congested, eyes widen with tears, mouth opens with saliva drooping and is often cyanosed. The child is struggling hard to take a breath. At the end of spasm, the child may vomit or spit tenacious thick sputum, exhausted and goes to sleep or straightway passes into another attack of cough. This stage lasts for about 2 to 4 weeks.

Convalescent Stage

This stage lasts for another 2 to 4 weeks. The symptoms diminish in frequency and severity. Recovery is slow.

Complications

Complications are mainly due to increased intra-abdominal pressure. They are umbilical or inguinal herniation, rectal prolapse, sub-conjunctival hemorrhage, petechiae, emphysema, epistaxis, etc. Severe complications are bronchopneumonia, flaring up of tuberculosis, pulmonary collapse and convulsions. Long term effect is malnutrition.

Management

Drug of choice is erythromycin, dose is 50 mg/kg body weight in 6 hourly dosage for about 15 days.

- Isolation and concurrent disinfection is carried out.
- Fluid and electrolyte balance is maintained.
- Antibiotics neither reduce the frequency or severity of spasms nor decrease the duration of illness. However they are useful in controlling the secondary bacterial infections.

Prevention

Active immunization against pertussis is the only effective preventive measure. There are two types of vaccines.

- *Vaccine of single antigen (Single vaccine):* It is a killed vaccine. *Dose* 0.5 mL deep IM. Three doses are given during infancy, starting as early as 6 to 8 weeks, with an interval of 4 to 6 weeks in between. Booster doses are repeated twice once in 3 years. Efficacy is 70 to 80 percent can result in adverse effects (already explained in Diphtheria).
- *Vaccine of multiple antigen (Combined vaccine):* This is the vaccine of choice, i.e. DPT (Triple antigen). Under UIP, 3 doses, each of 0.5 mL IM is recommended during 6th, 10th and 14th week followed by a booster dose during 18th month.
- Other vaccines of multiple antigen (described under diphtheria).

Passive immunization using human pertussis immunoglobulin given for postexposure prophylaxis does not alter the severity of the illness. So it is not advised.

MENINGOCOCCAL MENINGITIS (CEREBROSPINAL FEVER OR CEREBROSPINAL MENINGITIS)

It is an acute, infectious, type of pyogenic (bacterial) meningitis, caused by meningococci, *Neisseria meningitidis*. Clinically, it is characterized by fever, severe headache, vomiting, neck rigidity progressing onto coma within a few hours with a case fatality of about 80 percent, which can be reduced to less than 10 percent by early diagnosis and prompt treatment.

Distribution

The disease is distributed all over the world sporadically, often giving rise to epidemics. The area between 5 and 15 degrees

North of Equator in Africa, is called 'meningitic belt', because of frequent epidemics occurring. In India, serious outbreak occurred during 1983-84, in and around Delhi. During 1899 another epidemic occurred when about 7500 cases were reported with about 900 deaths.

Agent Factors

Causative Agent

Causative agent is *Neisseria meningitidis*. It is gram-negative diplococci, capsulated, nonspore forming and nonmotile organism, usually arranged in pairs, often in chains, readily demonstrated in cerebrospinal fluid. It rapidly dies outside the body. Depending upon the capsular polysaccharide antigen, several serotypes have been identified, namely Group A, B, C, D, 29 E, X, Y and W_{135}. These pathogens were first identified and described by Weichselbaum in 1887. Group A and C and often group B meningococci are capable of causing epidemics. It can be distinguished from *Gonococcus* by the production of hemolysin. It produces exo and endotoxins. *Neisseria meningitidis* differs from other Neisseriae, in that, it ferments glucose and maltose but not sucrose or lactose, lacking in pigmentation and fails to grow at room temperature.

Reservoir of Infection

It is disease of human beings only. Cases and carriers are the reservoirs. All infected persons do not develop meningitis. A large number of them develop only nasopharyngitis or septicaemia. Only a few develop meningitis. Active clinical cases constitute only a negligible source of infection. But carriers constitute the important source of infection. The prevalence of carrier state is about 20 to 30 percent of the population. During epidemic, it increases to 70 to 80 percent.

Infective Material

Infective material is nasopharyngeal secretions.

Host Factors

Age and sex incidence: It is a disease of young children and adolescents. Incidence is equal in both the sexes.

Immunity: Immunity is acquired by subclinical and clinical infection. One attack confers life long immunity. Immunity is type specific and does not provide cross immunity. Infants derive passive immunity through mother's milk.

Environmental Factors

Outbreaks usually occur during winter season, predisposed by factors like overcrowding, poor standard of living condition and malnutrition. Homogeneous communities like nursery school, day care center, play homes, crèches, etc. favor more rapid spread of the disease.

Period of Communicability

Cases are infectious for hardly 2 to 3 days after the start of treatment. However, carriers remain infectious for about 10 months.

Pathogenesis

Having entered the body through the nasopharynx, the organisms enter the circulation, cross the blood-brain barrier and reach the subarachnoid space, where it causes suppurative inflammation, especially at the base of the brain, CSF becomes purulent, increases the intracranial pressure resulting in the distension of the ventricles and pressure effects on the brain.

Incubation Period

Varies from 1 to 5 days.

Clinical Features

All cases of meningococcal infections do not develop meningitis. About 40 percent of them become nasopharyngeal carriers. Remaining develop the following forms of the disease.

- Meningococcemia, a form of septicemia without meningitis, characterized by fever, headache, cough and sore throat, followed by spiking fever, arthralgia and myalgia associated with prostration. Majority of them develop 'petechial rashes' which are sparse in distribution.
- *Fulminating meningococcemia (Waterhouse Friedrichsen syndrome)* characterized by a fulminating form of septicemia, features being high fever with chills, severe headache, myalgia, arthralgia, large ecchymosis, widespread petechial eruption, usually associated with vasomotor collapse and shock, followed by coma, carrying a high fatality rate.
- *Meningitis:* Characterized by fever with chills and cardinal features being headache and vomiting. Headache is violent and is of bursting type. It dominates the patient. He becomes irritable, resentful and uncooperative. Vomiting becomes persistent. As he vomits, he becomes aware that his headache is increasing in intensity. Petechial rashes are usually seen.

Meanwhile stiffness of the neck becomes outstanding. Kernig's sign and Brudzinski's signs become positive. It is closely followed by head retraction and irritability indicating increased intracranial pressure.

Diagnosis is confirmed by doing lumbar puncture. The CSF is under pressure and is purulent. Protein is increased and sugar is reduced. Microscopic examination reveals increased polymorphs and Gram stain reveals gram-negative diplococci. Culture of CSF is final confirmative test.

- *Chronic meningococcemia:* A rare form of the disease lasting for several weeks to several months. Characterized by fever, rash, arthritis, arthalgia, fever being intermittent. Rashes wax and wane with fever. There may be splenomegaly.
- *Complications:* Complications either because of mechanical damage in CSF circulation or systemic complications.
  - Hydrocephalus, due to blockage in cerebrospinal fluid (CSF) path, is followed by compression and destruction of cortical tissue, later resulting in facial paralysis, hemiplegia, neuropathies, etc.
  - Arthritis, affecting large, multiple joints, is a fairly frequent complication, occurring in about 5 to 10 percent cases.
  - Cardiac complications like pericarditis, myocarditis and endocarditis is seen in about 5 percent cases.
  - Convulsions are often followed by brain damage and mental retardation in about 5 percent cases.

Prognosis

Depends upon early diagnosis and prompt and intensive treatment.

Prevention and Control of Epidemic Meningitis

a. *Elimination of reservoirs:* Since the carriers outnumber the cases during epidemics, they are best eliminated by treatment and not by isolation. Penicillin is the drug of choice. Around 5 to 10 lakhs units of Benzylpenicillin is injected intrathecally during diagnostic lumbar puncture, followed by IM. Penicillin and Sulphonamide tablets, both readily pass into CSF. Supportive treatment consists of expert nursing care and maintenance of fluids and electrolyte balance. Ancillary treatment consists of giving anti-inflammatory drugs specially steroids, which reduce fibrin formation and prevent brain damage followed by administration of osmotic diuretic such as mannitol or urea to reduced intracranial pressure. Sedative treatment is given with injection. Morphine to relieve bursting headache. Diazepam is given to control convulsions. Antipyretics to control temperature.

b. *Breaking the channel of transmission:*
   - By avoiding indiscriminate spitting of sputum.
   - By improving the living condition.
   - By avoiding overcrowding during epidemics.
   - By health education.

c. *Protection of susceptibles:*
   - Family contacts are at high-risk. Chemoprophylaxis is given with rifampicin, being the drug of choice for chemoprophylaxis, given in a dosage of 600 mg twice a day for 2 days for adults and proportionately less for children. This is followed by vaccination.
   - Mass chemoprophylaxis is given to the population of closed community such as schools and camps and also for doctors and nurses. This causes immediate drop among carriers. This is followed by vaccination.
   - Immunization is by active immunization only. Vaccines are prepared from purified groups of A, C Y and W135 organisms. The preparation contains meningococcal polysaccharide antigen from the cell-wall (Cellular fractions). The vaccine may be monovalent A or C or polyvalent (A + C or A + C + Y). Immunity is group specific and lasts for 3 years. Booster dose once in 3 years. Immunization is recommended for high risk group and not for mass prophylaxis. It is contraindicated for pregnant mothers.

Haemophilus influenzae Meningitis

This differs from meningococcal meningitis in that it is caused by *Haemophilus influenzae* bacteria and often it presents less acutely. It is common among children, transmitted by droplet infection. Clinically characterized by fever, malaise, signs of meningeal irritation, if not treated the patient will become drowsy and finally enters coma. Those who recover may have residual neurological sequelae.

The organism was first isolated by Pfeiffer in 1892. He thought that this was the causative agent for influenza. During 1918 influenza pandemic, extensive investigations revealed that influenza is caused by a virus and not by *H. influenzae*, which results in meningitis.

H. influenzae is a small, pleomorphic, gram-negative, coccobacillus. There are both capsulated and non-capsulated strains. Among the capsulated strains there are six distinct types. Type A, B, C, E and F are more invasive and therefore cause severe diseases like meningitis, epiglotitis, pneumonia, septicemia, cellulitis, etc. *H. influenzae* type B (HIB) is the commonest cause of meningitis among young children of 6 months to 2 years. Type D is less invasive noncapsulate strains cause less severe infections like otitis media, sinusitis, conjunctivitis and bronchopneumonia. Nasal and throat carriers are responsible for the prevalence of the disease in the community. The annual ancidence of HB influenza in India is 50-60/1,00,000 children below 5 years of age.

With the introduction of HIB conjugate vaccine since 1995, the rates of *H. influenzae* meningitis is dropped by more than 95 percent in the developed countries. This vaccine also provides herd immunity like polio-vaccine **(Fig. 20.23)**.

Immunization with HIB vaccine (killed vaccine) is recommended for all under fives, especially during infancy, before 6 months of age, with 3 doses, intramuscularly alongwith DPT and OPV during 6th, 10th and 14th week respectively followed by a booster dose during 15th to 18th month.

For a child between 7 and 11 months only two doses are recommended for primary immunization, followed by a booster dose during 18th month.

For a child between 1 and 1¼ year, only one dose followed by one booster dose during 18th month and for a child above 1¼ year, only one dose and no booster dose.

Dosage schedule of Hib vaccine:

< 6 mths—3 doses + 1BD at 18th month.

7–11 mths—2 doses + 1BD at 18th month.

12–15 mths—1 dose + 1BD at 18th month.

> 15 mths—1 dose. No BD

TUBERCULOSIS

Tuberculosis is a chronic, common, infectious disease caused by *Mycobacterium tuberculosis*. Usually, the organisms affect the lungs primarily resulting in pulmonary tuberculosis. However, they can affect any organ or system in the body, such as bones, joints, meninges, intestine, lympho nodes, kidneys, etc. grouped under extrapulmonary tuberculosis. Tuberculosis is an age old disease. TB is not only a public health problem but also a social and an economic problem.

Memorable Discoveries and Milestones

1868 - Jean Antoine Villemin, a French Veterinary Surgeon, showed that tuberculosis is a communicable disease.

Fig. 20.23 Sii Hib Pro

1882 - Robert Koch, a German Scientist, discovered rod shaped bacteriae causing tuberculosis on 24th March 1882. So World TB Day is being celebrated on 24th March every year. From 2005 March, it is called 'World Stop TB Day'.

1890 - Robert Koch, produced tuberculin, an extract of dead tubercle bacilli, used for a diagnostic test of tuberculosis infection (and not disease).

1895 - Roentgen discovered the X-rays, which helped in radiological examination of the chest.

1921 - French scientists Calmette and Guerin discovered vaccine against tuberculosis.

1944 - Selman A Waksman and his Colleagues discovered Streptomycin, an antibiotic, effective against TB.

1946 - Drugs like INH and PAS were introduced.

1960 - National Tuberculosis Institute was established at Bengaluru to formulate a comprehensive National TB control program.

1962 - Government of India launched National TB Control Programme (NTCP).

1966 - Rifampicin proved to be an excellent drug against TB.

1972 - Wallace Fox and colleagues of British Medical Council showed that addition of Rifampicin and Pyrazinamide alongwith INH would reduce the duration of treatment from 1½ years to hardly 6 months. Thus short course chemotherapy was introduced.

1992 - NTCP was reviewed and found that the program was a failure one.

1993 - WHO declared TB as the 'Global Emergency'. (because of emergence of HIV.) Government of India revised and intensified the NTCP and renamed as 'Revised National TB Control Program' (RNTCP).

1997 - RNTCP was expanded in a phased manner to cover the entire country by the year 2004.

Tuberculosis: A Global Burden

Global scenario: TB which was a worldwide problem during 20th Century, was brought under control in all the developed countries in a natural way by the improvement in the living conditions, sanitation and quality of life coupled with the application of chemotherapy and BCG vaccination.

But since mid 1980s, there has been an increase in incidence of the disease in both developed and developing countries, as a silent pandemic and the scenario is becoming more complicated with the emergence of HIV epidemic, with which TB has formed a lethal combination and has resulted in more of AIDS cases and increased multidrug resistant strains. Thus there has been re-emergence of TB.

- Globally, 1.7 to 2.0 billion people are infected with TB bacilli.
  (1 billion = 100 crores; Global population = 7 billion).
- About 8.0 million people develop TB disease every year.
- About 1.3 million people die every year.

- Annual global incidence during 2009 was 9.4 million cases.

Since most of these deaths are preventable and if not controlled, the situation will become still worst. Due to the emergence of multidrug resistance TB (MDR-TB) and the rapid spread of HIV, WHO declared TB as 'Global Emergency' in 1993.

Indian Scenario

- India accounts for nearly one-fifth of the global problem **(Fig. 20.24)**.
- About 40 percent of the population are infected with TB bacilli (40 crores).
- About 14 million people are suffering from the disease (1.4 crore)
- Annual incidence in India during 2009 was 1.98 million cases (1/5 of global problem)
- About 4 million cases are infectious (sputum positive for AFB) (40 lakhs)
- About 1.5 million new cases are added every year (15 lakhs)
- About 0.37 million cases are dying every year (3.7 lakhs)
- About ₹ 12,000 crores is economic loss to Government of India every year.

Daily Burden in India

- Every day, more than 20,000 people become infected with TB bacilli.
- More than 5,000 people develop the disease.
- More than 1,000 people die of this disease
- Nearly 2 persons die every 3 minutes
- About 80 working days are lost per year per case.

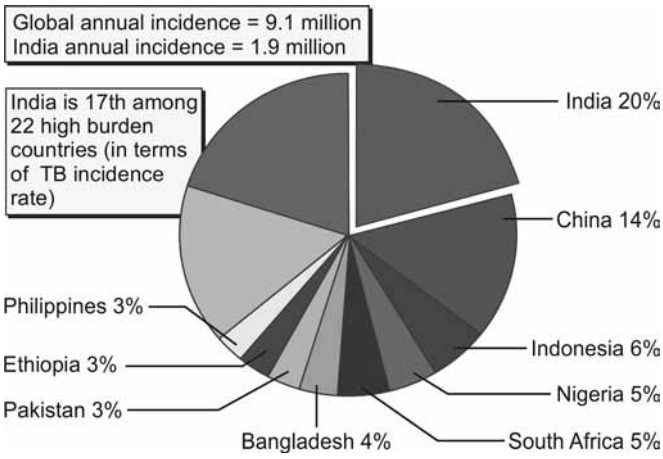


Fig. 20.24 India is the largest TB burden country accounting for one-fifth of the global incidence
Source: Reproduced from WHO global TB report 2008

Points of Serious Concern

- At any given point of time, there are 4 million infectious cases in India.
- One infectious case of TB can infect 10 to 15 persons in an year.
- TB is the leading infectious cause of death in our country.
- TB is silently killing 5 lakhs of people every year, more than 1000 everyday and more than 2 every 3 minutes.
- Nearly 3 lakhs children are forced to leave school, because their parents have tuberculosis.
- More than 1,00,000 women are stigmatized and rejected by their families each year due to TB, leading a large number of children to become orphans.
- Tuberculosis kills more women than all causes of maternal mortality combined together.
- It kills more adults of economically productive age group (15–50 years) than any other infectious disease.
- It is estimated that an average of 2 percent of new patients have multidrug resistance (MDR), representing nearly 20,000 cases in the country every year.
- The estimated annual incidence of MDR TB is 1,31,000 cases in India. The direct and indirect socioeconomic burden of TB to India amounts to about $ 23.7 billion annually.
- HIV infection being the most powerful provocative factor to flare up the latent infection of TB, the situation has become worst with the emergence of HIV and multidrug resistant TB cases.
- A person infected with only *M. tuberculosis* has 10 percent lifetime risk of getting TB disease, a person with only HIV infection has 30 percent risk, and a person with dual infection (both TB and HIV) has 50 percent lifetime risk of getting TB disease.
- TB is the commonest opportunistic disease among AIDS patients.
- It is estimated that more than 3 million will die in India from TB in this decade if timely action is not taken.
- More than 90 percent of these deaths are preventable provided early diagnosis and prompt treatment is given.

Epidemiological Indices (Measurement of TB)

Frequency of Infection

1. *Prevalence of infection (Tuberculin index):* This is the percentagae of the population infected with TB bacilli and show positive reaction to tuberculin test. It is about 30 percent in our country. But the limitation is that most of the people vaccinated with BCG also show positive reaction to the test.
2. *Incidence of infection (Annual infection rate):* This is the number of uninfected persons getting TB infection newly

per 1000 MYP during a given year, i.e. annual infection rate or tuberculin conversion Index. This explains the attacking force of the disease. This is average 15/1000 MYP per year (1 to 2% i.e; 10 to 20 per 1000 MYP/yr). It is a sensitive indictor to evaluate the TB problem and its trend.

Frequency of Disease

1. *Prevalence of disease (Case rate):* This is the percentage of the population suffering from TB disease (both old and new cases) and sputum is positive for TB bacilli. This reflects the 'Case-load' in the community. It is estimated to be 0.4 percent (or 4 per 1000 population) in India.
2. *Incidence of the disease:* This is the number of 'New' TB cases occurring in a given population during a given year, expressed per 1000 MYP. It has increased to 1.5/1000 MYP, i.e. 15 lakhs cases occur every year.

Prevalence of Drug Resistant Cases

It is the percentage of TB cases resistant to routine anti-tuberculosis drugs. This index is related to chemotherapy.

TB Mortality Rate

Specific death rate due to TB: It is the number of deaths due to TB per 1000 MYP, per year. It is estimated to be 5 lakhs every year in India.

Agent Factors

The following groups of Mycobacteriae are responsible for this disease:

- *M. tuberculosis var hominis* (human variety) is responsible for majority of the cases.
- *M. bovis* is the bovine strain of the bacilli affecting mainly the cattle.
- Atypical mycobacteriae (Opportunistic mycobacteriae): They are grouped into four groups, namely photochromogens (e.g. *M. kansasii*), scotochromogens (e.g. *M. scro-fulaceum*), nonphotochromogens (*M. intracellulare*) (Battey bacillus) and Rapid growers (*M. fortuitum*).

TB bacilli are both acid-fast and alcohol-fast. They may be extracellular or intracellular. They are divided into rapid growers and slow multipliers. Latter remain alive for years and are the seeds of future relapse. They are seen in singles. They are gram-positive but as a routine Gram's staining is not done because they require 2 to 3 days for staining. So Zeihl-Neelson stain is adopted. They are called tubercle bacilli because they result in lesion called 'tubercle'.

The pathogens are fairly resistant to usual chemical disinfectants and survive in dried sputum for long periods of time.

The infectivity of the organism is very high but pathogenicity is fairly low.

Reservoir of Infection

Persons suffering from TB disease whose sputum is positive for tubercle bacilli are the common reservoir of infection. Often cattle suffering from TB act as reservoir. But animal reservoirs are not important in India, because of the practice of boiling the milk before consumption. There is no carrier state.

Infective Material

Infective material is the sputum of TB patients.

Period of Infectivity

Period of infectivity is as long as the sputum positive TB cases are not treated. Effective chemotherapy reduces the infectivity by 90 percent within 48 hours and becomes totally non-infectious by about 15 days.

Host Factors

Age incidence: TB affects people of all age groups. There are 3 peaks of incidence in less developed countries, a small peak in early childhood (getting from TB parents), an extensive peak in adolescent age and a moderate peak in the old age. As the quality of life improves, the childhood type of TB declines. In the developed countries the incidence is more common in the elderly.

Sex incidence: The disease is more among men than among women, but the death rate is more among women than among men.

Heredity: TB is not a hereditary disease. But the susceptibility to the disease is inherited in some families, may be due to common environmental situations to which they are exposed.

Nutrition: Malnutrition, specially among children, is a risk factor for the development of the disease. When TB occurs among malnourished children, it becomes very severe.

Socioenvironmental factors: TB is called a 'Social disease', because of the prevalence of many social factors like poverty, illiteracy, ignorance, poor standard of living, overcrowding, etc. which are all inter-related and contribute to the prevalence of the disease.

Immunity: There is no inherited immunity but only acquired either by infection or by immunization with BCG vaccine. The immunity is the cell mediated one.

Modes of transmission: The disease is mainly transmitted by infected droplet method. The disease is also transmitted indirectly through infected dust. But it is not transmitted through contaminated fomites. In case of bovine strain of tubercle bacilli, transmission is possible through drinking unpasteurized raw milk of an infected cattle, underwhich circumstance, TB of the intestine occurs. Congenital transmission is possible but extremely rare.

Incubation Period

Varies from several weeks to several months. In case of reactivation of old lesions, the latent period varies from 5 to 50 years.

Pathology and Pathogenesis

Having entered the body through the respiratory route, the bacilli reach the small bronchioles in the lungs, and lodge in the subpleural part of lower 2/3 of the right lung, where ventilation is best and exposure to contaminated inspired air is the greatest. Bacilli multiply there and then reach regional lymph nodes (hilar and mediastinal) and multiply there also. Usually by the time the pathogens reach and multiply in regional lymph nodes, cell-mediated immunity is developed and multiplication of bacilli drops down, resulting in caseation and necrosis. Macrophages phagocytose the bacilli. The intracellular bacilli inhibit 'phagolysosomal fusion' and multiply and survive within lysosomes. The infected macrophages then initiate the immunity and the infection is contained. The host is asymptomatic or minimally symptomatic. This form of the disease is called 'Primary Complex.' In 95 percent of the cases, the primary lesion heals by a combination of resolution, fibrosis and calcification within 1 to 2 months. Rarely immune mechanism fails resulting in the disease.

In about 1 to 5 percent of the cases, the bacteriae disseminate from the primary focus by lympho-hemotogeneous spread usually (in 90%) to apical portion of right lung where ventilation is poor and oxygen concentration is high and blood supply is also poor comparatively, which is a most favorable environment for the growth of the bacilli and it also spreads to other parts of the body such as meninges, bones, joints, intestine, kidney, etc. resulting in extrapulmonary tuberculosis. This is called postprimary chronic tuberculosis.

Thus 90 percent of the cases are pulmonary TB cases, 1 percent is TB meningitis and rest of 9 percent is extrapulmonary TB cases.

The TB bacilli can remain latent within the reticuloendothelial cells both within pulmonary and extrapulmonary areas. They can also survive for a long period within the lysosomes of macrophages. About 10 percent of the individuals with latent infection later progress to active disease.

Wherever the lesion is dormant, there will be fibrocaseation. Occasionally, the caseous hilar lymph node liquefies and spills the contents into a bronchus to produce lobar tuberculous pneumonia. Its invasion in the blood stream may result in military tuberculosis.

Clinical Features

There will be gradual onset of low grade fever, with evening rise of temperature, which subsides in the night associated with sweating. Patient will also have malaise, headache, loss of appetite and loss of weight. Patient looks emaciated.

Cough is usually present, associated with expectoration, which is progressive in nature. Sputum is yellowish, copious, viscid and foul smelling, more during morning hours. Hemoptysis is often reported.

Breathlessness is exertional and progressive. As the disease progresses, the patient becomes emaciated.

Complications

- Hemoptysis
- Spontaneous pneumothorax
- Pleural effusion
- Empyema
- Bronchiectasis
- Fibrosis of the lung
- Cor pulmonale
- TB meningitis
- Miliary TB.

Investigations

Following investigations are done:

- Sputum examination
- X-ray of the chest
- Tuberculin test
- ESR.

Sputum Examination

There are three tests:

1. *Direct smear microscopic examination:* Sputum examination for AFB is done by Zeihl-Neelson staining procedure. This is a simple, cheap, easy, reliable, confirmative and practical test. This helps to identify infectious cases of TB. Sputum smear microscopy for AFB is the 'Gold Standard' test for adults with pulmonary TB and not for children and it is the first-line of investigation.
2. *Concentration method:* If clinically tuberculosis is suspected and smear examination is negative for AFB in 2 or 3 slides, the sputum is centrifused and the sediment is examined for direct microscopy.
3. *Culture test:* Sputum culture for AFB can also be done. But this is not done as a routine because it requires 6 weeks for the organisms to grow. The culture media used is L-J media. This test is done only in district laboratories, regional chest clinic laboratories and National Tuberculosis Institute, Bengaluru, Karnataka, India. More than the diagnosis, it is necessary for carrying out sensitivity tests and to monitor drug treatment.

X-ray of the Chest

This is only a complimentary tool.

Limitations
- Expensive procedure
- Many other diseases resemble TB on X-ray
- Low yield of cases
- Examination of sputum is a must even if X-ray is positive
- Requires the services of a skilled person.

Tuberculin Test (Mantoux Test; PPD Test)

It is an intradermal, hypersensitivity test, discovered by Von Pirquet in 1907, to know whether the individual is infected or not. It may be present infection or past infection. This test has only limited value in India. The test is significant only among children below 2 years.

Test material is 'Tuberculin', a protein, derived from the body of 'RT-23' strain of TB bacilli, which is purified and standardized. It is called PPD-S (Purified Protein Derivative – Standardized). Tuberculin 1 unit of PPD-S contains 0.00002 mg of tuberculin antigen, which is routinely used for the test.

Procedure: 0.1 mL of 1TU of PPD-S is administered intradermally, with the help of tuberculin syringe on the flexor surface of the forearm so as to raise a wheal of 8 mm diameter and the result is read after 48 to 72 hours.

Result: The result consists of an hypersensitivity reaction, characterized by the development of erythema and induration. In tuberculin test induration is taken into consideration and not erythema (Erythema is taken into consideration in Schick test and lepromin test).

Interpretation of the Reaction

- *Negative:* The reaction is said to have become negative, if there is no induration or less than 6 mm in diameter. It indicates that the child is not infected so far and thus at a risk getting the infection and the disease. Therefore tuberculin-negative is an indication for BCG vaccination.
- *Nonspecific (or doubtful):* It is so called when the reaction (induration) is between 6 and 9 mm in diameter. It indicates present or past infection with tubercle bacilli. However, if a child below 2 years is found to be tuberculin positive, it is an indirect evidence of an active pathology in the body. Therefore, it is considered as a case. Thus, it is a diagnostic test only among children below 2 years.
- *Strongly positive:* The reaction is said to be strongly positive, when the diameter of induration is more than 20 mm. Such reactors are at a greater risk of getting the disease than those showing 10 mm induration.

Limitation of the test: A negative test does not rule out the disease because the negativity could be due to defect or suppression in the cell-mediated immunity as in severe malnutrition, malignancy, steroid therapy, HIV-infection and other viral infections such as measles, chickenpox.
- The test is not significant among adults.
- The test is positive among BCG vaccinated.
- Occasionally the test can become negative in a child with anti-TB treatment.

Blood examination for ESR and TC, DC are nonspecific investigations. However, ESR has got prognostic significance. In differential count, there is lymphocytosis.

Prevention and Control

According to WHO the disease, TB is said to have brought under 'control', when the prevalence of infection among children below 14 years, is reduced from the current rate of 40 percent to less than 1 percent.

The different control measures are:
A. Elimination of reservoirs
B. Breaking the channel of transmission
C. Protection of susceptibles.

Elimination of Reservoirs

This consists of early detection of cases and prompt treatment. Early diagnosis is very important in the control of TB because they can be treated early and made noninfectious and further spread can also be prevented.

The cardinal features of TB are persistent cough of more than 3 weeks duration, intermittent fever, loss of appetite, loss of weight, chest pain and hemoptysis. Diagnosis is confirmed by sputum microscopy examination and chest X-ray. Prompt treatment consists of giving effective chemotherapy.

Chemotherapy

Effective chemotherapy is the only means of controlling TB in the community.

Objectives of chemotherapy are:
- To make the infectious case noninfectious very soon
- To make the lesions sterile quickly and completely
- To prevent the development of complications, such as resistance and relapse
- To prevent further spread in the community
- To prevent death due to TB.

Principles of chemotherapy (To achieve the above objectives):
- Only those drugs are chosen, for which bacteriae are susceptible.
- Treatment must be started with a combination of 3 or 4 drugs because there are different groups of organisms such as persisters, intracellular, extracellular, rapid growers, slow multipliers, etc. So all the groups are attacked simultaneously.
- Treatment must be given completely and regularly,
- All drugs must be given before breakfast in single dose, because they are absorbed better,

- Single dose would be more effective than multiple doses in a day because that ensures peak concentration for a longer period.

Anti-TB drugs: The currently used drugs are grouped into 2 groups. First-line drugs and second-line drugs. First-line drugs are further grouped into bactericidal and bacteriostatic drugs. A combination of these are used.

First-Line Drugs

Bactericidal drugs: INH, rifampicin, pyrazinamide, streptomycin.

Bacteriostatic drugs: Ethambutol, thiacetazone.

Bactericidal drugs

- *INH (Isonicotinic acid hydrazide; isoniazed):* It is a most powerful bactericidal drugs. It is effective against both intracellular and extracellular bacilli. Its action is marked on rapidly multiplying bacilli. It is less active against slow multipliers.
  Dose: 5 mg/kg/day (or 300 mg/day). For intermittent therapy, the dose is 600 mg.
  Side effects are peripheral neuritis (common), gastrointestinal irritation, and major side effect is hepatitis (jaundice) but rare. Addition of pyridoxine (10-20 mg daily) prevents peripheral neuropathy.
  It is cheapest among the lot and very safe drug.
- *Rifampicin:* It is a powerful bactericidal drug. It is also effective against both intracellular and extracellular bacilli. It is the only drug among the lot active against 'persisters' or dormant bacilli, which are found in the solid caseous lesions. With INH, it makes an excellent combination.
  Dose: 10 mg/kg body wt/day (450–600 mg/day).
  Side effects: Major effect is hepatotoxicity, but rare. So it is discontinued if jaundice occurs. Other effects are flu-like illness (fever, arthralgia, malaise), rashes, etc.
  The patient is informed that with rifampicin, the urine becomes red-colored. It indicates that the patient is taking the drugs.
- *Pyrazinamide:* This bactericidal drug is active against slow multiplying intracellular bacilli. It is found to increase the effect of rifampicin.
  Dose: 30 mg per kg body wt (1500 mg per day).
  Complications are hepatitis, arthralgia and rarely gout.
- *Streptomycin:* It acts mainly on rapidly multiplying bacteriae, which are usually extracellular. It is less active against slow multipliers and has no action on persisters.
  Dose: 0.75 to 1.0 g per day, single dose a day, intramuscularly.
  Main side effect is vestibular damage, characterized by ringing in the ears, giddiness and ataxia. Occasionally, it causes hypersensitivity reaction. Streptomycin is never recommended during pregnancy because it can cause permanent deafness in the fetus.

Bacteriostatic drugs

- *Ethambutol:* This is effective in combination with any of the bactericidal drug. The combination prevents drug resistance.
  Dose: 15 mg per kg body weight (800 mg a day) and 1200 mg for intermittent therapy.
  Common complication is blurring of vision. Major effect is retrobulbar neuritis. This has replaced para amino salicylic acid (PAS).
- *Thioacetazone:* This is also effective in combination with INH.
  Dose: 2 mg per kg wt per day (150 mg a day)
  Complications are gastrointestinal disturbances, hepatitis, blurring of vision, etc. This is not given for HIV positive with TB because it results in fatal reactions such as cutaneous hemorrhages. Thioacetazone is the only drug not effective when given intermittently. Another reason why thiacetazone is not recommended is that the margin is too narrow between the therapeutic dose and the toxic dose.

Second-Line Drugs

These are used in drug resistant cases or where first-line drugs cannot be used due to toxicity or other constraints. These are ethionamide, prothionamide, cycloserine, kanamycin, viomyein, ofloxacin and capreomycin. But they are not giving promising results. These reserve drugs are very costly, not available and least effective.

Phases of Chemotherapy

The treatment is given in two phases. Namely intensive phase and continuation phase.

Intensive Phase

This is the initial phase started early in the course of the treatment, lasts for 2 to 3 months. It is called 'Intensive phase' because treatment is started intensively or aggressively, using 3 or more drugs simultaneously to destroy rapidly multiplying organisms so that the sputum becomes negative for AFB within 2 weeks. The different groups of TB bacilli are also attacked simultaneously. The more rapidly the bacilli are killed initially, the less likely are the 'persisters' to emerge. Thus the relapse, treatment failure, and the development of resistance is prevented. Transmission is also brought under control very soon. Risk of drug resistance is high during the initial phase if multiple drugs are not given.

Continuation Phase

This is the next, maintenance phase lasting for about 6 to 8 months under short course chemotherapy, when 2 or 3 drugs are given. During this phase the remaining bacilli are all destroyed resulting in total cure of the disease.

Domiciliary Treatment

This means self consumption of anti-TB drugs (generally oral drugs) by the patients, without getting admitted to the hospital. Domiciliary treatment is not only as effective as institutional treatment, but also in the long run works out to be economical. Thus sanatorium approach of managing the cases, fell into disuse. Domiciliary treatment is also called as 'Ambulatory treatment'. Streptomycin is not included under domiciliary treatment, because it is given intramuscularly and requires the help of a doctor or a nurse.

Studies have also shown that domiciliary treatment does not pose a hazard to the family members, because all the harm an index case could do, has already been done before it was diagnosed so that subsequent isolation is not helpful and since the patients under adequate chemotherapy become noninfectious very soon. However, hospitalization is necessary under the following circumstances.

- Those who develop serious extrapulmonary TB such as TB meningitis, massive effusion (pleurisy)
- Those who have developed complications like hemoptysis, spontaneous hemothorax, etc.
- Those TB patients who require surgery such as lobectomy, pneumonectomy, etc.
- Those who are socioeconomically deprived and destituted.

Treatment Regimens

Long course, conventional chemotherapy and short course chemotherapy.

Conventional long course chemotherapy: It was also called 'Standard Regimen'.

This was practiced till 1972. It consisted of administration of drugs for 18 to 24 months, out of which first three months was with streptomycin + INH followed by either of the following regimens for the remaining period.

INH + thioacetazone or INH + PAS or INH + ethambutol.

But because of the long duration of treatment, patients were not taking correctly and completely resulting in relapses, treatment failure and development of resistance and complications. Cure rate was less than 50 percent. Now this is outdated.

Short Course Chemotherapy

In 1972, Wallace Fox and his colleagues from British Medical Research Council showed that addition of Rifampicin and Pyrazinamide to the regimen containing INH would reduce the duration of treatment from 18 months to hardly 6 to 8 months. Hence the name short course chemotherapy. Thus introduction of rifampicin and pyrazinamide has opened a new avenue in the control of TB.

The drugs are given in two phases – initial intensive phase of 2 months with 3 or 4 drugs followed by continuation phase, given daily or bi-weekly (i.e. intermittent regimen) with 2 or 3 drugs for the remaining 4 to 6 months.

Short course chemotherapy (SCC) is centered around INH and rifampicin.

In intermittent regimen, the dosage of the drugs is almost double the daily dose.

Different regimens under SCC are:

- 2 RHSZ + 4 HR
- 2 RHSZ + 4 H2R2
- 2 RHZ + 4 HR
- 2 RHSZ + 5 S2H2Z2
- 2 RHSZ + 6 HR
- 6 R3H3S3Z3

Note:

1. Prefix number indicates the number of months for that regimen.
2. Suffix number indicates the frequency of administration in a week.
3. No suffix means given daily.

Advantages of Short Course Chemotherapy (Compared to Long Course Chemotherapy)

- Duration of treatment is short.
- Rapid bacteriological conversion (Infectivity is reduced within 48 hours and the patient becomes noninfectious within 2 weeks)
- Failure rate is very low (Cure rate is very high)
- Risk of development of resistance is minimum
- No chances of relapse
- It improves the patient-drug compliance
- It is cost-effective.

Disadvantage

The only disadvantage is that it is a costly regimen. But under the national program it is supplied free of cost (SCC is standardized and simplified under RNTCP).

Breaking the Channel of Transmission

This is done by concurrent disinfection of sputum mainly and also the belongings of the patient, (such as linen, utensils, etc.) as long as the patient is in the hospital. Sputum has to be collected in a sputum-cup, half filled with disinfectant like 5 percent cresol or 8 percent bleaching powder or sputum is received in paper handkerchiefs and disposed off by burning and burial.

The patients are also advised to avoid indiscriminate spitting of sputum.

Protection of Susceptibles

Protection of susceptibles by general measures and specific measures.

General Measures

General measures are health promotion and heath education.

- *Health promotion:* Improvement in the general health of an individual improves the resisting capacity and the general health can be improved by improving the living condition with good lighting and ventilation, personal hygiene, good food, adequate nutrition, exercise, recreation facilities, etc. The promotion of health not only protects against TB but also against many communicable diseases. This is how these disease have come down in the developed countries.
- *Health education:* People are made aware of the mode of transmission of the TB disease, hazards of the disease and the availability of the free treatment. They are also educated to protect their children with BCG vaccine. TB patients are educated to take the treatment correctly and completely with regular follow-up.

Specific Measures

Specific measure is by BCG vaccination.

Two French scientists namely Calmette and Guerin (1906) prepared a vaccine by culturing and subculturing repeatedly bovine strain of TB bacilli 230 times over a period of 13 years and ultimately in 1919, they were able to evolve a strain which retained its antigenicity and lost its pathogenecity, thus capable of providing immunity, when administered in the form of vaccine. Thus the vaccine was named after them (Bacille Calmette Guerin).

This was first used orally during 1921 to 1925. First time it was given intradermally during 1921. WHO has recommended to use 'Danish-1331' strain to prepare the vaccine. In India it is manufactured at Guindy, Chennai, and Serum Institute, Pune, Maharashtra.

BCG Vaccine

Nature

It is a live, bacterial, freeze – dried vaccine.

It contains live attenuated, bovine strain (Danish 1331) of TB bacilli. Thus bovine strain is employed to protect against human strain, a good example of cross-immunity. It is used to protect the children against childhood type of TB such as TB meningitis and military TB. However, it does not protect the children against adult type of TB **(Fig. 20.25)**.

Indication

For active immunization of children against TB.

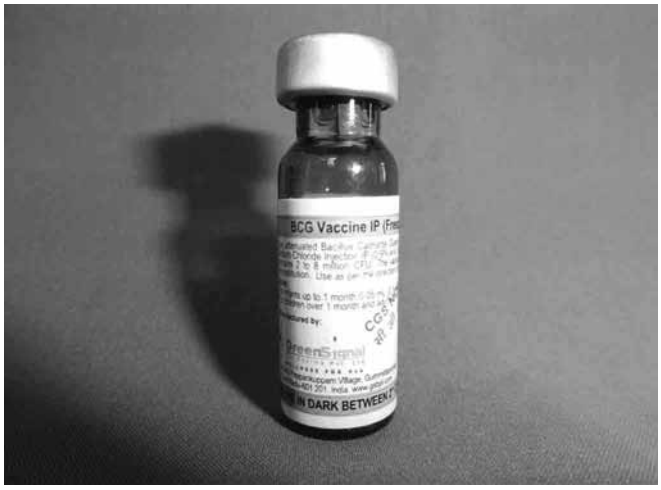


Fig. 20.25 BCG vaccine

Diluent

Since BCG vaccine is a freeze-dried vaccine it is always supplied alongwith sterile normal saline. It is used within 3 hours of reconstitution.

Dose

0.05 mL for the newborn because skin is thin and 0.1 mL for an infant above 1 month.

Route

The vaccine is administered intradermally, using 'Tuberculin-syringe' on the upper outer aspect of left arm above the insertion of the deltoid. This region is preferred for administrative reasons. The vaccine should not be given intramuscularly or subcutaneously because of the complications such as regional lymphadenitis or abscess.

Schedule

It is recommended to be given to children as early as at birth, because infection with atypical TB bacilli can interfere with the development of immunity. However, it can be given alongwith DPT and OPV during 6th week, but in different site. Earlier the better.

Immunity

Starts from 15 days and lasts for about 15 years.

Protective value: Varies from 0 to 80 percent.

Phenomena after vaccination: Wheel of 5 mm diameter at the time of injection.

First	2 weeks	- No reaction seen
During	3rd week	- Papule
	4th week	- Vesicle

5th week - Pustule
6th week - Ulcer
7th week - Crust formation
8th week - Scar

The vaccinated scar is about 4 to 8 mm in diameter, circular, superficial, shiny and permanent. Overdosage can result in irregular and larger scar. BCG vaccinated individual becomes Mantoux positive.

Complications

Local – Abscess, ulcers, keloid.
Regional – Axillary lymphadenitis.
General – Disseminated BCG infection, tetanus.

These complications can be avoided by giving the vaccine strictly intradermally and no other injection should be given for at least 6 months in the same site of vaccination, because BCG may not be well taken up.

Contraindications—infantile eczema, acute febrile disease, infective dermatosis, keloid, steroid therapy and HIV positive child.

Storage of the vaccine: 2 to 8°C.

Direct BCG vaccination: This consist of giving BCG vaccine to the child without a prior tuberculin test. This was carried out under National TB control program. This used to permit a more rapid and complete coverage of the children population and also no adverse effect can occur even if BCG vaccine is given to tuberculin positive reactors. Now under UIP, BCG is given at birth.

Limitation of BCG vaccination: BCG vaccination is less effective in controlling TB because of the partial protection and varying protective value. So the disease can be better controlled by active case finding and prompt chemotherapy.

Drug resistance: It is of two types – Primary and Secondary.

Primary resistance (Pretreatment resistance): It is the presence of resistance in a TB patient much before the chemotherapy is started. Either it could be due to the infection with the resistant strain or it could be due to the appearance of new mutants while the bacilli are multiplying. In this type, usually there is resistance to only one drug.

Secondary resistance (Acquired or Post-treatment resistance): In this type, the organisms develop resistance during the course of the treatment due to intake of drugs irregularly, incompletely and inadequately.

The resistance could be due to one or more drugs.

Newer Anti-TB Drugs

- *Rifabutin:* It is a derivative of rifampicin. It is four times more active than rifampicin.
  Dose—300 mg orally once daily.
- *Rifapentine:* It is also 3 to 4 times more potent than RMP. But it has cross resistance with rifampicin. Therefore, it cannot be used for the treatment of RMP resistant cases.
- *Macrolides:*
  - Roxithromycin is effective.
  - Clarithromycin and azithromycin are effective against MAC disease (i.e. caused by *M. avium* and *intracellulare*). The infection with these occurs among HIV positives when CD4 count becomes less than 200. Therefore, these two drugs are used in the treatment and prophylaxis against MAC disease among HIV-positives. Dose 500 to 1000 mg bid.
- *Amikacin:* It is an aminoglycoside. Dose—15 mg/kg wt in two divided doses. It has oto and nephrotoxicity.
- *Fluoroquinolones*: They penetrate and concentrate in macrophages where MDR-TB bacilli survive and multiply. Hence, they are highly effective and least toxic. Therefore, they must be reserved as second-line anti-TB drugs and not to be used among uncomplicated TB patients and in a respiratory condition where TB is a possibility.
  Dose—Ciprofloxacin – 500 to 750 mg bid.
  Ofloxacin – 400 mg bid.
  Sparfloxacin – 400 mg OD.
- β-*lactum antibiotics:* Trials are going on with amoxycillin clavulanic acid.
- *Clofazimine:* Dose 100 to 300 mg OD. It causes brownish discoloration of skin and body fluids.
- *Paromomycin:* It is useful in MAC-disease.
- *Cytokine immunotherapy:*
  - *Cytokine IL-2:* It may kill infected macrophage through activation of lymphocyte activated killer cell.
  - *Cytokine gamma interferon:* It inhibits intracellular bacilli.
  - *Cytokine IL-12:* Stimulates natural killer cells.

Review on National Tuberculosis Control Program

Since TB affected the socioeconomic development of the country, Government of India, launched NTCP in 1962-itself with the following objectives:

- *Short-term objectives:*
  - To detect maximum number of TB cases and give them effective treatment.
  - To vaccinate all newborns and infants with BCG vaccine.
- *Long-term objective:* To reduce the prevalence of TB infection among children below 14 years of age to less than 1 percent, which was then about 30 percent.

Because of the gigantic task of detection of cases and giving conventional treatment for 18 to 24 months, National Tuberculosis Institute (NTI) Bengaluru, in 1962, recommended that the basic functional unit of national program should be District Tuberculosis Program and thus District TB Center (DTC) became the structural and functional unit of NTCP.

The functions of District TB Control Program were as follows:

- *Case finding:* Cases of TB were detected 'Actively' by the health workers by taking single sputum smears from those who were having cough with expectoration of more than 2 to 3 weeks and sending smears to PHC laboratory. As a result case detection rate went up from 31 percent in 1962 to 51 percent in 1988.
- *Treatment:* After registering the sputum smear positive cases, patients were instructed to collect the drugs for the month, regularly, on a 'Fixed day', for 18 to 24 months.

  Short course chemotherapy (SCC) was introduced in 1972, which opened a new avenue in the control of TB in the country.
- *BCG vaccination:* This was carried out systematically by the vaccinators as 'Mass BCG Vaccination'. Ever since BCG vaccination was included under UIP (since 1985) it was dropped by vaccinators. However, immunization coverage went up gradually.
- *Recording and reporting:* The sputum positive cases were registered by the Medical Officer of the PHC alongwith the identification data (address) and treatment used to be given.

  Reporting used to be done by sending weekly report to District TB center. Even nil report were also sent.
- *Supervision:* This was done by District TB team by visiting the PHCs periodically and guiding and supervising the program activities, keeping drugs moving and proper work.

Revised National Tuberculosis Control Program

In 1992, the NTCP was reviewed and it was observed that there was no improvement in the extent of TB problem in the country. On the other hand, there was increased incidence of MDR-TB cases and also the emergence of HIV infection made the situation still worst.

It was concluded that NTCP was a failure one due to following reasons:

- Low quality microscopy (single smear examination)
- Case detection was very low, eventhough it went up from 31 to 51 percent
- Over reliance on clinical and radiological diagnosis.
- More emphasis was laid on the case detection rather than cure
- Response from the patients was poor, to come and collect the drugs, because of long duration of treatment, side-effects, ignorance, negligence, etc. (Treatment completion rate was less than 30%)
- Budgetary outlay was inadequate
- Drug supply was also not regular and adequate (Shortage)
- Treatment regimens were many (multiplicity of regimens) and not standardized
- Case holding was poor; (follow-up was not regular)
- Cure rate was very low (Hardly 25%)
- Increased incidence of MDR-TB cases.

After reviewing the program, (1992) Government of India, WHO and World Bank together concluded that the program must be revised and intensified by overcoming all the above mentioned lacunaes, for which the following recommendations were made.

- Case finding must be 'Passive' (and not by active means) by Quality sputum microscopy of 2 sputa smear examinations.
- Systematic registration of the cases.
- Categorization of the TB cases into 2 types since January 2010.
- Standardization of the treatment regimens accordingly.
- Only intermittent regimen and not daily regimen.
- Entire course of drugs must be ensured free of cost by patient-wise boxes before the commencement of treatment.
- Treatment given must be ensured by direct observation of consumption of the drugs by the treatment observer.
- Regular follow-up of the patients by sputum smear examinations.
- Provision of services at a health facility close to patients home.
- Evaluation of treatment outcome by the Health worker.
- Effective health education.

Meanwhile in 1993, because of emergence of HIV pandemic and increased incidence of MDR-TB cases, WHO declared tuberculosis as 'Global Emergency.'

Therefore in 1993, Government of India intensified and revised the NTCP and renamed and launched as 'Revised National Tuberculosis Control Program' **(Table 20.10)**. It was launched in 1993 as a pilot project and expanded in 1997, with a plan to cover the entire country by 2004, in a phased manner, with the following twin objectives.

- Detection of at least 70 percent of estimated cases through Quality sputum microscopy (estimated prevalence of infectious cases is 4/1000 population, i.e. 4 millions out of 100 crores)
- Achievement of at least 85 percent cure rate among newly detected sputum smear positive infectious cases.

Strategies

To achieve the above objectives:

- Directly observed treatment short course chemotherapy (DOTS).
- Involvement of nongovernmental organizations.
- IEC (Information Education and Communication) activities and improved operational research.

During first phase 2.35 million population was covered and the program was successful. So during second phase 13.85 million population was covered. During third phase

Table 20.10 Differences between NTP and RNTCP

Sl. no.	NTP	RNTCP
1.	It is National TB Control Program	It is Revised National TB Control Program
2.	Launced in 1962 in all the states of the country simultaneously. The objective was case detection and treatment	Objective is 70% case detection and 85% cure rate. Launched in 1993 in a phased manner and expanded in 1997. Strategy is DOTS
3.	District TB center was the functional unit	Tuberculosis unit is the functional unit.
4.	Case finding was 'active' by the health worker	Case finding is 'passive' by quality microscopy.
5.	Only one sputum smear examination used to be done	Minimum two sputum examination is a must (Spot-morning)
6.	Patients were not categorized for treatment purposes	Patients are categorized into two types for treatment purposes
7.	Treatment regimens were many	Treatment regimens are standardized
8.	Chemotherapy was not supervised	Chemotherapy is supervised by DOTs-agent
9.	Drug supply was not regular	Drug supply is ensured before beginning the treatment by 'patientwise' boxes
10.	Follow-up was not regular	Follow-up is regular
11.	Case detection rate and success rate was less than 50%	Case detection rate is more than 85% of estimated cases and success rate is more than 85%
12.	Incidence of MDR cases was very high	Incidence of MDR cases has become low
13.	Monitoring, supervision and accountability was not efficient	Monitoring, supervision and accountability is done at all levels efficiently

271.21 million population was covered. By 2002 half of the country and by 2004-05 entire country to be covered.

Directly Observed Treatment-Short Course

It is Directly Observed Treatment of Short Course chemotherapy (DOTS), identified as the 'KEY' strategy to control TB under Revised National Tuberculosis Control Program (RNTCP), which was launched in 1993 and expanded in 1997.

DOTS has 5 components **(Fig. 20.26)**.

- Political commitment.
- Diagnosis by quality microscopy.
- Adequate and uninterrupted supply of good quality drugs.
- Directly observed treatment.
- Accountability.

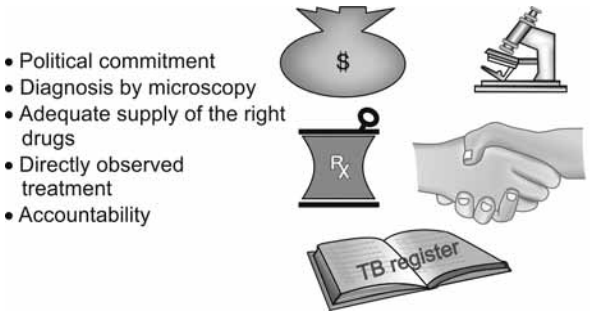
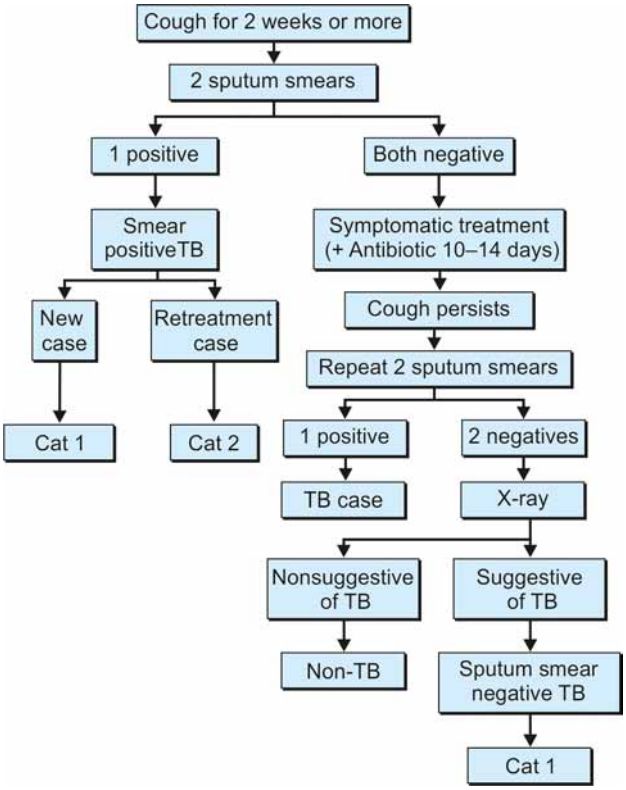


Fig. 20.26 The DOTS strategy

1. *Political commitment:* In 1997, Government of India obtained a 'soft' loan from World Bank an amount of US $ 142 million for implementation of RNTCP. It also consists of celebration of World TB Day on 24th March of every year by conducting rally, specially by TB cured patients, to create awareness among the people.
2. *Diagnosis by quality microscopy:* Under RNTCP, the case finding is 'Passive' and not 'active' as in the previous NTCP (i.e. cases were found by health workers). On the other hand, TB has to be thought of and ruled out by the physician among those, who come with persistent cough of 2 weeks duration by screening them through 2 sputum smear examinations by a technician who is specially trained in National TB Institute, Bengaluru. The examination is done in designated RNTCP microscopy centers. Two sputum smear examinations is a must under RNTCP, since 1 April, 2009.

With one sample of sputum, the chances of detecting smear positive case is 80 percent and it is 93 percent with two samples and 100 percent with three samples. Since the secretions build up in the airways overnight, the early morning sample is more likely to contain the bacilli. Since it is difficult for an outpatient to provide three early morning specimens, 'Spot-Morning-Two' samples are collected. That means a sample of sputum is collected on the spot when the patient attends the outpatient department and is then given a cup to collect the sputum of next day morning. The diagnostic algorithm is shown in **Flow chart 20.1**.

Flow chart 20.1 Diagnostic algorithm of pulmonary TB



Sputum microscopy not only confirms the diagnosis, but also helps in assessing the prognosis. The smears are graded as, 1+ if there are 1 to 9 bacilli/10 fields (< 1/freid) and 2+ if there are 1 to 9/field and 3+ if more than 10 bacilli/field.

Sputum smear microscopy is more objective and reliable than X-ray of chest. It is 98 percent specific than X-ray.

X-ray chest is only a complimentary tool. Nearly 50 percent of the persons with X-rays suggestive of TB do not have TB. Over reliance on X-ray for TB diagnosis is an example of unwarranted treatment and avoidable expenditure. It also results in inability to categorize the patient by distinguishing between smear +ve and smear –ve patients, failure to give appropriate treatment, improper monitoring ultimately resulting in lower cure rates and increased spread of TB.

Changes in Revised National Tuberculosis Control Program Policy

On diagnosis of smear positive pulmonary TB (effective from 1st April 2009)

- A pulmonary TB suspect is any person with cough for 2 weeks or more.
- The number of sputum smear specimens to be examined for screening of TB cases is reduced from three to two, in places where workload is very high and human resources are limited; specimens being collected over one or two consecutive days and one of them being a morning sputum specimen. Results should be reported within a day.
- Presence of even a single acid-fast bacillus (AFB) in at least one sputum sample in countries with a well functioning External Quality Assessment (EQA) system, is considered as a new sputum smear positive pulmonary TB case.
- One specimen positive out of the two is enough to declare a patient as smear positive TB. Smear positive TB is further classified as a new or retreatment case based on their previous treatment history and appropriate therapy is prescribed. Patients in whom both the specimens are smear negative should be prescribed symptomatic treatment and broad spectrum antibiotics for 10 to 14 days. In such cases antibiotics such as fluroquinolones (Ciprofloxacin, Ofloxacin, etc.), Rifampicin or streptomycin, which are effective against tuberculosis, should not be used. If the symptoms persist after a course of broad spectrum antibiotics repeat sputum smear examination (2 samples) must be done for such patients. If one or both smears are positive, the patient is diagnosed as having smear positive pulmonary TB. If both smears are negative, a chest X-ray is taken and if the findings are consistent with pulmonary TB, patient is diagnosed as a case of sputum negative pulmonary TB.
- Since January 2010, TB patients are categorized into only two, Cat I and II.

Points on Revised National Tuberculosis Control Program Treatment

- After confirmation of the disease, the patients are 'Categorized' into two categories and treatment is given accordingly **(Table 20.11)**. Treatment is standardized and simplified according to the category of patients.
- The treatment regimen recommended under RNTCP is 'Intermittent Regimen', given thrice weekly.
- The regimens are scientifically proven and highly effective. The respective colors indicate patientwise boxes **(Fig. 20.27)**.

Category of treatment	Type of patient	Regimen
Category I	New sputum smear-positive Seriously ill sputum smear-negative Seriously ill extrapulmonary	$2(HRZE)_3$/ $4(HR)_3$
Category II	Previously treated Sputum smear-positive relapse Sputum smear-positive failure Sputum smear-positive treatment After default Others	$2(HRZES)_3$/ $1(HRZE)_3$/ $5(HRE)_3$

Fig. 20.27 Treatment regimens under the RNTCP

Table 20.11 Color coded boxes, categories/groups, type of TB patients, the regimens and their follow-up

Categorization of TB Patients (wef January 2010) Treatment regimen					Sputum examination			
Color of the box	**Treatment group**	**Type of patient**	**Intensive phase†**	**Continuation phase†**	**Pre-treatment**	**Test at month**	**If result is**	**→ Then**
Red	New* (category I)	Sputum smear positive Sputum smear negative Extrapulmonary	$2(HRZE)_3$	$4(HR)_3$	+	2	–	Start continuation phase, test sputum again at 4 and 6 months*
					–	2	+	Continue intensive phase for one more month. Test sputum again at 3, 5 and 7 months.*
Blue	Previously treated** (category (II)	Smear positive relapse Smear positive failure Smear positive Treatment after default Others***	$2(HRZES)_3$ $1(HRZE)_3$	$5(HRE)_3$	+	3	–	Start continuation phase. Test sputum again at 5 and 8 months
							+	Continue intensive phase for one more month. Test sputum again at 4, 6 and 9 months

* 'New' includes former categories of I and III and the box is Red colored.
** 'Previously treated' is former category II and the box is Blue colored.
*** 'Others' includes those patients who are sputum smear negative (pulmonary or extrapulmonary), and have recurrence or nonresponse (relapse or failure), diagnosis being based on culture or histological evidence of current active TB. They are given treatment as Cat. II
† The number before the letters refers to the number of months of treatment. Suffix number refers to the number of doses per week (i.e. thrice a week)
Dose (thrice week). H = INH 600 mg; R = Rifampicin 450 mg; Z = Pyrazinamide 1500 mg; E = Ethambutol 1200 mg and S =Streptomycin 750 mg.
Patients weighing less than 30 kg, receive drugs as per pediatric weight band boxes according to body weight.
* Patients whose sputum is negative to start with and becomes positive during continuation phase or whose sputum remains positive at the end of the treatment in Cat. I, should be considered as 'Failure' and put on Cat. II treatment afresh.

Note: It is very important to elicit history of previous treatment for tuberculosis. It helps in defining the case, to identify the cases with increased risk of acquiring drug resistance and to prescribe appropriate treatment.

Medication

Medication	Dose (thrice a week)***	Number of pills in combipack
Isoniazid	600 mg	2
Rifampicin	450 mg*	1
Pyrazinamide	1500 mg	2
Ethambutol	1200 mg	2
Streptomycin	0.75 g**	–

* Patients who weigh 60 kg or more at the start of treatment are given an extra 150 mg dose of rifampicin
** Patients ever 50 years of age and those who weigh less than 30 kg are given 0.5 g of streptomycin.
*** Adult patients who weigh less than 30 kg receive drugs in patient wise boxes from the weight band suggested for pediatric patients.

Phases and duration of treatment

Category	Duration (number of doses)		Total
	Intensive phase (IP)	Continuation phase (CP)	
Category I	8 weeks (24 doses)	18 weeks (54 doses)	30 weeks (78 doses)
Category II	12 weeks (36 doses)	22 weeks (66 doses)	34 weeks (102 doses)

Duration if sputum is positive at the end of intensive phase*

Category	Duration (number of doses)		Total
	Intensive phase (IP)	Continuation phase (CP)	
Category I	12 weeks (36 doses)	18 weeks (54 doses)	30 weeks (90 doses)
Category II	16 weeks (48 doses)	22 weeks (66 doses)	38 weeks (114 doses)

* Category I: At the end of 2 months Category II: At the end of 3 months

Regimen for non-DOTS in RNTCP areas

Treatment	Type of patient	Regimen
Non-DOTS regimen 1 (ND 1)	New smear-positive pulmonary seriously ill sputum smear-negative Seriously ill extrapulmonary	2 SHE + 10 HE
Non-DOTS regimen 2 (ND 2)	Smear-negative pulmonary, not seriously ill Extrapulmonary, not seriously ill	12 HE

In RNTCP areas, less then 5% of patients may get non-DOTS treatment

- The doses for Int. Regimen are INH = 600 mg, RMP = 450 mg, Z = 1500 mg, E = 1200 mg and S = 750 mg intramuscularly.
- Patients weighing more than 60 kg are given extra 150 mg of rifampicin.
- Patients aged more than 50 years and those weighing less than 40 kg are given 0.5 g of streptomycin.
- WHO has included one more category, which includes 'Chronic' cases, means those patients of Category II, whose sputum remains positive even at the end of a supervised retreatment regimen. Such cases are referred to chest specialists and treated with second-line of drugs daily for 2 years.
- Pyrazinamide is used only in the initial intensive phase, because it has its maximum bactericidal action within the first two months. Its use in the continuation phase is not necessary. There is less benefit from longer use.
- Pyrazinamide and rifampicin are contraindicated for TB patients with liver disease (jaundice). The regimen for such patients is 2 SHE/6HE.
- Intermittnet regimen is as effective as daily regimen. Therefore it has less toxicity and is economical.
- It provides 95 percent relapse free, cure rate.
- It facilitates observation and less adverse reactions.
- It reduces not only total drugs consumed but also number of patient visits.
- It prevents concealed irregularity.
- It results in less adverse reactions.
- It is less expensive.

Some Important Definitions Under Revised National Tuberculosis Control Program

- *New sputum smear positive cases:* A sputum smear positive patient who had never taken treatment for TB or has taken anti-TB drugs for less than one month.
- *Cured:* This refers to only new sputum smear positive patients. Initially a new sputum smear positive TB patient who has completed the treatment and has become sputum smear negative at or one month prior to the completion of the treatment.
- *Treatment completed:* Initially a sputum smear positive case who has completed the treatment with negative smear at the end of intensive phase but sputum results are not available subsequently or a sputum smear negative TB patient who has received a full course of treatment and has not become smear positive during or at the end of treatment or an extrapulmonary TB patient who has received a full course of treatment and has not become smear positive during or at the end of treatment.
- *Relapse case:* Is a one who has been declared 'cured' of pulmonary TB by a physician but comes back to the health services and is found to be sputum positive.
- *Treatment after default:* Is a case of TB who has taken treatment for one month or more but definitely not more than 2 months and is found to be sputum positive.
- *Failure case:* This is one who has remained sputum smear positive at 5 months or more after starting the treatment. Failure also includes a patient who was smear negative to startwith but becomes positive during the course of the treatment.
- *Chronic case:* A TB patient who remains smear positive after completing a retreatment regimen.

3. *Adequate supply of drugs:* The entire course of drugs supply is ensured free of cost, under RNTCP before beginning the treatment, thus ensuring regular supply without interruption. The drugs are supplied as 'Patient-wise' boxes, colored red, and blue for Category I and II respectively, containing full course of treatment

Seriously ill extrapulmonary TB	Not seriously ill extrapulmonary TB
• Meningitis	• Lymph node
• Miliary	• Unilateral mild or moderate pleural effusion
• Pericarditis, Peritonitis	• Bone (excluding spine)
• Bilateral pleural effusion	• Peripheral joint
• Unilateral extensive pleural effusion	• Adrenal gland
• Spinal, Intestinal, Genitourinary	
• Coinfection with HIV	

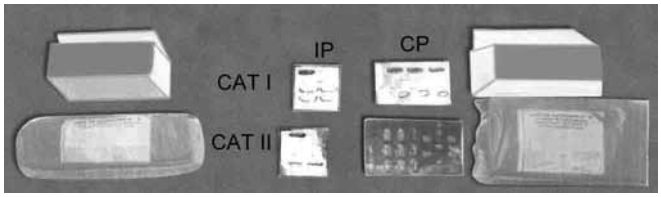


Fig. 20.28 Patient/categorywise colored boxes

(Fig. 20.28). Each box has 2 chambers, the smaller containing drugs of intensive phase and the larger containing drugs of continuation phase.

In these boxes medications for the entire duration of treatment is earmarked for every patient registered. This ensures the availability of the full course of medication to the patient the moment he/she is registered for treatment. Patientwise drug boxes have helped to improve patient care, adherence, drug supply and drug stock management. Under RNTCP, padiatric patientwise boxes are also available for children. These boxes are also used for adult patients with body weight less than 30 kg.

4. *Directly observed treatment (DOT)*: It envisages the direct observation, watching and supporting the patient swallowing every dose of anti-TB drugs, all at a time, preferably in empty stomach in the intensive phase and only the first dose of the week during the continuation phase, by the treatment observer, (health worker) known as 'DOTS-agents.' These agents are, accessible and acceptable to the patients and accountable to the health system, such as teachers, anganwadi-workers, social-workers, ex-patients, members of nongovernmental organization, etc. They are paid an incentive of ₹ 250 per patient completing the treatment. Family members are not effective DOTS-agents **(Fig. 20.29)**.

The drugs are packed in blister packs. For the intensive phase, each blister pack contains one day's medication. For the continuation phase each blister pack contains one week's supply of medication. The combipack for extension of intensive phase are supplied separately (Prolongation pouches). The consumption of medicine in the continuation phase is also checked by return of multiblister combipack, when the patient comes to collect medicine for the next week. Follow-up is done by the health system. The follow-up of smear positive and smear negative TB patients is shown in **Flow chart 20.2**.

Fig. 20.29 A DOTS agent giving medicine

Thus DOT is a community based, supervised, anti TB-treatment care strategy. It ensures that the patient takes Right drugs, in Right dose, at Right interval for the Right duration. DOT not only ensures 95 percent relapse free cure rate but also prevents MDR. It also builds a human bond between the health care provider and the patient. DOT is not only just supervising the swallowing of drugs by the patient, but also it is a mechanism to support the patient and help him/her to complete the treatment. Direct observation ensures adherence to drugs. More than 4 lakhs have been identified as DOT providers in the country.

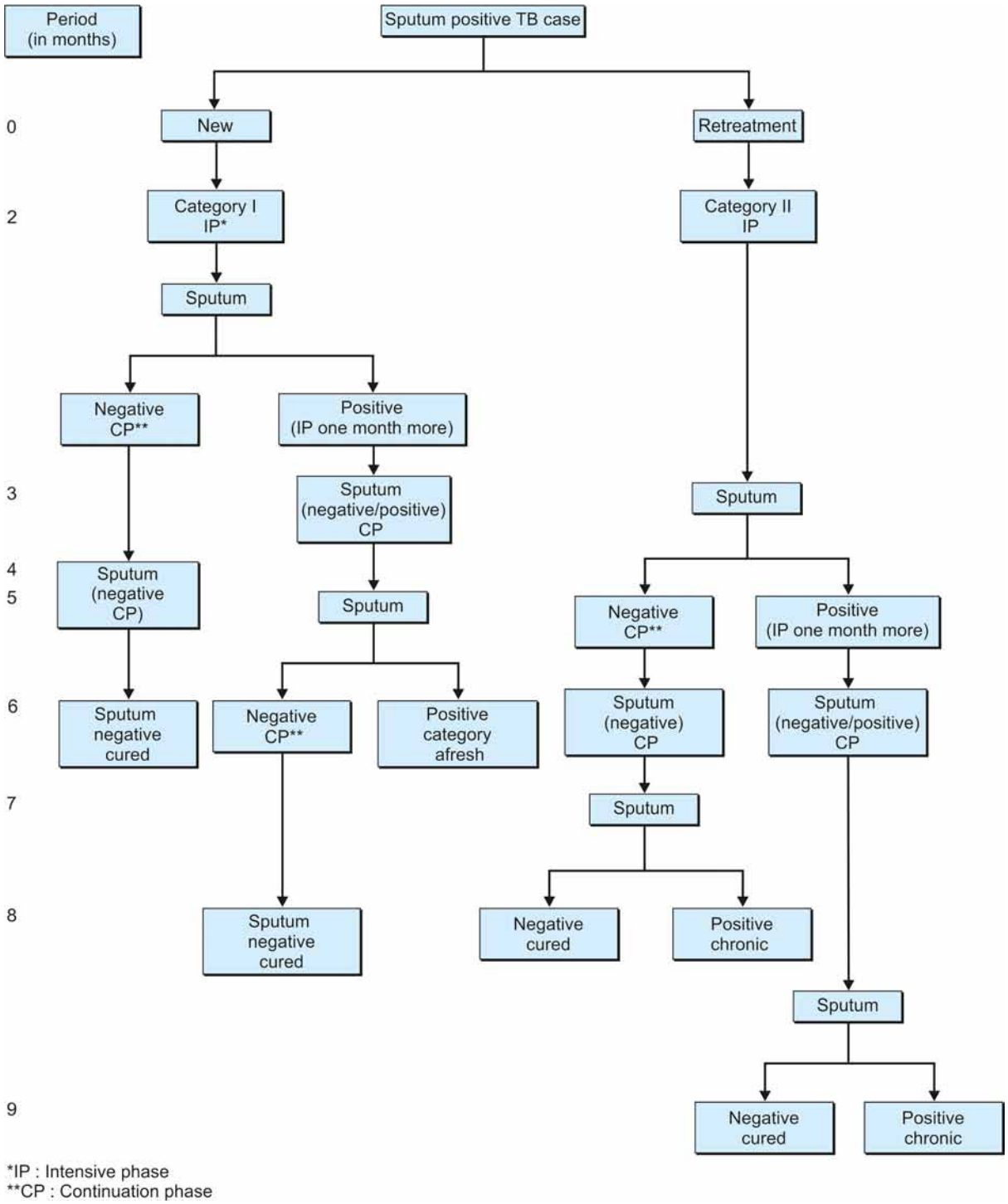
Since DOTS involves provision of basic, essential, utilitarian service starting by the people, of the people and for the people, it is a classical example of 'Community participation' of primary health care (Democratization of health service).

DOTS is the only cost-effective strategy proved to be effective in controlling TB on a mass basis. Therefore DOTS is internationally accepted. 'DOTS-strategy represents the most important public health break-through of the decade in terms of lives, which can be saved'- Director General of WHO March 24, 1997.

India has become the second largest country in the world in terms of population coverage under DOTS.

Thus with diagnostic facilities, case detection rate is very much improved and with DOT the success rate is also increased to 86 percent compared to 25 percent of the previous program.

Flow chart 20.2 Treatment and follow-up smear-positive cases



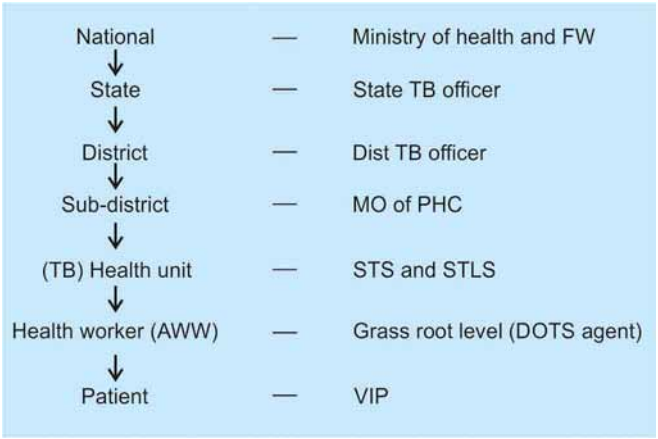


Fig. 20.30 Accountability at various levels

DOTS-Plus is a strategy for the diagnosis, management and treatment of multidrug resistant TB cases.

It is currently under development.

5. *Accountability:* RNTCP ensures systematic monitoring, supervision and accountability at every level **(Fig. 20.30)**.

Each level must do its part to ensure cure of the patient and to break the chain of its transmission. For the exclusive purpose of supervision and monitoring of TB control activities, RNTCP creates a sub-district level 'Tuberculosis Unit (TU)'.

A TB unit covers a population of about 5 lakhs. It is staffed by one Senior Treatment Supervisor (STS) and one Senior TB Laboratory Supervisor (STLS). A designated Medical Officer supervises the work of the TB unit in addition to his/her other responsibilities.

Functions of Tuberculosis Unit

- Maintains TB register which contains information on the diagnosis and treatment of every patient.
- Ensures effective diagnosis by microscopy and treatment by directly observed treatment.
- Completes quarterly reports on diagnosis, sputum conversion, treatment outcome and program management.
  - *On diagnosis:* To achieve at least 70 percent case detection rate, 5 microscopy centers are established, at the rate of 1 per lakh under each TU. They are located either in Community Health Center, Primary Health Center, Taluka hospitals or in the TB dispensary. Each center has a trained technician. The STLS supervises 5 such centers. He rechecks all the positive and 10 percent of the negative slides of these five microscopy centers. So the error in diagnosing a patient is minimized.
  - *On sputum conversion:* Target is 90 percent conversion of new smear-positive cases to negative by 3rd month of treatment. A sputum conversion rate of less than 80 percent indicates serious problems and a need for intensive supervision. Thus it is viewed seriously.
  - *On treatment outcome:* This is the most important measure of the success of the program. Objective is to achieve at least 85 percent cure rate of new smear positive cases. Cure rate of less than 80 percent or default rate of more than 10 percent indicates a need for intensive supervision. The different parameters (indicators) of treatment outcome are expressed in percentage of cure rate, completion rate, death rate, failure rate, default rate and transfer rate.
  - *On program management:* This consists of ensuring regular and uninterrupted supply of drugs and laboratory reagents. It also helps monitor staffing and training activities.

Thus in DOTS strategy, patients are the VIPs of the program and the health system is accountable for ensuring cure. Thus DOTS ensures systematic monitoring, supervision, and accountability at every level.

Failure to use DOTS in the face of HIV can lead to explosive spread of TB with cases tripling and drug resistance increasing rapidly.

Screening of Contacts

Any contact of a smear positive TB patient should have 3 sputum examinations done, irrespective of the duration of symptoms. This is particularly important in HIV positive patients. Children below 6 years of age, who are contacts of smear positive cases should be evaluated for tuberculosis.

TUBERCULOSIS AND HIV

Impact of HIV on TB

HIV infected persons are more susceptible to infectious diseases because of progressive weakening of the immune system. HIV infection flares up the latent TB infection into active disease process and later it leads to progressive pulmonary TB a life-threatening condition. Thus HIV acts as a powerful provocative risk factor. HIV infection causes a two to ten fold increased risk of reactivation of latent TB infection. Over the past decade, HIV has emerged as the single most important risk factor for the development of TB. This is especially important in India because prevalence of TB infection is about 30 percent among the adult population. Tuberculosis is the most common opportunistic infection among people living with HIV/AIDS.

A person with only TB infection has only 10 percent life time risk of getting TB disease and with only HIV infection, has 30 percent life time risk of getting TB disease and with

dual infection of TB and HIV has 50 percent life time risk of getting TB disease.

Impact of TB on HIV

When TB disease occurs among HIV positives, tuberculosis accelerates the progression of HIV by increasing the replication of the virus, worsens the immune status and increases the susceptibility to opportunistic infections and death.

Usually opportunistic infections occur when CD4 count falls below 200 cells/cu mm. But TB can manifest at any stage of HIV infection. Since TB is rampant in India, the National AIDS Control Organization (NACO) includes only extensive pulmonary TB, disseminated TB or extrapulmonary TB as criteria for AIDS defining illness.

Clinical Presentation

The clinical presentation of TB in the early stage of HIV infection, is the same as among HIV negatives, i.e. the disease tends to be more pulmonary than extrapulmonary, more in the upper lobes or apices than lower lobes and more of fibrocavitory response.

With the progressive paralysis of the immune system and CD4 count lesser than 200 cells/cu mm, TB tends to result in more of disseminated, miliary or lower lobe tuberculosis. Extrapulmonary TB is significantly more common in AIDS patients. Tuberculin test becomes negative (False negative test) and sputum smear test for AFB is also often becomes negative. Sputum test can be positive by concentration method and culture method.

Chest radiograph of TB in early HIV shows classic upper lobe fibrocavitory picture. But in advanced HIV, it shows a predilection for lower lobes, pneumonia like consolidation and decreased cavitory response. Miliary response is also more common in profound immunosuppression. Paradoxically, chest film may show normal lung appearance despite the sputum smear or culture being positive. In advanced stage sputum will be positive only by concentration method and culture method.

Finally, TB in the setting of HIV shows higher incidence of relapse, reinfection and even drug reactions. HIV positives are more prone to develop Multidrug resistance TB (MDR-TB), because of immunosuppression, poor drug absorption, high bacillary load and irregular drug intake.

If a HIV positive person with pneumonia fails to respond to antibiotics, TB must be thought of. Extrapulmonary TB commonly manifests as lymphadenitis, pleural effusion, meningitis or abdominal TB, which seems to be common among dually infected persons.

The co-existence of TB and HIV is so infamous that all patients with active TB should ideally be counseled and then investigated for HIV infection. Conversely should also be done.

Management of HIV and TB

The treatment of TB in HIV positives should always be DOTS. That means the treatment is same as in HIV uninfected persons and is category wise as follows.

- All new TB cases known to be HIV positive should be treated with Category I Regimen. The retreatment cases are to be treated with Category II Regimen.
- It is very important to elicit the history of previous antituberculosis treatment to help define a case and to prescribe appropriate category of antitubercular treatment.
- Failure to use DOTS in the face of HIV can lead to rapid spread of TB, multidrug resistance, more relapses and higher case fatality.

In INH is contraindicated, pyrazinamide and ethambutol can be given for one year. Thiacetazone is absolutely contraindicated among HIV positives because of fatal, hemorrhagic, cutaneous lesions. It is difficult to cure TB among HIV positives, when CD4 count is less than 200 cells/cu mm. The people with dual infections need to have dual therapy (i.e. HAART and ATT) for maximum benefit. Otherwise the risk of death is higher. However, co-administration of HAART and ATT brings up certain vexatious issues as follows:

- Significant drug interactions occur with rifampicin and ARTs.
- Pill burden goes up and the compliance comes down.
- Exact time of starting HAART in patients who need both treatment is not clear. However NACO and Central TB Division under RNTCP recommend to start antituberculosis treatment (ATT) first, followed by HAART after two weeks of ATT, irrespective of CD4 count.
- As long as the situation is not life-threatening, the treatment of tuberculosis takes precedence over the treatment of HIV.
- Patients who are already on HAART, need not stop the same when starting anti tuberculosis treatment (ATT), but continue with suitable modifications.
- Paradoxical hypercalcemia and acute renal failure has been reported after the dual use of ATT and HAART.

In a person with dual infection (TB and HIV), one will accelerate the disease process of another, resulting in rapid breakdown and short survival. Thus HIV and TB constitute lethal partners and both constitute one of the worst combinations in the medical field.

Magnitude of the Problem

Everyday 16,000 new HIV infections occur globally and every minute about 11 people are getting infected with HIV.

In India, about 3.5 million people are living with HIV/AIDS (1998), out of which about 3.5 lakhs would breakdown to TB every year.

Recent Advances in Multidrug Resistant TB Cases and Revised National Tuberculosis Control Program

Drug Resistance

Drug resistance is manifested when there is a growth of new resistant mutants while the bacilli are multiplying in the presence of drugs. The genetic mutation makes the drug ineffective against the mutant bacilli. This depends upon the frequency of the mutants growing, the size of the bacillary population in the lesion and the antimicrobial quality of the drug used. Drug resistance has to be suspected in a patient who continues to remain sputum positive after four months of regular treatment with an established shortcourse chemotherapy regimen. History of irregular treatment predicts the occurrence of resistance. Noncompliance with the therapy and HIV infection aggravate the situation.

Challenges posed for the treatment of resistance cases: (1) Treatment is less effective, more toxic and expensive. (2) Detailed history of previous treatment to TB has to be obtained. It should include the names of drugs, duration of treatment and regularity of treatment. (3) Drug susceptibility testing is necessary. (4) Treatment regimen should include those drugs which the patient has not received.

Types

There are two types of drug resistance in tuberculosis namely primary and acquired drug resistance.

1. *Primary drug resistance:* The resistant tubercle bacilli isolated from the TB patients, who have never been treated previously (i.e. infection with the resistant strain) or treated for less than one month is called 'primary' (or initial) drug resistance.
2. *Acquired drug resistance:* The resistant bacilli isolated from the TB patient who have been treated for one month or more is called 'acquired' drug resistance.

Resistance to single drug is defined as 'monoresistance' and resistance to two or more drugs is defined as 'poly resistance'. Resistance to isoniazid and rifampicin with or without resistance to other anti-TB drugs, is termed as 'Multidrug resistance (MDR)'. MDR-TB is usually an iatrogenic problem. It is associated with decreased probability of cure.

Extensively Drug Resistant TB

In extensively drug resistant TB type, the resistance is amplified from isoniazid (INH) and rifampicin to second-line drugs. Extensively drug resistant TB (XDR-TB) is defined as resistance not only to INH and rifampicin but also to any of the fluoroquinolones (Ciprofloxacin, ofloxacin, levofloxacin, moxifloxacin, gatifloxacin, sparfloxacin, pefloxacin) and to any one of the second line injectable drugs (Amikacin, Kanamycin, Capreomycin). The chance of cure becomes further lowered. It leaves the patient including those living with HIV virtually untreatable and death becomes imminent. The combination of XDR-TB and HIV leads a high mortality within a short period of time.

Importance

- The resistant cases of TB are as infectious as untreated susceptible cases (for many years, it was believed to be less infectious).
- They are often fatal and very expensive to cure.
- They are posing a potential threat to the control of TB in the country.
- Development of resistance is both an individual tragedy and a reflection of poor program.
- Thus development of resistance has become a significant public health problem.

Magnitude of the Problem

MDR-TB is a global problem and virtually it has been known from the time anti-TB drugs were introduced. The description of XDR-TB was first given in early 2006 following a joint survey by WHO and US Center for Disease Control and Prevention (USCDC).

In India, Tuberculosis Research Center, Chennai and National Tuberculosis Institute, Bengaluru have found MDR-TB to be 1 to 3 percent in new cases and about 12 percent in retreatment cases.

Risk Factors (Causes)

- Genetic mutation among the multiplying bacilli
- Nonstandardized treatment regimen
- Inadequate treatment regimen (improper dosage and duration of treatment)/inappropriate use of drugs
- Monotherapy
- Irregular (selective) drug intake
- Poor patient drug compliance/patient nonadherence
- Poor drug quality
- Rarely erratic absorption of drugs.
- Erratic supply of drugs.

Diagnosis

- History of close contact with a case of MDR-TB
- No improvement or even deterioration while on chemotherapy
- Sputum smear remaining positive even at the end of treatment in category II cases
- History of improper chemotherapy
- Sputum culture and susceptibility report from RNTCP accredited Intermediate Reference Laboratory (IRL), designated one for each state.

Table 20.12 Differences between DOTS and DOTS-plus

DOTS	DOTS-plus
• This strategy is to control tuberculosis	• This strategy is to control MDR-TB
• Launched in India during 1993	• Launched in India during 2007
• Diagnosis is confirmed by two sputum smear examination done in microscopy center/laboratory (since April 1, 2009)	• Diagnosis is confirmed by sputum culture and susceptibility test done in intermediate reference laboratory (IRL)
• Patients are categorized as I, II only (since January 2010)	• Patients are categorized as resistant cases only
• Treatment is by intermittent regimen with first-line of drugs	• Treatment is by daily regimen with second-line of drugs
• Patients are usually not admitted in the hospital	• Patients are admitted and treated in the RNTCP designated sites only
• The entire course of intensive phase (IP) and the first dose of the week of continuation phase is provided by DOTS provider	• Entire course of treatment during both intensive phase and continuation phase is given by DOTS-provider
• Total duration of treatment is for 6 to 9 months only	• Total duration of treatment is minimum 2 years
• IP is for 2 months in Cats I and for 3 months in Cat II, CP is for 4 to 6 months	• IP is for 6 to 9 months CP is for 18 months

Case Finding Strategy

- An MDR-TB suspect case is defined as Cat II patient whose sputum smear remains positive at the end of the fourth month of treatment or later. Such cases are further investigated by sputum culture and susceptibility test in IRL.
- A confirmed MDR-TB case is an MDR-TB suspect whose sputum culture is positive and the bacilli are resistant *in vitro* to at least INH and rifampicin.

DOTS-Plus

This refers to a DOTS program that adds components for diagnosis, management and treatment of MDR-TB patients. This was launched by WHO during the year 2000 and by RNTCP in India during 2007. The differences between DOTS and DOTS-plus are shown in **Table 20.12**.

DOTS-plus program should strengthen the basic DOTS strategy. Since the treatment of MDR-TB cases is very complex, treatment is given as per the internationally recommended DOTS-Plus guidelines, in the designated RNTCP DOTS-Plus sites, one for each state that will have ready access to sputum culture and susceptibility testing laboratory, i.e. IRL.

Framework of DOTS-Plus

The framework of DOTS-plus strategy is organized around the same five components of DOTS-strategy, as the underlying principles are the same. They are as follows:

- Sustained political and administrative commitment.
- Diagnosis of MDR-TB through quality assured culture and drug susceptibility testing.
- Appropriate treatment strategies with uninterrupted supply of quality assured second line anti-TB drugs.
- Directly observed therapy for the entire course.
- Recording and reporting system designed for the DOTS-plus program that enable monitoring and evaluation of treatment outcome.

Anti-TB Drugs

The anti-TB drugs have been grouped as follows **(Table 20.13)**.

Treatment of MDR-TB/XDR-TB

Once MDR-TB is confirmed, the patients are treated in the RNTCP DOTS–plus designated centers, under two phases – intensive and continuation phases, by using a standardized treatment.

Intensive phase (IP) consists of six months of six drugs namely kanamycin (Km), ofloxacin (Ofx), ethionamide (Eto), cycloserine (Cs), pyrazinamide (Z) and ethambutol (E). Out of six, at least four drug must be those, which the patient had not received previously or to which the bacilli have demonstrated susceptibility by laboratory testing. The use of more number of drugs is associated with greater toxicity, drug–drug interactions, greater expense and least effectiveness.

Table 20.13 Anti-TB drugs

Group 1: First-line drugs	Isoniazid (I) rifampicin (R), ethambutol (E), pyrazinamide (Z)
Group 2: Injectable drugs	Streptomycin (S), amikacin (Am), kanamycin (Km), capreomycin (Cm).
Group 3: Fluoroquinolones	Ciprofloxacin (Cfx), ofloxacin (Ofx), levofloxacin (Lvx), moxifloxacin (Mfx), gatifloxacin (Gfx)
Group 4: Oral second line drugs	Ethionamide (Eto), prothionamide (Pto), cycloserine (Cs), terizadone (Trd), thiacetazone (T), para-aminosalicylic acid (PAS)

Newertheless, the aggressive and appropriate therapy will obtain good results. This phase should be extended to nine months in those patients who have a sputum positive culture test taken in the fourth month of treatment.

Continuation phase (CP) consists of minimum of eighteen months of four drugs namely ofloxacin, ethionamide, ethambutol and cycloserine.

Para-aminosalicylic acid (PAS) is included in the regimen as a substitute drug if any of the bactericidal drugs (Km, Ofx, Z and Eto) or any two bacteriostatic drugs (E and Cs) are not tolerated.

Antitubercular treatment of HIV positive individuals with MDR-TB is the same as for MDR-TB in HIV negative patients. However Nevirapine based regimens are preferred.

WHO Guidelines

- Strengthen basic TB care to prevent the emergence of drug resistance
- Ensure prompt diagnosis and treatment of drug resistant cases to cure existing cases and prevent further transmission
- Increase collaboration between HIV and TB control programs to provide necessary prevention and care to coinfected patients
- To increase investment in laboratory infrastructure to enable better detection and management of resistant cases.

Drug Dosages and Administration

The drug dosages of MDR-TB cases are recommended according to the weight band, as shown in **Table 20.14**.

Pyridoxine at a dose of 100 mg should be administered to all patients of Category IV regimen.

If the patient gains weight during the treatment and crosses the weight band range, the DOTS-plus site committee may consider moving the patient to the higher weight band drug dosages, when the patient is due for the next supply of drugs.

Table 20.14 Recommended dosage according to weight in DOTS-plus

Drugs	<45 kg	> 45 kg
Kanamycin	500 mg	750 mg
Ofloxacin	600 mg	800 mg
Ethionamide	500 mg	750 mg
Ethambutol	800 mg	1000 mg
Pyrazinamide	1250 mg	1500 mg
Cycloserine	500 mg	750 mg
Na PAS	10 mg	12 mg

Note: All drugs are given in single daily dosage under directly observed treatment (DOT) by a DOT provider, over the entire course of treatment.

It is also necessary to rule out the side effects of the drugs by the necessary investigations.

Follow-up

- Sputum smear examination should be conducted monthly during IP and at least quarterly during CP.
- Sputum culture examination should be done at least 4, 6, 12, 18 and 24 months of treatment.
- Relevant additional investigations should be performed as indicated.

Recording

There should be a systematic record of treatment regimen, dosage, duration, side effects, investigation results and treatment outcome for all patients initiated on second line treatment.

Prevention of Spread of MDR-TB

- Early diagnosis and appropriate treatment of MDR-TB cases (i.e. implementation of good quality DOTS program will prevent the emergence of MDR and XDR-TB in the community).
- Screening of contacts.
- Close contacts should receive careful, clinical follow-up for a period of at least 2 years.
- No prophylactic treatment is recommended for contacts.

WHO Stop TB Strategy

Global TB control has made major progress in the past decade by the widespread implementation of DOTS strategy. The prime task for the next decade is to achieve the global TB related millennium development goals (MDGs) by 2015.

The new WHO Stop TB Strategy, released in 2006 has identified six principal components, as shown in **Figure 20.31**.

SEVERE ACUTE RESPIRATORY SYNDROME

It is an acute highly, infectious, respiratory disease, caused by a new strain of corona virus, usually transmitted by droplet infection, common among adults, clinically characterized by short incubation period, mild prodromal symptoms followed by respiratory symptoms rich as cough, breathlessness and progressive hypoxemia (i.e. decreased concentration of oxygen in the arterial blood and tissues). Attack rate is very high (about 50%) and case fatality rate is about 5 percent. There is no treatment, prevention is the only intervention.

It is a new, emerging, infectious disease posing a challenge to the entire medical faternity in the world today.

The first case was reported from Guangdong province of China in late November 2002, in a health care worker. Later, he developed pneumonia and died but the disease remained undiagnosed.

Later in 2003, it spread to Hongkong, Vietnam, Singapore, from where a series of similar cases suffering from cough, fever, breathlessness were reported. This new syndrome was designated after its symptoms as 'Severe Acute Respiratory Syndrome' (SARS). By August 2003, about 8422 cases were reported from 30 countries, including Canada and USA with 916 deaths. Dr Carlo Urbani, who first identified the disease also became the victim of SARS. WHO identified SARS as a global health threat and pinpointed Guangdong province of China as the epicenter of the pandemic of SARS **(Fig. 20.32)**.

Because of war in Iraq, it was suspected to be a biological warfare. Dr Sapatnekar highlighted that this new disease is a major occupational hazard to the health care providers, because of the increased incidence among the health care providers of those victims.

Agent Factors

It is a deadly new strain, belonging to coronavirus family, closely related to common cold virus. It is a single stranded, RNA virus, non-segmented and enveloped. Around 80 to 140 nm in size, has projections on the surface, known as peplomers, giving it the appearance of a halo (corona = halo) **(Fig. 20.33)**.

The envelop has "S" (spike) protein, "M" (Matrix) protein and "HF" (hemagglutinin).

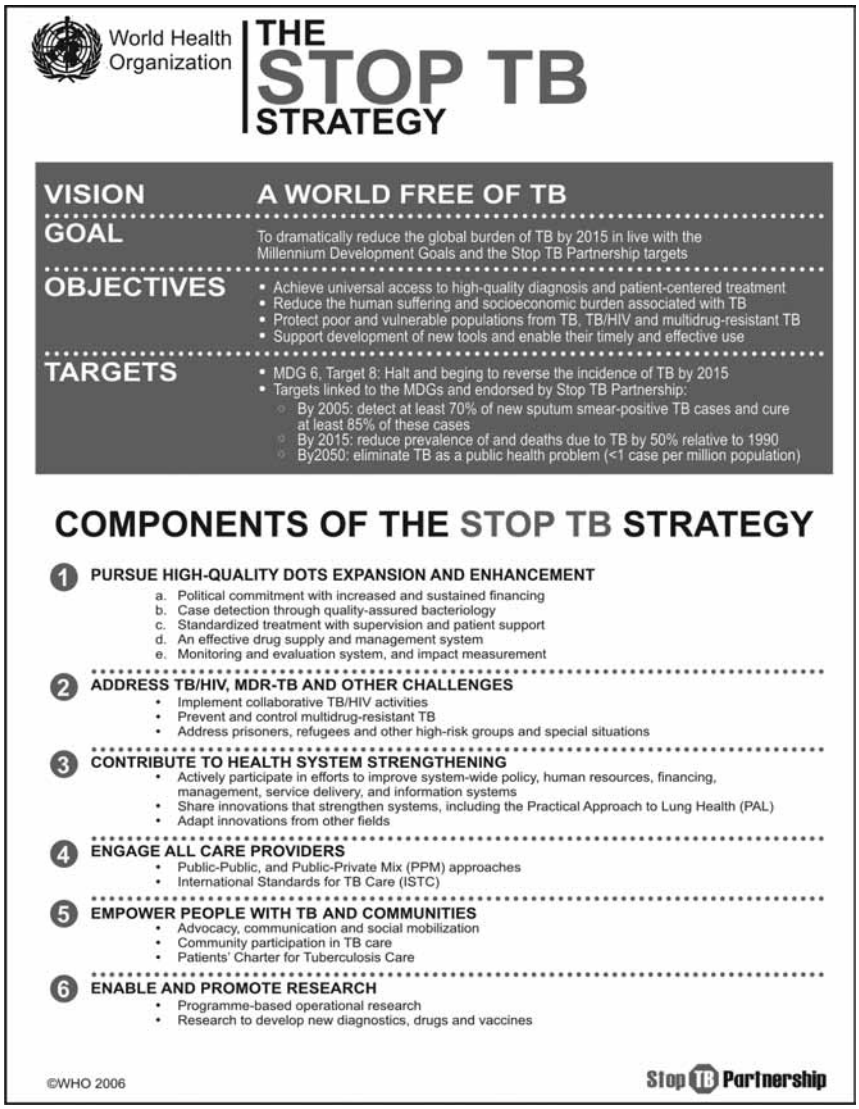


Fig. 20.31 The WHO stop TB strategy

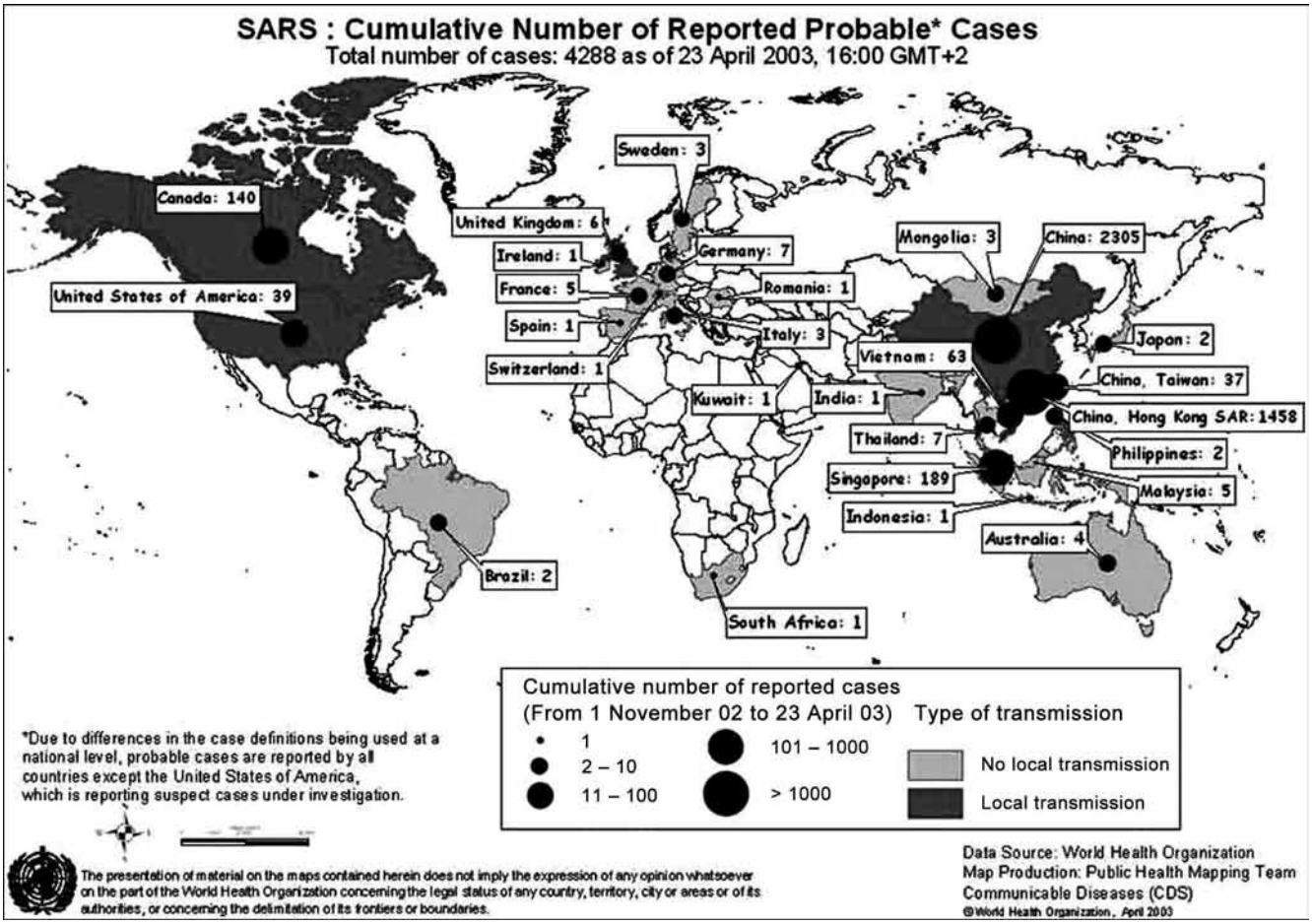


Fig. 20.32 WHO figures as of April 24, 2003

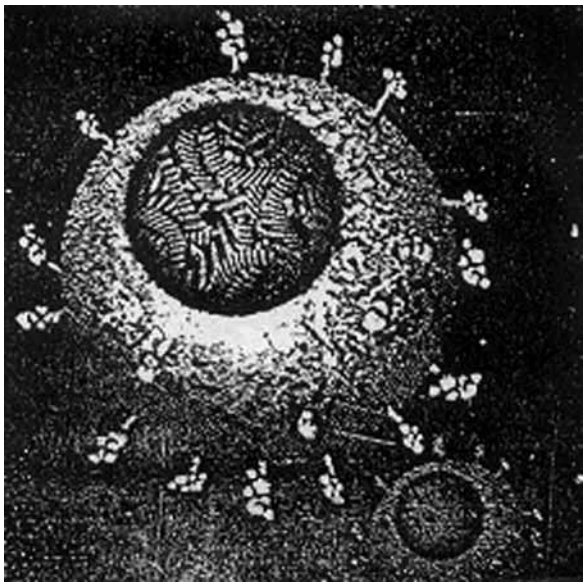


Fig. 20.33 SARS – Primer

The human pathogens of corona-virus belong to 2 serogroups namely 229 E and OC-43. They survive for about 3 hours on the dry surface and 229 E can survive for about 6 days in suspension.

This virus was identified and proved to be the causative agent using Koch's postulates on 17th April, 2003. For the first time, in the history of Medicine, it was possible to identify a disease agent by the concerted efforts of 13 international laboratories.

Reservoir

There is only human reservoir and no animal reservoir.

Age Incidence

Common among people above 25 years of age. Children are rarely affected by SARS.

Sex Incidence

SARS is more among men than among women.

Mode of Transmission

Mode of transmission is by droplet nuclei. Outbreak has shown clear pandemic potential. The other suspected mode of transmission is through fomites, because touching the patient's belongings such as linen, clothes, utensils and also door-handle of the attached bathroom, etc. contaminated with infected droplets and then touching the face, eyes, nose or mouth has resulted in development of the disease.

Infectious Material

Highly infectious material is the nasal or the throat secretions. However viruses have also been found in the urine and stools of SARS-patients.

Period of Infectivity

It is not clearly known. However, SARS patients are infectious during the period of illness. But it is not known, whether they are infectious during incubation period and during convalescent period also.

Incubation Period

2 to 7 days (Maximum 10 days).

Clinical Features

Occur in two phases—prodromal and respiratory.

Prodromal Phase

(Febrile phase) characterized by mild to moderately high fever associated with chills, rigors, headache, malaise and myalgia, lasting for two to four days.

Respiratory Phase

Later, patient develops dry cough, breathlessness, features of atypical pneumonia, progressing to hypoxemia. About 10 to 20 percent may require intubation and mechanical ventilation following hypoxemia. Few inspiratory crackles may be heard. Anorexia, confusion, muscular stiffness may also be present. Case fatality is due to progressive respiratory failure.

Investigations

- *X-ray chest:* Febrile phase—normal
  Respiratory phase—generalized patchy infiltrations seen.
- *CT scan:* Ground-glass opacification in the peripheral sub-pleural areas.
- *Hematological findings:* Leecopenia, lymphopenia, thrombocytopenia.
- *Biochemical findings:* Hyponatremia, hypokalemia, elevated serum ALT level, LDH and creatinine phosphokinase.
- *Specific tests:* Electron microscopy, culture on Vero E 6 cell lines, indirect immunofluoroscent tests, DNA based polymerase chain reaction (PCR) test.

Case Definition for Surveillance (WHO)

A suspect case and probable case.

- *A suspect case*: A person presenting after 1st November 2002 with history of:
  - High fever (>38°C)
  - Cough and difficulty in breathing
  - One or more of the following features such as:
    - Contact with a case of SARS
    - Recent travel to areas reporting SARS, within 10 days of onset of symptoms
    - Residing in an affected area.
- *A probable case*: It is a suspect case with radiological evidence of infiltrates consistent with pneumonia on chest X-ray.

  A suspect case dying of an unexplained respiratory illness with an autopsy finding consistent with the pathology of respiratory distress syndrome without an identifiable cause.

Treatment

There is no specific treatment for SARS, because there is no appropriate antibiotic. The antiviral agent ribavirin in combination with steroids have given promising results **(Flow chart 20.3)**.

Prevention and Control

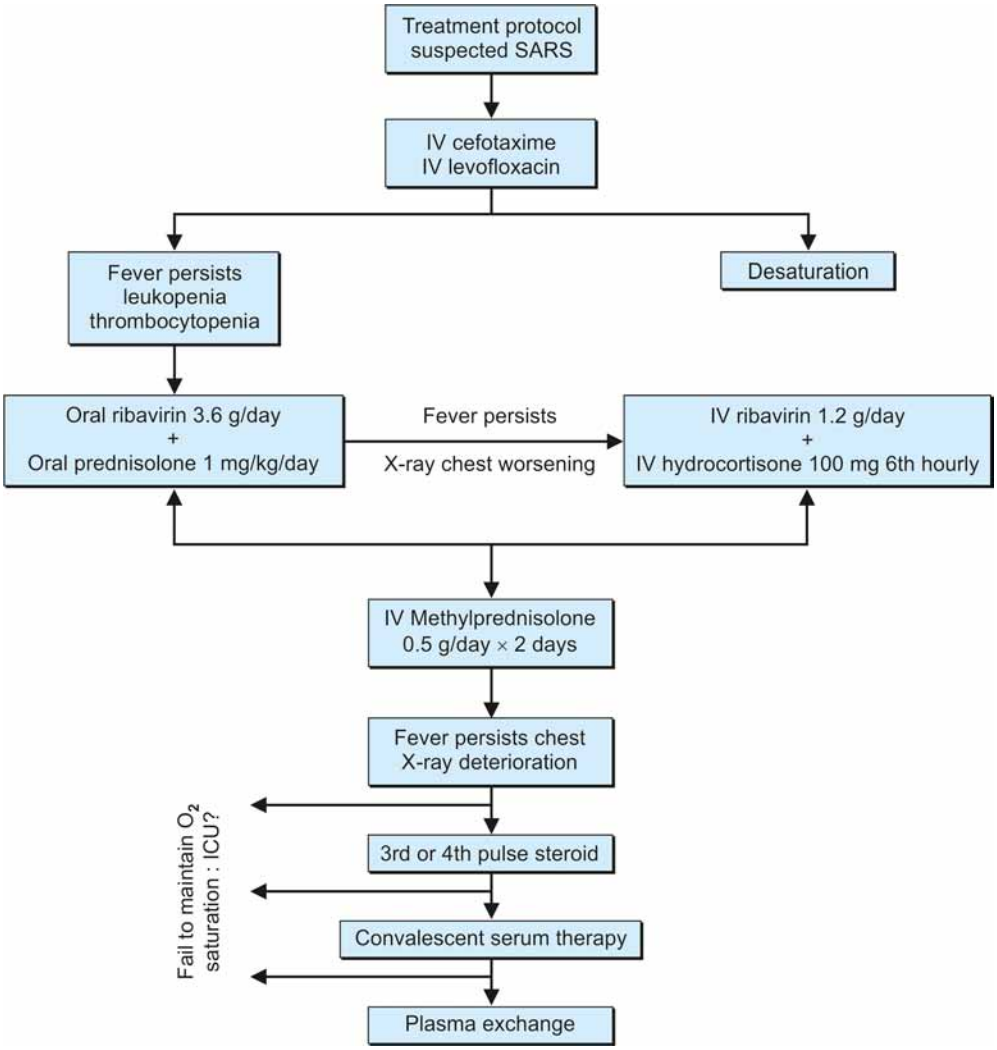
The key objectives are:

- Early detection of infection
- Containment of infection
- Personnel protective attire
- Care of the environment
- Hand hygiene
- Other measures.

Early Detection of Infection

- IEC activities to be carried out vigorously.
- Heightened index of suspicion among the patients giving history of contact with SARS patients or history of travel in SARS areas.
- Segregation of symptomatics
- Notification
- Visual alert.

Flow chart 20.3 Treatment protocol of suspected case of SARS



Containment of Infection

- Segregation of suspected cases until diagnosis is established.
- Isolation of SARS patients in designated wards, having a negative pressure room with attached bathroom facility.
- Doors always kept closed.
- Prohibition of visitors.
- Maximizing natural ventilation by opening the windows and also by using exhaust fans.
- Minimizing the person traffic in the hospital.
- Dedicated staff to take care of the patients.
- Barrier nursing is a must for all the SARS patients.
- Concurrent disinfection of respiratory secretions, linen, utensils, etc. of the patients.
- Treatment protocol.

Personnel Protective Attire

- Respiratory protection—preferably by N-95 masks (WHO), surgical masks, if N-95 masks not available
- Eyes protection—by use of goggles
- Contact protection—by use of gowns and gloves.

Care of the Environment

- Disinfection of soiled linen
- Safe disposal of biohazard waste.

Hand Hygiene

This is the "corner stone" of prevention. This must be performed following contact with a SARS case by washing with soap and hot water or alcohol based hand rubs.

Miscellaneous Measures

- Avoid the use of nebulizers, because it may cause aerosolization.
- Limit the movements of the patients.
- Place mask or gown on the patients, during their transportation.

Instructions to House-hold Contacts

- They should be vigilant for fever and respiratory symptoms.
- They should strictly adopt personnel protective attire with a special reference to hand-hygiene.
- They should not touch their nose, eyes or mouth without washing hands after touching the patient.
- Disposable gloves to be used to clean the surfaces such as table-top, door-knob, bathroom fixtures, etc.
- Not to share towels, linen and clothes until they are washed with soap and hot water.

SARS—What We Need to Know?

- Future course of the outbreak
- Source of the virus
- Other modes of transmission
- Risk of transmission on aircrafts and ships
- Period of infectivity
- Explanation for age distribution
- Importance of hypertransmitters
- Role of coinfection with metapneumovirus
- Optimal diagnostic test
- Effective therapy
- Vaccine approaches.

BIBLIOGRAPHY

1. Background Material for Workshop on Avian Influenza at NICD, Bengaluru, 2005.
2. Central TB Division. TB India 2009. RNTCP Status Report. MOHFW, New Delhi, March 2009.
3. Central TB Division. TB India 2010. RNTCP Status Report. MOHFW, New Delhi 2010.
4. Christie AB. Infectious Diseases, Epidemiology and Clinical Practice 3rd Edn. 1980.
5. DGHS. Revised National Tuberculosis Control Programme, Key Facts and Concepts. Central TB Division, MOHFW, New Delhi.
6. DGHS. RNTCP, Operational Guidelines for Tuberculosis Control. Central TB Division, New Delhi, 1999.
7. DGHS. RNTCP, Technical Guidelines for Tuberculosis Control. Central TB Division, New Delhi 1999.
8. DGHS. TB India 2001 and 2002. RNTCP Status Report. MOHFW, New Delhi.
9. Gagandeep Singh Grover, Jaspreet Takkar. Recent Advances in Multi Drug Resistant Tuberculosis and RNTCP. IJCM 2008;33(4).
10. GOI. Acute Respiratory Infections and Its Control in Under five Children. DGHS, NICD; New Delhi: 1991.
11. GOI. National Child Survival and Safe Motherhood Programme; Program Interventions. MCH Division. MOHFW, New Delhi, 1994.
12. Healthizen.com/Swine Flu.
13. http://en.wikipedia.org/wiki/2009_flu_pandemic.
14. ICMR Bulletin: Human Disease Due to Avian Influenza Virus: The Influenza A (H5N1) Virus. ICMR, New Delhi, 2004;34:2-3.
15. India Today Magazine 2003.
16. Iseman MD. Treatment of Multi Drug Resistant Tuberculosis. N Eng J Med 1993;329:784-91.
17. JIMA. 2009;107(8).
18. NACO. Central TB Division. TB HIV Module for ART Center Staff. MOHFW, GOI, New Delhi, Jan 2010.
19. Park K. Park's Text Book of Preventive and Social Medicine. 20th Edn. 2009.
20. Samastha. Training in the comprehensive care of PLWHA. Flip Chart. St. John's National Academy of Health Sciences, Bangalore, 2008.
21. Shankar PS. Extensively Drug Resistant Tuberculosis. Medicine Update. A Passi Publication 2009;17(8).
22. Someswara. Severe Acute Respiratory Syndrome. Bulletin, IM Asso, Bengaluru 2003.
23. Tapan Kumar Koley. Severe Acute Respiratory Syndrome—A Preliminary review. J Ind Med Association 2003;101:5.
24. Voluntary Health Association of India. Bird / Avian Flu. Avian Flu Cell, New Delhi.
25. WHO, TB/HIV, A Clinical Manual. 1996.
26. WHO. Global Influenza Programme. Pandemic Influenza. Preparedness and Response. A WHO Guidance Document. 2005.
27. WHO. Tech Rep Ser No. 682, 1982.
28. WHO. Tech Rep Ser No. 693, 1983.
29. WHO. Tech Rep Ser No. 771, 1988.
30. WHO/UNICEF. Basic Principles for Control of Acute Respiratory Infections in Children in Developing Countries; A Joint Statement; Geneva, 1986.
31. William Harris H. Natural History of Pulmonary Tuberculosis, WHO Regional Office, 2001.

WATER-BORNE DISEASES

TYPHOID FEVER

It is an acute infectious disease of the small intestine, caused by *Salmonella typhi*, transmitted through fecal contaminated water, food and vegetables, usually affecting the school children. Clinically, it is characterized by continuous fever for prolonged period, severe prodromal symptoms and involvement of lymphoid tissues. With the availability of the antibiotics, case fatality rate is reduced to 10 percent.

The term 'Enteric fever' includes both typhoid and para-typhoid fevers. Para-typhoid fever is caused by Salm para-typhi A and B. Unless otherwise specified, enteric fever always means typhoid fever. Para-typhoid is less severe.

Milestones

- In 1829, Louis distinguished typhoid from typhus fever.
- In 1839, Schonlein showed by post-mortem studies that the lesions in the Peyer's patches and mesenteric lymph nodes were specific in typhoid fever and not in typhus fever.
- In 1856, Budd pointed out that the disease is transmitted through the excreta of the patients.
- In 1880, Eberth saw the organisms in the lymphoid tissues.
- In 1884, Gaffky successfully grew it in pure culture.
- In 1890, Pfeiffer, Kolle and Wright independently performed the vaccination experiments.
- In 1975, Germanier and Furer developed live, oral vaccine against typhoid.

Magnitude of the Problem

In 20th century beginning, typhoid was a global problem. In the latter half of the century, with the improvement of quality of life and socio-economic conditions, specially with reference to protected water supply, disposal of sewage and improvement in the sanitation, there has been a tremendous decline in all the developed countries, whereas in the developing countries it continues to be unabated.

In India, typhoid is still an endemic disease, often giving rise to epidemics. It is 5th most common communicable disease. It has a huge socioeconomic impact on the country, because typhoid patients require several weeks to several months to recover and resume work. The incidence rate is about 100 to 200 cases per lakh population with CFR of 10 percent in untreated cases. Presence of typhoid is the barometer of the sanitation of the country or community.

Agent Factors

Causative Agent

The etiological agent is *Salmonella typhi*. It is a gram negative bacilli, capsulated, flagellated, actively motile organism. (Exception: *S. gallinarum* and *S. pullorum* are non-flagellated and hence non-motile organisms). The organisms possess three types of antigens, namely somatic or 'O' antigen, (specific for the group), Flagellar or 'H' antigen (specific for the type), and capsular or 'Vi' antigen, related to the virulence of the organism. Antibodies to 'O' antigen is usually higher in cases of typhoid, antibodies to 'Vi' antigen among carriers and antibodies to 'H' antigen among immunized persons.

There are about 80 types of phage types. Phage typing has proved an useful epidemiological tool in tracing the source of epidemics.

The organisms are sensitive to heat and chemicals. They are readily killed by heat at 60°C for 15 minutes and also by routine disinfectants like chlorine, bleaching powder, $KMnO_4$, cresol and formalin. *S. typhi* mainly live in the intestine of human beings, which is the natural habitat, they also survive intracellularly in the tissues of various organs like spleen, heart, kidney, bone-marrow, etc. They can also survive in the environment like food, water, sewage, ice-cream, soil, etc. for quite a long period of 15 to 20 days.

On autolysis, inside the body, these pathogens release an endotoxin, which plays an important role in the development of the disease process.

The nonhuman strains of Salmonellae, such as *S. typhimurium* (from rats), *S. gallinarum*, *S. pullorum*, *S. enteritidis* result in Salmonellosis and not typhoid. Thus Salmonellosis is a zoonotic disease.

Reservoir of Infection

Human being is the only known reservoir of typhoid. Such a reservoir may be a case or a carrier.

A case may be an active clinical case or a subclinical case. For every clinical case, there are about 10 subclinical cases. A carrier may be, according to the type, an incubatory, convalescent or a contact carrier and depending upon the duration may be temporary or chronic and depending upon the portal of exit, may be intestinal, urinary or biliary carrier. They may shed the organisms continuously or intermittently. Thus, all types of carrier state occur in typhoid. These carriers constitute the submerged portion of the ice in iceberg phenomenon and are responsible for the endemicity of typhoid in the community. Thus, they are more dangerous than cases.

Mary was a chronic carrier of typhoid, working in the food establishment. She was responsible for 25 deaths due to

typhoid and 1250 cases of typhoid. Thus, she was named as 'Typhoid Mary'.

Such a carrier state occurs in typhoid following a clinical or a subclinical infection or incomplete treatment. Nearly 2 to 5 percent of the cases and majority of subclinical cases become carriers. The incidence of the carrier state is more among women than among men in the ratio of 5:1.

Thus, these carriers constitute a challenge to the modern techniques of community medicine to detect them, treat them and prevent them from acting as a source of infection to others.

Carriers of typhoid are detected either serologically by blood examination for 'Vi-antibody' titer or bacteriologically by culture of urine and/or stools.

Treatment of Carriers

Treatment of carriers–discussed under treatment of typhoid.

Instructions to Typhoid Carriers

- They must abstain from working in food, water and milk establishments, till they are bacteriologically cured.
- They must undergo periodical medical check-up including laboratory investigations to rule out their carrier state.
- They must maintain a high standard of personal hygiene.

Prevention of Carrier State

- Healthy carrier state cannot be prevented because they become carriers following subclinical infection.
- Convalescent or chronic carrier state can be prevented by giving a correct and complete chemotherapy, with a follow-up to ensure their bacteriological recovery also.

Source of Infection

The main source of infection is the feces of the infected person, to some extent urine also. Secondary sources are fecal contaminated water, food and fruits and vegetables.

Infective Material

It is the feces of the cases and feces and/or urine of the carriers.

Period of Communicability

Varies from several days to months or even years.

Host Factors

- *Age incidence:* Typhoid is common among children (5–15 years) often among adults and rare among elderly. Incidence is less above 30 years of age, because of development of immunity following subclinical infection.
- *Sex incidence:* Incidence of typhoid is more common among boys than among girls. However, the carrier state is more common among women than among men, in the ratio of 5:1.
- *Immunity:* There is an acquired, cell mediated, partial immunity following a clinical illness. Hence reinfection and relapses are known to occur.
- *Environmental factors:* The peak incidence is during monsoon season (July – September).
- *Predisposing factors (Social factors):* Typhoid is called a 'Social disease', because there are many social factors responsible for the prevalence of this disease in an endemic form in our country, such as poverty, illiteracy, ignorance, poor standard of living, lack of sanitation, lack of personal hygiene, open air defecation and urination, low standard of food hygienic practices, lack of protected water supply, etc. All these factors go hand-in-hand. When the conditions are favorable, the endemic disease becomes an epidemic disease.

Mode of Transmission

The disease is mainly transmitted by 'Feco-oral' route, i.e. the pathogen is transmitted from one 'F', through six 'Fs' to a susceptible person, as shown in the **Figure 20.34**.

Typhoid is mainly transmitted through fecal (sewage) contamination of water and often through contaminated food through house-flies, which act as mechanical vectors by flying from filthy substances to food substances. The disease is also transmitted through contaminated milk because water is added to milk or the milk-handler may be a carrier. Vegetables grown in sewage farms also favor the spread of the disease. Lack of personal hygiene such as non trimming of nails, also favors the transmission through fingers.

Pathology and Pathogenesis

Having entered the body through the mouth, the pathogens enter the blood stream, reach reticuloendothelial cells, where they multiply and after rupture of RE cells, they are poured into the blood resulting in bacteraemia and circulate for one week.

After circulation, they lodge mainly in the Peyer's patches of ileum. They also lodge in the spleen and gallbladder. However, any tissue or organ may be affected and may result in complication.

Ileum

Peyer's patches are the most common site of involvement. These patches are all inflamed resulting in minute, innumerable ulcers with discharge of bacilli and pus into the lumen of the gut. The regional mesenteric lymph nodes are also inflamed and enlarged.

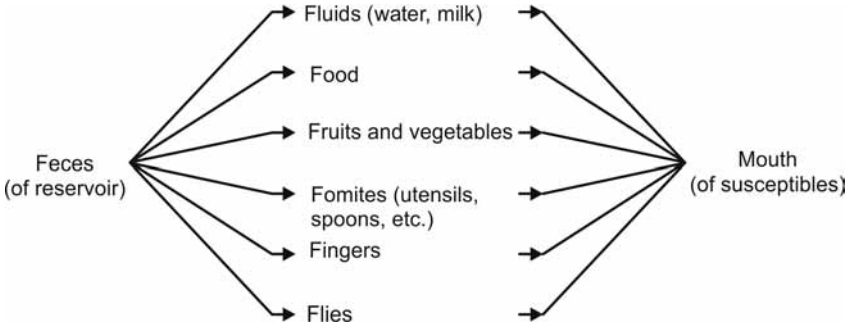


Fig. 20.34 'Feco-oral' route of transmission

Spleen

There is lymphoid hyperplasia, resulting in splenomegaly. Presence of organisms in the spleen may act as a seed of future relapse.

Gallbladder

There will be chronic infection in the gallbladder resulting in cholecystitis and cholelithiasis (stones).

On autolysis, the pathogens release endotoxin, which enters the circulation resulting in toxemia (fever). This endotoxin supresses the activity of the heart and bone-marrow; resulting in relative bradycardia and leucopenia. Antibodies are produced in the second week and subsequently as the antibody titer increases, the patient recovers slowly after 3 weeks.

Incubation Period

10 to 15 days.

Clinical Features

During the first week of illness, there is gradual onset of fever, continuous, raises day by day in a 'step ladder' fashion, associated with chills and severe prodromal symptoms such as headache, body ache, malaise, loss of appetite, joint pains with occasional vomiting. Fever will be in the range of 38 to 40°C. Often there will be dry cough.

During second week, temperature reaches its plateau (104°F), skin is dry and hot, tongue is coated, patient looks tired, abdomen is distended, spleen is enlarged and soft, tenderness in the right iliac fossa, relative bradycardia and often there will be transient appearance of rashes over the abdomen, which fade on pressure (Relative bradycardia means the heart-rate is lesser than what it should have been for that temperature). There may be diarrhea with 'pea-soup' stools.

During third week, the patient will have signs of toxemia such as very high temperature, rapid thready pulse, mentally dull, delirious, disoriented, sleepy, confused, talks irrelevantly, will have toxic face, later becomes stuporous, develops coma and dies. Case fatality rate is 10 percent in untreated cases.

Those who recover following the development of antibodies and with or without treatment, temperature falls by lysis, appetite improves, distension of abdomen disappears, strength improves and the convalescence is slow.

Investigations

During First week of illness	- blood for culture.
During Second week of illness	- blood for widal, TC (Leucopenia)
During Third week of illness	- blood for repeat widal and stool and urine for culture.

Note: Blood for widal will be negative during first week of illness because sufficient antibodies are not produced and blood for widal will be positive only during second week and blood for repeat widal during third week shows increase in antibody titer, which is confirmative. Stool and urine for culture will be positive only during third week onwards.

Complications

No other disease has so many complications, as much as it is in typhoid because any organ may be affected. Recognized complications are mainly three—Relapse, Hemorrhage (from the intestinal ulcers) and Perforation (of these ulcers). Hemorrhage in the gut is characterized by malena and perforation is characterized by acute peritonitis, which constitutes an acute surgical emergency.

Other complications of typhoid are meningitis, myocarditis, gallstones, pneumonia, hepatitis, osteomyelitis, arthritis, thrombophlebitis and others.

Treatment

- *Isolation:* Preferably in the isolation ward till 2 to 3 stool culture report comes as negative. It may take about 2 weeks.

- *Concurrent disinfection:* Of mainly the excreta (urine and stools) by collecting it in a container containing 10 percent cresol or 8 percent bleaching powder.
- *Chemotherapy:* Now the drug of choice is cefotaxime, 200 mg twice a day for adults and 100 mg twice a day for children, for about 10 days. Ceftriaxone can also be given. Resistance has been observed against quinolone drugs. Antipyretics are also given.
- *Follow-up:* It is done by sending three consecutive samples of stool and urine for culture, to ensure bacteriological recovery of the patient.
- *Treatment of carriers:* Depends upon the type of carriers.
  Biliary carriers–Cholecystectomy
  Intestinal carriers–Resection of loop of gut.
  Urinary carriers–Partial or total nephrectomy depending upon the damage of the kidney.

Thus, since the carriers invariably suffer from surgical problem, surgery followed by chemotherapy is the rule. This offers 70 to 90 percent cure.

Prevention and Control

Elimination of Reservoir

This consists of making the infectious persons non-infectious by giving treatment for cases and carriers.

Breaking the Channel of Transmission

(Interruption of transmission).
Since the mode of transmission is by feco-oral route, it is interrupted by construction of 'Sanitation barrier'. It consists of construction and use of sanitary latrine, which prevents the access of the pathogens from feces to six F's **(Fig. 20.35)**.

The construction and use of sanitary latrine will be more effective, when it is supplemented with the following measures.

- Chlorination of water for drinking purposes
- Pasteurization of milk
- Adoption of food-hygienic measures
- Disinfection of fruits and vegetables with $KMnO_4$
- Disinfection of fomites like utensils, plates
- Adopting high standard of personal hygienic measures (such as trimming of nails, washing the hands with soap and water after the using toilet and before eating the food)
- Control of house flies by keeping the environment clean.

Protection of Susceptibles

Protection of susceptibles is mainly by Health promotion and Immunization.

Health promotion: This consists of:

- Provision of protected (chlorinated) water supply
- Sanitary disposal of sewage

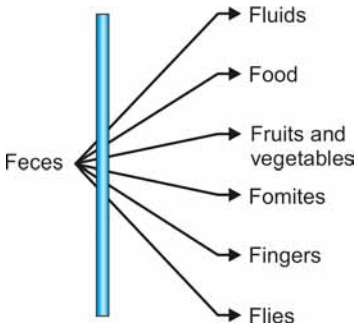


Fig. 20.35 Sanitation barrier (Sanitary latrine)

- Health education of the people about hazards of open-air defecation, importance of sanitation in and around the house, importance of personal hygiene, use of sanitary latrines, spread of the disease, etc.

Specific protection is by vaccination.

There are three types of vaccines—Killed vaccines, Live vaccines and Cellular extract vaccines.

- Killed vaccines are of three types – Trivalent (TAB) vaccine
  – Bivalent (TA) vaccine
  – Monovalent antityphoid vaccine.

These are all less effective and outdated vaccines. Not used.

- *Live vaccine:* It was first developed by Germanier and Furer in 1975. It is a live, lyophilized vaccine, made available in a pack of 3 capsules, each capsule containing not less than 10^9, viable, attenuated, Salmonella typhi-21 a Strain. It is indicated for all adults and children above 6 years of age. (because children below 6 years may not swallow capsules) **(Fig. 20.36)**.

Schedule consists of one capsule, to be swallowed, on alternate days, preferably 1 hour before meals, irrespective of age and sex, above 6 years, for 3 days, i.e. on Day 1, 3 and 5.

Immunity is developed about 2 weeks after taking the third capsule and lasts for 3 years. It is 60 percent effective. Booster dose consists of the same 3 capsules, recommended once in 3 years.

Side effects are nil. Acute febrile disease is a contra-indication. A note of caution is that oral antibiotics should not be given alongwith oral typhoid vaccine because they may destroy the live vaccine strain, resulting in vaccine failure.

The capsule is marketed as *Typhoral*, best stored at 2 to 8°C.

Cellular Extract Vaccine

It is a liquid vaccine. It contains capsular, polysaccharide–Vi – antigen of *S. typhi*. It is given in a single shot of 0.5 mL (containing 25 microgram Vi-antigen), intramuscularly or subcutaneously, irrespective of age and sex. Immunity is

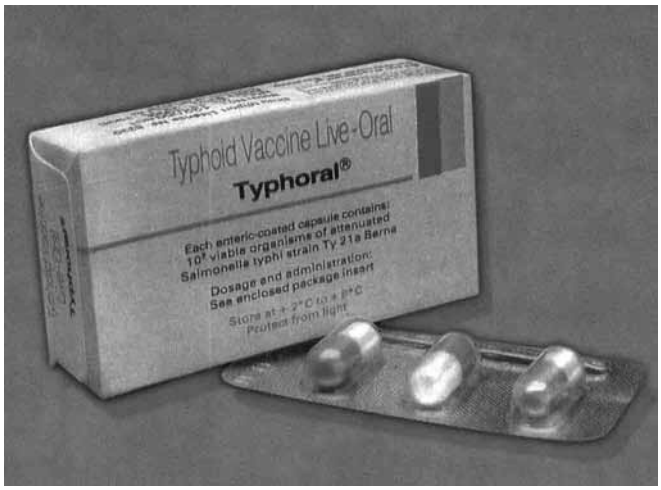


Fig. 20.36 Oral typhoid vaccine

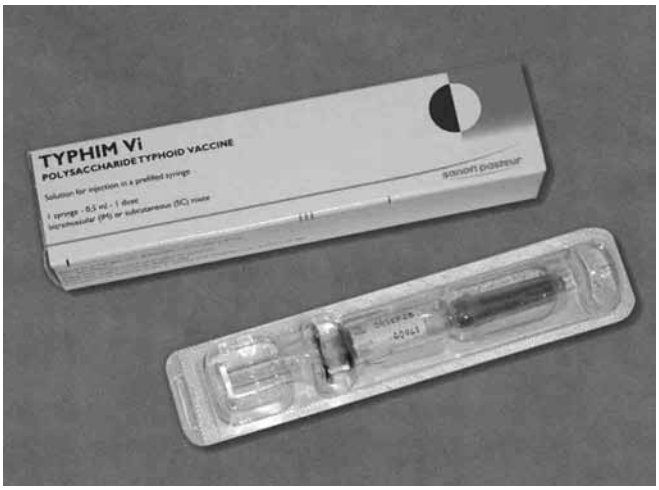


Fig. 20.37 Typhoid vaccine (cellular extract)

developed about 10 to 15 days after the injection and lasts for 3 years. Efficacy is 80 percent. It is not recommended for children below 3 years, because typhoid is rare below 3 years of age. Booster dose is recommended once in 3 years. Acute febrile illness is a contraindication. Best stored between 2 and 8°C. It is marketted Typhim-Vi. **(Fig. 20.37)**.

ACUTE DIARRHEAL DISEASES

These are a group of diseases, in which the predominant symptom is diarrhea.

Diarrhea is defined as passing three or more times, loose or watery stools, per day. However, passing even once a large amount of watery stools among children also constitutes diarrhea. Frequent passing of normal stools is not diarrhea. Breastfed children often pass soft stools. This is also not diarrhea. Loose stools is a one that would take the shape of a container.

Acute diarrhea means sudden onset of diarrhea with or without vomiting and fever. It may continue for 10 to 14 days. Diarrhea lasting for 3 weeks or more, is called chronic diarrhea. Dysentry means passing blood and mucus.

The term 'gastroenteritis' means inflammation of the intestine, characterized by diarrhea, with or without vomiting and fever. Thus this term is frequently used to describe acute diarrhea.

Diarrhea is dangerous because of two complications, namely dehydration and malnutrition.

Dehydration means loss of fluids (water) and electrolytes (minerals) from the body, either due to loss of absorbing capacity of the intestine or due to increased secretion of electrolyte rich intestinal juice. If these fluids and electrolytes are not replaced quickly, it leads to acidosis, renal failure, shock (peripheral circulatory failure) and death. Such a state of dehydration occurs faster among infants and young children than among adults.

Rehydration means replacement of fluids and electrolytes. That means correction of dehydration.

Malnutrition (loss of body weight) occurs because of three reasons:

1. Decreased intake of nutrients (food) – either due to loss of appetite or food taboos and blind beliefs and restricting the food intake.
2. Increased loss of nutrients due to diarrhea and vomiting.
3. Increased demand for the nutrients due to biochemical activities following infection of the intestine.

Such an undernourished child becomes more susceptible for other acute infections, making the condition still worse.

Magnitude of the Problem

Global

Diarrheal disease is a major public health problem in all the developing countries like Asia, Africa and Latin America. It is estimated that nearly 750 million children below 5 years of age suffer from diarrheal diseases every year and nearly 5 million children under-fives die from it per anum, at the rate of 10 per minute.

India

In India, out of 120 crores of population, under-fives constitute 15 percent of total population, i.e. 18 crores. It is estimated that nearly 1.5 million under-fives are dying every year only due to acute gastroenteritis. Infants are hit hardest. It comes to about 5000 deaths per day, 200 per hour and 3 per minute. 70 percent of them die following dehydration. Ninety percent

of these deaths are preventable provided little care is taken with the onset of diarrhea to see that the child is rehydrated with oral rehydration therapy.

Causes of Diarrhea

- Infections and infestations
- Malnutrition
- Metabolic disorders (like inborn error of metabolism such as congenital enzyme deficiency)
- Drug (Iatrogenic, e.g. broad spectrum antibiotics destroy the gut-flora)
- Allergic
- Psychological (nervous)
- Idiopathic (unknown).

Infectious Diarrhea

The infectious agents are viruses, bacteriae, protozoa and certain fungi, in the order of frequency.

Viruses

Viruses are responsible for nearly 50 percent of the episodes, of which Rota-virus (discovered in 1973) has been found to be the single most important cause of diarrhea among infants. The other viruses are adenovirus, astrovirus, coxsackie virus, calcivirus, corona virus, echovirus, norwalk—agents and parvo-virus. The viruses result in destruction of villi.

Bacteriae are responsible for about 45 percent of the cases. In the order of frequency of cause, they are *Vibrio Eltor, Escherichia coli, Campylobacter jejuni, Shigella*, and *Salmonella*. *Vibrio Eltor* and *E. coli* (entero-toxigenic strain) produce a potent entero-toxin, which produce 'adenyl-cyclase' enzyme in the intestinal cells, which increases the production of 'cyclic adenosine monophosphate' (cyclic—AMP), which drives the fluids and electrolytes out from the cells into the lumen of the gut. Thus they act by toxin.

Campylobacter jejuni do not seem to produce any toxin. Among shigella group, shigella dysenteriae type-1 is the commonest one, often resulting in epidemics of bacillary dystentry.

Protozoa like *Entamoeba histolytica* and *Giardia lamblia* are responsible in about 5 to 8 percent of the cases. Their role in acute diarrhea is minimal. However, they result in sub-acute and chronic illness, by causing mucosal adhesions and shortening of villi.

Among fungi, *Cryptosporidium* is the important one. Diarrhea is neither severe nor prolonged, except in immuno-deficient patients such as malnutrition and AIDS. It belongs to toxoplasma group. Infection can occur through contact with pets and farm animals.

Mixed infections can occur in about 2 to 5 percent of cases. Among young children, diarrhea often occurs in conditions of ENT infections, respiratory or urinary infections or even with simple teething process.

Reservoir

In most cases, human being is the principal reservoir. Often animals also act as reservoir for *Salmonella*, *Campylobacter* and *Yersinia enterocolitica* and also for fungi like *Cryptosporidium*.

Age Incidence

Diarrheal disease occurs in all the age groups. However, it is common among young children below 5 years and infants are hit hardest. Infantile diarrhea deserves special mention, because very soon they develop dehydration. Younger the age, faster is the development of dehydration. Infantile diarrhea constitutes an important cause of infant mortality in India **(Table 20.15)**.

Sex Incidence

It is equal in both the sexes.

Environmental Factors

Bacterial diarrheas are common during summer and viral diarrheas during winter season.

Predisposing Factors

There are many social factors, responsible for the prevalence of diarrheal disease such as poverty, illiteracy, ignorance, lack of sanitation, lack of protected water supply, poor standard of living, all playing together. The important influencing factors in infantile diarrhea are malpractices in breastfeeding such as feeding prelacteal feeds, discarding colostrum, using feeding-bottles, pre-mature weaning, etc.

Thus, diarrheal diseases in general, are multifactorial in origin.

Mode of Transmission

The diarrheal diseases are exclusively transmitted through 'feco-oral' route, i.e. through the faecal contamination of 6 Fs (described under typhoid.)

Related Terms

Secretory Diarrhea

It is due to decreased absorption of and increased excretion of fluids and electrolytes in the gut. This occurs in all infectious diarrheas.

Osmotic Diarrhea

It is due to ingestion of an osmotically active substance, which prevents the absorption of fluids and electrolytes from the lumen of the gut, resulting in diarrhea, e.g. purgatives like $MgSO_4$, isotonic saline, etc.

Table 20.15 Assessment of the child with diarrhea for the degree of dehydration and management

Degree of dehydration → Signs	A	B	C
a. Look for • General condition* • Eyes • Tears on cry • Mouth and tongue • Thirst*	 Well, alert Normal Present Moist Not thirsty (drinks normally)	 Restless, irritable* Sunken Absent Dry Thirsty* (drinks eagerly)	 Lethargic, floppy*, unconscious, Deeply sunken and dry Absent Very dry Very thirsty* but (drinks poorly or unable to drink)
b. Feel for Skin pinch*	 Goes back quickly within a second	 Goes back slowly*, takes 1 to 2 seconds	 Goes back very slowly*, takes more than 2 seconds
c. Decide	Patient has no signs of dehydration	If the patient has 2 or more signs including at least 1 key sign*, there is 'some dehydration'	If the patient has 2 or more signs including at least 1 key sign*, there is 'severe dehydration'
d. Treatment	Plan A with home available fluids to prevent dehydration	Plan B With WHO recommended ORS solution to correct some dehydration	Plan C With IV Infusion urgently to correct severe dehydration and to prevent death
Fluid deficit is	< 5% of body weight	5-10% of body weight	>10% of body weight

* KEY signs

Effects of Loss of Fluids and Electrolytes

- Loss of water results in hypovolemia.
- Loss of sodium and chlorides results in electrolyte imbalance (Hyponatremia).
- Loss of bicarbonate salts favors the development of acidosis and renal failure. When HCO_3 level falls below 12 m. Mol/liter, breathing becomes deep and hurried (Kussmaul type of respiration). It indicates acidosis. Anuria indicates renal failure.
- Loss of potassium salts (Hypokalemia), which usually occurs in the later stage, results in muscular weakness, cardiac arrhythmia and paralytic ileus.

Incubation Period

Varies from few hours to few days.

Clinical Features

These are mainly due to dehydration. In the early stages among children, the child is irritable, thirsty and drinks water eagerly. As the condition progresses, dehydration worsens. The child becomes more irritable, develops pinched look due to dry and sunken eyes, anterior fontanella is depressed in an infant, tongue becomes dried, abdomen becomes scaphoid, child passes urine at longer intervals, and scanty, later, skin looses elasticity. There may be associated features like fever, vomiting, etc.

If not attended to at this stage and if the condition progresses, the child develops shock characterized by all features of peripheral circulatory failure such as hypothermia (cold extremities), rapid and thready pulse, drowsiness or even unconsciousness and hypotension.

Acidosis and renal failure is characterized by Kussmaul type of respiration and anuria. Meanwhile hypokalemia occurs followed by coma and death.

Degree of Dehydration

Assessment of degree of dehydration is necessary for the management purposes and that is done by 'Looking' and 'Feeling' for the signs of dehydration, including three 'KEY-SIGNS', i.e. General condition of the child, Thirst and Skin-pinch.

Note:

- Always move from column C to column A for assessment and management
- Skin-pinch is less useful in patients with malnutrition (marasmus), kwashiorkor and obesity
- Tears on cry is a relevant sign only among infants and young children.

Treatment Plan A (Prevention of Dehydration)

There are three rules:

1. Increase fluid intake—to prevent dehydration, i.e. to maintain hydration
2. Continue feeds (food) to prevent malnutrition
3. Watch for signs of dehydration—to prevent acidosis, renal failure and death.

Increase fluids: Risk of dehydration starts with onset of diarrhea. Therefore, oral fluids must be started from the time of onset of diarrhea with the Home Available Fluids (HAF), such as rice ganji, barely water, carrot soup, butter milk, lassi juice, fruit juice and weak tea. Tender coconut water is not necessary because it is poor in sodium and rich in potassium. Infact, sodium is required in the early stage of diarrhea and not potassium. Potassium is required only in the advanced stage. Thus, tender coconut does not serve the purpose. One liter of tender coconut provides 3 mg of sodium, 70 mg of potassium and 160 to 200 kcal of energy.

Best HAF is 'Salt–Sugar Solution (SSS)'

It is prepared as follows:
8 level spoons of sugar + 1 level spoon of salt + 1 liter of potable water

(= 40 g of sucrose) + (5 g of NaCl) + (1 liter of boiled and cooled water).

or

1 closed fistful of sugar + 3 finger pinch of salt + 1 big glass (250 – 300 cc) of water.

After preparing SSS, it should taste like tears.

Dose—50 to 100 mL, after every loose stool for a child below 2 years of age.

100 to 200 mL, after every loose stool for a child between 2 and 10 years of age.

As much as the patient desires for a child above 10 years and for adults. If the child vomits, mother should wait for about 10 minutes and then continue to feed slowly with small amounts.

Administration of SS Solution with HAF constitutes Oral Rehydration Therapy (ORT). This is based upon the principle that in diarrheal diseases, absorption of sodium and other electrolytes is impaired but not glucose. Therefore, when glucose is given alongwith sodium chloride and water, glucose is absorbed first, which enhances the passive absorption of sodium chloride which in turn promotes the absorption of water, thereby prevents or corrects dehydration. Thus, ORT does not stop diarrhea but maintains hydration, thereby prevents or corrects dehydration.

This was observed in 1960-itself but the method of ORT was introduced by WHO/UNICEF in 1971. Thus, introduction of ORT has opened a new avenue in the control of diarrheal diseases. Still better HAF than SS Solution is the SS Solution with half a lemon squeezed into it, because lemon provides sodium citrate.

Continue feeds (or food): To prevent malnutrition. If the child is on breast milk, continue breastfeeding more frequently. If the child is on solid food, soft cooked food is given more frequently. Child should be given additional meals after the episode of diarrhea, to make up the weight loss.

Watch for the signs of dehydration: Mother must be educated about the signs of dehydration and to watch for it. She must be instructed to bring the child back to the doctor, if the child does not improve even after 2 days or if it develops signs of dehydration.

Treatment Plan B (Correction of Some Dehydration)

When the child has developed some dehydration, HAF are not ideal for correction of dehydration. The ideal method would be WHO/UNICEF recommended balanced oral rehydration salt–sugar (ORS) solution. The salts and sugar are made available in a dry powder form, in a packet, to be reconstituted when required. This can be used to correct some dehydration, resulting from diarrhea of any cause, in any age group, including newborns. After correction of some dehydration, ORS. Solution is continued to be used to maintain hydration till the disease is cured.

The scientific formula per packet consists of:

Sodium chloride (NaCl)	3.5 g
Sodium-bi-carbonate ($NaHCO_3$)	2.5 g (or Trisodium citrate – 2.9 g)
Potassium chloride (KCl)	1.5 g
Dextrose (Glucose)	20.0 g

One such ORS packet of powder to be dissolved in 1 liter of clean drinking water, preferably boiled and cooled. The mixture is called ORS solution. Once it is prepared, it should not be used beyond 24 hours. It should be prepared fresh every time. Once it is prepared, it should not be boiled, because it will alter the nutritive value. Trisodium citrate insead of sodium bicarbonate makes the product more stable and also helps in better absorption of sodium and water.

Such a solution per liter provides 90 mEq of sodium
80 mEq of chloride
30 mEq of bicarbonate
20 mEq of potassium.

Sodium prevents hyponatremia and along with chloride it replaces electrolytes and maintains electrolyte balance. Bicarbonate prevents acidosis and renal failure. It also serves to enhance sodium absorption. Potassium prevents hypokalemia (hypopotassemia) which is likely to occur in the later stages of dehydration. Absorption of glucose facilitates the passive absorption of salts and water. However, increasing amount of glucose is potentially dangerous, as it can worsen diarrhea by resulting in reverse osmosis of water into the gut with subsequent loss in the stools. The solution then becomes a dehydrating solution instead of rehydrating solution.

For the correction of some dehydration, following dose of ORS solution is recommended in first four hours.

50 to 100 mL per kg body wt. [≈ 75 mL × Wt (in kg)] per 4 hours. Or

According to the age, the dose is as follows:

< 1 year	– 500 mL	to be used in first four hours. If the patient wants more, can be given.
1–2 years	– 750 mL	
2–4 years	– 1000 mL	
4–10 years	– 1500 mL	

After 4 hours, the child is reassessed for the degree of dehydration by moving from column C to column A. If there is improvement and no signs of dehydration seen, treatment is shifted to plan-A. If there is no improvement and some dehydration persists, ORS is continued (repeat plan-B treatment) and if there is severe dehydration, treatment is shifted to plan-C.

'Super ORS' is an improved ORS formulation, in that it contains lysine/glycine, an essential amino-acid, present in the cereal (rice). This organic molecule not only enhances the absorption of sodium and water from the lumen of the gut but also induces reaborption of endogenous intestinal secretion, thus reducing the volume, frequency and duration of diarrhea.

To prepare one liter of Super ORS, 50 g of rice-powder is boiled in 1.1 liter of water for 5 minutes. The extra 0.1 liter of water allows for the loss, by evaporation, while boiling. It is then cooled, to which one packet of ORS powder is added and mixed well. Such a cereal based ORS solution should be used within 8 to 12 hours, after which fresh solution should be prepared.

Merits of ORT

- 90 to 95 percent cases of acute watery diarrhea can be managed with ORS alone at home
- It is of modern scientific technology
- Preparation is easy and administration is also simple and safe
- It prevents hospitalization and thus reduces the cost of treatment
- It involves the mother directly in taking care of her child
- It has minimized the use of antibiotics
- It is free from side effects
- It has reduced the mortality due to dehydration considerably.

  Thus ORT is scientifically sound, practically adoptable, culturally acceptable and economically cheap. Thus, it is of 'Appropriate Technology,' which is one of the principles of primary health care.

Limitations of ORT

- ORT cannot be given to those, who have persistent vomiting or unconscious or in a state of shock due to severe dehydration
- It cannot be given to those, who have paralytic ileus and marked abdominal distension
- It cannot also be given to those who have 'Glucose Malabsorption syndrome'
- Its use among Low Birth Weight babies has not been evaluated.

Maintenance of Hydration (i.e. by Treatment Plan A)

After correction of some dehydration with ORS, hydration has to be maintained, till the patient is cured, by giving, after every loose stool 50 to 100 mL of ORS for a child below 2 years and 100 to 200 mL for a child between 2 and 10 years and as much as for adults. Thirst is the adequate guide.

Treatment Plan C (Treatment of Severe Dehydration)

This consists of hospitalization and replacement of fluids and electrolytes by intravenous infusion. The best IV fluid is Ringer's lactate. It is a polyelectrolyte solution containing Na, K, HCO_3 and lactate but not glucose (Lactate is metabolized to bicarbonate).

Dosage of IV Fluids

Age	First give 30 mL/kg	Then give 70 mL/kg wt	Total
Infants	in 1 hour	in 5 hours	100 mL/kg in 6 hrs
Older children	in 30 minutes	in 2 ½ hours	100 mL/kg in 3 hrs

After starting the IV infusion, reassessment is done every alternate hour and the infusion is continued till the general condition improves. The signs of improvement are return of strong radial pulse, improved level of consciousness, ability to drink improved, skin turgor and passing of urine. If the patient does not pass urine within 3 to 4 hours, renal failure is suspected and an osmotic diuretic such as Mannitol drip is given intravenously instead of Ringer's lactate solution, till the patient passes urine.

As the general condition improves and the patient is able to drink, drip is disconnected and ORS solution is continued to maintain hydration, till the patient is cured. For maintenance therapy, thirst is the adequate guide. Patient is told to drink ORS solution as much as he/she wants to quench the thirst.

Prevention and Control

Elimination of Reservoirs

This consists of treatment of cases and carriers and making them non-infectious. This includes the following steps:

- Prevention of dehydration (Treatment Plan A)
- Correction of some and severe dehydration (Treatment Plan B and C)
- Maintenance of hydration
- Chemotherapy
- Restoration of nutritional status
- Treatment of associated features

  First three steps are already explained.

Chemotherapy: Antibiotics play no role in the treatment of viral diarrheas, because they are self limiting diseases. However, in bacterial diarrheas, specific antibiotic has to be given as per the stool culture report. For amoebiasis and giardiasis, metronidazole or tinidazole is an excellent drug.

Binding agents like pectin, kaolin, bismuth salts are not scientifically useful, but only give psychological satisfaction by making the stools appear more solid temporarily.

Anti-motility drugs reduce paristalsis and give temporary relief, e.g. Diphenoxylate hydrochloride (Lomotil, Loperamide). In fact they give more time for the bacteriae to multiply in the gut and results in prolonged illness.

Role of anti-secretory agents has not been evaluated.

Zinc sulphate: In addition to ORS, for treatment of diarrhea, zinc sulphate has been shown to substantially reduce the use of unwarranted drugs during acute diarrhea. It reduces child mortality by 3–5 percent. It also decreases the further episodes of diarrhea. Dose is 20 mg (1 tab) daily for 14 days children above 6 months and 10 mg (½ tab) for children between 2 and 6 months. Not recommended below 2 months of age.

Restoration of Nutritional Status

Since the diarrheal disease is known to result in malnutrition, the nutritional status can be restored by giving breastfeeding more frequently to a breastfed child and by giving more frequently soft cooked diet to the older children.

Treatment of associated features: Such as vomiting, fever, pain abdomen are treated symptomatically.

Breaking the Channel of Transmission

Since the mode of transmission of diarrheal diseases is by feco-oral route, it can be broken by construction of 'Sanitation barrier' (explained under control of typhoid fever).

Protection of susceptibles by the following measures:

- Health education of the people about
  - Improvement in the living condition
  - Sanitation in and around the house
  - To maintain personal hygiene
  - Correct weaning and feeding practices
  - To use protected water supply for drinking purposes
  - If not available, use boiled and cooled water for drinking
- Vitamin A prophylaxis for children below 3 years, which improves the integrity of intestinal epithelium and prevents diarrhea.
- Routine immunization against measles to prevent post measles acute gastroenteritis.
- Immunization against cholera during the fear of outbreak.

Newer Antidiarrheal Vaccines

They are under trial such as vaccine against rota-virus, oral cholera vaccines, anti-shigella vaccines, anti-enterotoxigenic *E. coli* vaccines.

Rota Virus Vaccine

The Rota virus vaccine (RV vaccine) vaccine namely Rota Shield vaccine licensed for use in US was withdrawn from the market during 1999, because of its association with intussusceptions.

There are three, new, live, oral, attenuated RV vaccines. The monovalent human rotavirus vaccine (Rotarix) and the pentavalent bovine – human, reassortant vaccine (Rota Teq). They provide 75-85 percent protection against rotavirus diarrhea and 90-100 percent protection against rotavirus disease. Thus both are safe and effective.

Mexico is the first country to introduce Rotarix in 2004 and then US in 2008.

Rotarix

This is a three dose schedule, given orally, to infants during two and four months of age, the first dose is given as early as 6 weeks of age, but definitely not beyond 12 weeks of age and the second dose after 4 weeks, i.e. 10th week and third dose during 14th week.

Composition: Each dose of 1.0 mL contains live attenuated human rotavirus RIX 4414 strain, not less than 10^{60} CCID50. It is a lyophilised vaccine to be reconstituted with a liquid diluent before oral administration. It prevents gastroenteritis due to rotavirus infection. It is given orally and never injected **(Fig. 20.38)**.

Contraindications: Hypersensitivity to previous dose and congenital malformation such as Meckel's diverticulum of gut would predispose to intussusception. Administration is postponed under circumstances of nausea, vomiting and acute febrile disease. Storage temperature is 2 to 8°C. If it is not used within 24 hours of reconstitution, it should be discarded. After reconstitution, it should be used immediately or kept in refrigerator.

The instructions for reconstitution and administration of rotarix vaccine is shown in the **Figure 20.39**.

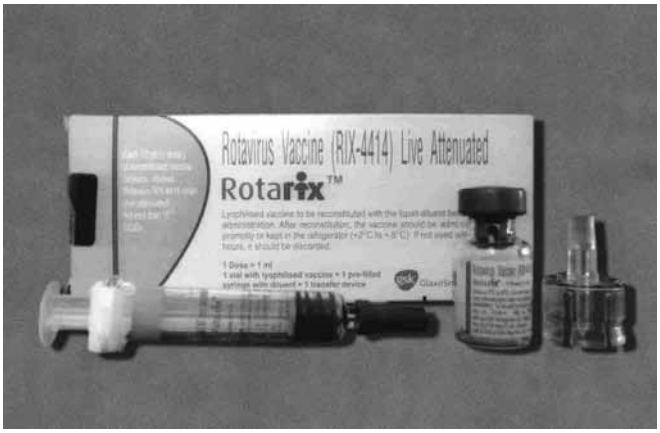


Fig. 20.38 Rotarix vaccine

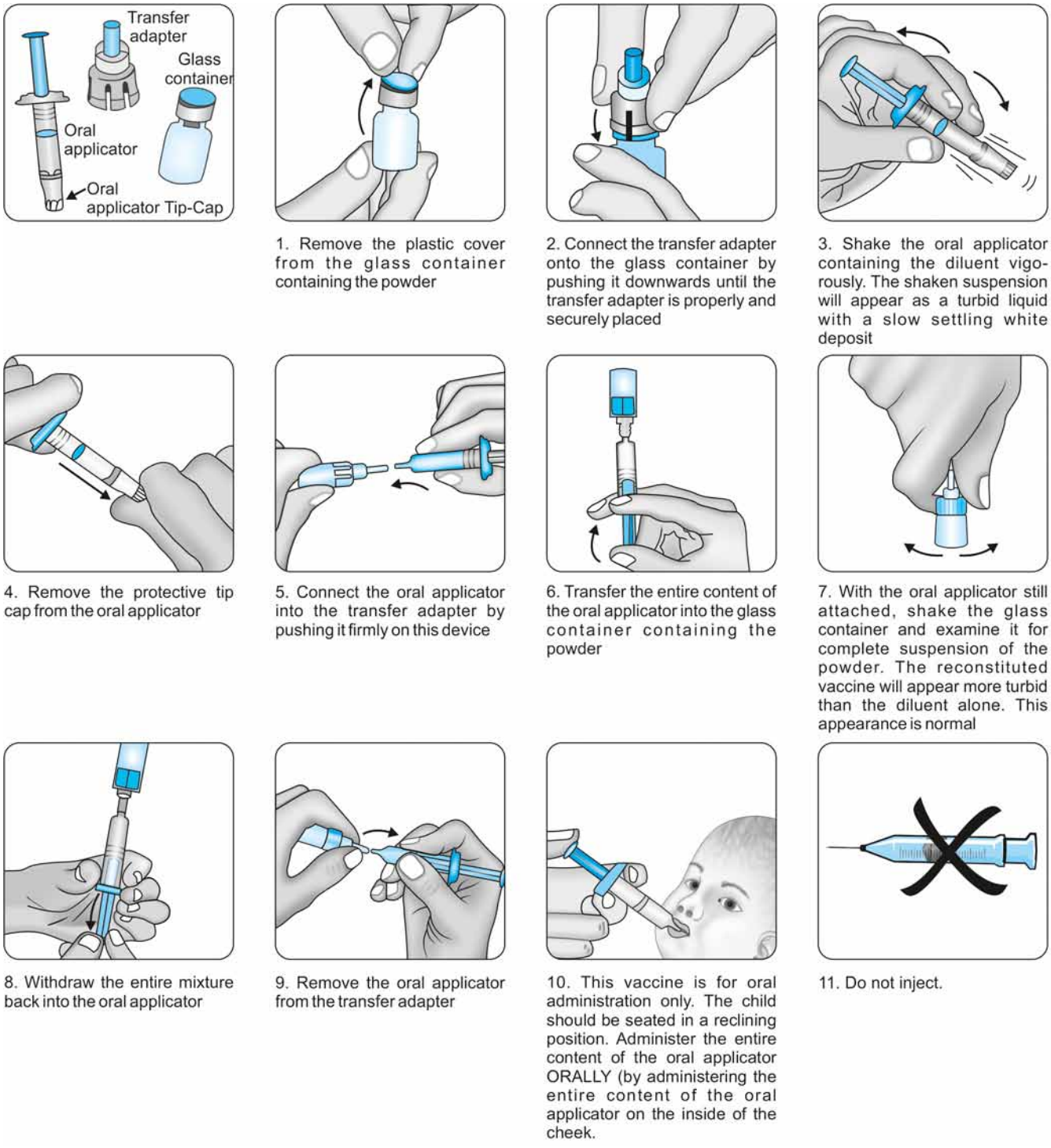


Fig. 20.39 Instructions for reconstitution and administration of Rotarix vaccine

Rota Teq

This is a three dose schedule, given orally, at ages two, four and six months, starting as early as six weeks of age. Immunization should not be initiated beyond 12 weeks of age, because of the potential risk of intussusceptions. Three doses should be completed before 32 weeks.

Limitations:
- They provide protection only against childhood diarrhea.
- Each dose costs ₹ 1000/- in India.

ORT–Corner

It is a center (place) established in primary health centers or sub-centers, where mothers are demonstrated about the preparation of ORS solution and the assessment of the children for signs of dehydration. The cases of some dehydration are fed with ORS solution and are kept under observation for further management.

CHOLERA

It is an acute, infectious, disease of the small–intestine, caused by the bacteriae *Vibriocholerae*, transmitted usually by the fecal contamination of food and water, clinically characterized by sudden onset of painless, profuse, effortless, watery diarrhea, followed by vomiting, muscular cramps, rapid onset of dehydration, acidosis, renal failure, shock and death. Case fatality rate is 30 to 40 percent.

History

Cholera has an endemic disease in our country, since the beginning of the recorded history, often resulting in epidemics and pandemics. In India it was originated from the regions of river Ganges and Brahmaputra. Therefore, West Bengal and Bangladesh is considered as 'Home' of cholera. It was in 1817, that cholera broke out into an epidemic causing high fatality and in a short time spread to many countries in all directions, affecting millions of people. Between 1817 and 1923, six pandemics occurred, all caused by classical vibrios, five of which originated from its hometown, India. After 1923, the disease retreated from the European countries to India. So it was called as 'Asiatic-cholera'. The seventh pandemic broke out in 1961, starting from the island of Sulawesi (Celebes) of Indonesia, spread all over the world and reached India by 1964. The seventh pandemic was not caused by classical vibrois but by Vibrioel tor. By 1965, eltor vibrios completely replaced classical vibrios, still continuing the seventh pandemic.

After the eltor vibrio reached India in 1964 replacing classical vibrios, West Bengal lost its reputation as 'Home of cholera'. Many states in India became an endemic foci of this disease, with periodical epidemics. But the epidemics with Eltor are not explosive, but only protracted, lasting for several weeks with low mortality.

Magnitude of the Problem

Cholera is responsible for about 5 to 10 percent of all acute diarrhea cases in the country, thus constituting one of the major public health problems.

Epidemiological Features

- Cholera epidemic is a self-limiting disease. (It declines after reaching its peak, due to acquisition of temporary immunity and also due to large number of sub-clinical cases).
- Acute peak of the curve is due to force of infection through water and tail of the curve is due to force of infection through contacts **(Fig. 20.40)**.
- The nature of the epidemic curve is sudden rise and gradual fall.
- The tail of the curve is due to the continuation of the transmission through contacts and carriers.
- During inter-epidemic period, cholera is hidden among carriers.

Agent Factors

Causative Agent

The causative organism is *Vibriocholerae*. (Latin: 'Vibrare' means 'to vibrate'). Classical vibrios was first discovered by Robert Koch in 1883 in Egypt.

The other variant namely Vibrio-eltor was isolated in 1905 from Mecca-Pilgrims at a place called 'eltor' in Egypt by Gotschlick.

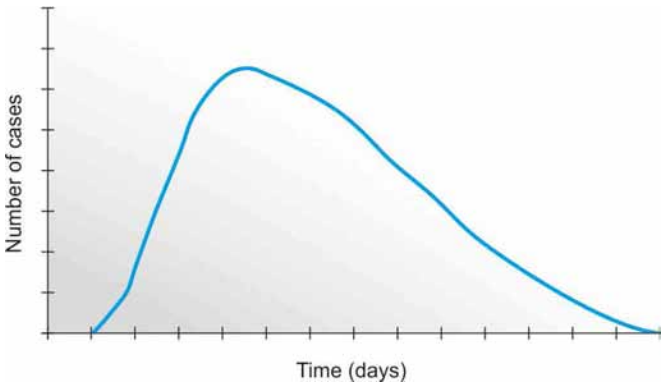


Fig. 20.40 Epidemic curve of cholera

Vibrio is a comma shaped, minute, bacillus, of 1 to 5 mm in length and 0.3 to 0.4 mm in breadth. It is Gm –ve, actively motile, flagellated bacillus. It is aerobic, non-spore forming. It often shows pleomorphism. Hence it is also called cocco-bacillus. Often two or more bacilli are united, giving an 'S' shaped body. Several such 'S' shaped bacilli are united giving a spirillar appearance in old cultures.

Vibrios show their motility as 'fish in a stream'. The movement is called as 'darting' or 'scintillating' movement. It is also described as 'shooting stars' in the dark sky. The vibrios are very susceptible to heat at 56°C, dessication, acids and disinfectants like bleaching powder, cresol and $KMnO_4$. With bleaching powder, they are destroyed by super chlorination (at 5–6 ppm.) Vibrios can remain alive in natural water, favored by temp of 18 to 23°C, pH between 6 and 9 and salt content of 1 to 4 percent. They can remain alive in ice also for about 4 to 6 weeks.

On autolysis, they release enterotoxin in the gut, which is responsible for its pathogenesis. The produce H and O antigens. H-antigen is heat labile, non-specific, non-protective, flagellar-antigen. O-antigen is heat stable, specific and protective somatic antigen.

Serological Classification (Gardner and Venkataraman's Classification)

Depending upon the property of agglutination with polyvalent antisera, vibrios were classified into two major groups: namely Agglutinating (Epidemic Strains) and Non-Agglutinating Group Vibrios (NAG) in the past. They are now respectively called as Vibrio Cholerae 0 group 1 (or vibrio cholerae 01) and Vibrio cholerae non – 0 group 1. (i.e. Epidemic and Non epidemic Strains respectively).

The 0 group 1 consists of two bio-types: classical and eltor. Since 1965, eltor biotype has totally replaced the classical vibrios. Each biotype is further divided into 3 sero-types namely Inaba, Ogawa and Hikojima strains. The eltor biotype isolated in India belong to Ogawa serotype.

Eltor differs from classical vibrios in that:

- It agglutinates chicken and sheep erythrocytes
- It is resistant to Polymyxin B and to classical phage IV
- It gives positive reaction to Vogues – Proskauer test (not consistent)
- It survives in adverse conditions
- It produces more number of mild cases and a greater carrier state.

The non 0 group 1 includes pathogenic strains like vibrio-parahemolyticus which have caused outbreaks of cholera-like diarrhea (food-poisoning).

The culture of vibrio-eltor in nutrient agar shows smooth, moist, raised, transluscent, bluish colonies.

Infective material: It is the stools and vomitus of cases and carriers.

Period of Infectivity

A case of cholera is infectious for about 8 to 10 days, an incubatory carrier for 1 to 5 days, a contact carrier for about 10 days, a convalescent carrier for about 15 to 20 days and a chronic carrier for about few months to few years.

Reservoir of Infection

The human being is the only known reservoir of infection. These are no animal reservoirs. Such a human reservoir may be a case or a carrier. A case of cholera may be an active clinical case or a subclinical case. For every case there are about 50 to 100 subclinical, inapparent cases. (1 : 50 – 1 : 100).

Among the carriers, all types of carrier state is known to occur in cholera, i.e. incubatory, contact, convalescent and chronic carriers.

The subclinical cases and the carriers are responsible for the prevalence of the disease in the country.

Host Factors

Age and Sex

No age and sex is bar from cholera. during epidemics, usually adults are affected and during non-epidemics, children are affected. They develop immunity as they grow older.

Environmental Factors

Season

Cholera has got a definite seasonal trend. The season varies from state to state. In Karnataka, it is high in May and June months.

Climate

We found that cholera tends to occur only when the absolute humidity exceeds 10 mmHg vapor pressure. Humidity often helps in forecasting the epidemic.

Modes of Transmission

In 1855, John Snow proved that cholera is transmitted through the ingestion of water contaminated with the excreta of cholera patients. Thus cholera is transmitted by feco-oral route, not only through water, but also through contaminated food, fruits and vegetables. House flies act as mechanical vectors. Contaminated fingers and fomites also transmit the disease (6 Fs. explained under typhoid).

Predisposing Factors

Poverty, illiteracy, ignorance, poor standard of living with lack of sanitation greatly favor the spread of the disease.

In addition to these, other factors such as fairs, festivals and pilgrimages, which are peculiar in our country, are going on throughout the year, in one part or the other, exposing a large number of people, even in lakhs as in Ardh-Kumb (in Allahabad) and *Kumbha mela* (in Hardwar) under insanitary conditions, also predispose for epidemics.

Pathology and Pathogenesis

It is the same as that of toxigenic strains of *E.coli*, i.e. the vibrios in the intestine secrete an enzyme called 'mucinase' which helps the organisms to pass through the mucus. The pathogens then get attached to the surface of the epithelial cells with the help of adherence factor. On autolysis, the pathogens release endotoxin, (enterotoxin), which consists of 2 parts namely L (light) toxin and H (heavy) toxin. L-toxin helps in irreversible binding of the vibrios with the cell-wall. The H-toxin activates an enzyme called 'Adenyl-cyclase', which in turn increases the secretion of another substance called 'Cyclic Adenosine Monophosphate' (CAMP) which drives the fluids and electrolytes from the intestinal epithelial cells into the lumen of the gut, which when expelled constitutes diarrhea of cholera; It used to be 'Rice-watery' stools in cholera, caused by classical vibrios and just watery by Eltor vibrios.

Incubation Period

Varies from a few hours to a few days (Average 1–2 days).

Clinical Features

There is sudden onset of painless, profuse, effortless, watery diarrhea followed by vomiting.

Once the vomiting sets in, there will be rapid onset of dehydration and collapse characterized by sunken eyes, hollow cheeks, scaphoid abdomen, hypotension, hypothermia, rapid, feeble and thready pulse, loss of skin elasticity and hurried respirations. Decreased output of urine indicates anuria and renal failure. These will be associated cramps in the legs. Kussmaul's type of respiration indicates acidosis. Thus dehydration leads to acidosis, renal failure and death. CFR is 10 percent **(Table 20.16)**.

Laboratory Investigations

This consists mainly of examination of stools of a cholera patient and water sample of the suspected source.

Method of Collection of Stools

- *Rubber catheter method:* A sterile rubber catheter of no. 26 to 28 is lubricated with liquid paraffin and passed into the rectum for about 5 cm and stool is collected in a sterile McCartney bottle of 30 mL capacity at the other end, containing holding (or transport) media (Venkataraman – Ramakrishnan medium or Alkaline Peptone water). Collection of stools by catheter is the best method.
- *Rectal swab method:* A sterile rectal swab is dipped into the holding medium and then inserted into the rectum and a swab is taken, placed in the sterile plastic bag, tightly sealed and sent to the laboratory.

Table 20.16 Differences between cholera and food poisoning

	Cholera	Food poisoning
Diarrhea	Precedes vomiting	Follows vomiting
Tenesmus	Absent	Present
Stools	Watery and not offensive	Never watery and offensive
Vomiting	Projectile Follows diarrhea	Violent and distressing Precedes diarrhea
Vomitus	Watery	Never watery
Urine	Secretion suppressed	Never suppressed
Muscular cramps	Constant and severe	Occurs only in severe cases
Fever	is sub-normal	is increased
Headache	is absent	is present
Leads to	Acidosis	Alkalosis

Method of Collection of Water

About 1 to 3 liters of water is collected from the suspected source and mixed with 10 percent of alkaline–peptone (A-P) water in the ratio of 9 volumes of water with 1 volume of A-P water, sealed and sent to the laboratory by the quickest mode of transport.

Culture

In the laboratory, the stool specimen is inoculated into the enrichment medium, i.e. potassium tellurite and incubated for 6 hours and then inoculated into the Bile Salt Agar or Meat Extract Agar and incubated for 24 to 48 hours.

If the stool sample is collected by rectal swab method, the culture media used in Cairy Blair media.

V. cholerae usually appear as translucent, moist, smooth, raised and easily emulsifiable colonies of about 1 mm diameter.

The colonies are picked up and tested as follows:

- *Gm staining:* They are Gm –ve rods.
- *Hanging drop preparation:* They exhibit characteristic scintillating movements. Mixing with polyvalent antisera ceases the motility.
- *Dark-field illumination:* They look like shooting stars in a dark sky.

- *Serological test:* A homogeneous suspension made with sterile normal saline is taken over a slide to which one drop of polyvalent cholera antisera is added. If agglutination is positive, it is repeated with particular Inaba or Ogawa anti-sera, to determine the sub-type.
- *Biochemical examination:* The colonies are then sub cultured in sugar broths sucrose, mannose and arabinose. Fermentation with production of acid in sucrose and mannose but not arabinose is characteristic of *V. cholerae*.
- Other tests are:
  - *Hemolytic test*: V. eltor hemolyse sheep erythrocytes.
  - *Vogues – Poskure test*: V. eltor gives positive reaction to VP test but not consistent results.
  - *Polymyxin B sensitivity test:* V. eltor resistant to Polymyxin B.
  - *Agglutination test*: V. eltor agglutinates sheep or chicken erythrocytes.

Prevention and Control

Elimination of Reservoirs

This consists of making the infectious cases, such as cases and carriers of cholera, non-infectious by giving treatment.

Cases

- Isolation in the hospital, till 2 to 3 consecutive stool culture report comes as negative.
- *Concurrent and terminal disinfection:* Stools and vomitus to be disinfected with cresol.
- Chemotherapy (Particular antibiotic to be given as per the culture report)
- Rehydration therapy (Orally or IV depending upon the degree of dehydration).

Carriers: They are detected only by stool culture report and are treated accordingly.

Thus, reservoirs are eliminated from acting as reservoir or source of infection.

Blocking the Channel of Transmission

Since the disease cholera is transmitted by feco-oral route, the best way of blocking the channel is by construction of 'Sanitation barrier', which prevents the access of the pathogens from feces to the remaining 6 F's, i.e. Fluids (Water and Milk), Food, Fruits and Vegetables, Fomites (utensils), Flies and Fingers (Explained under typhoid).

Protection of Susceptibles

This is done by Immunization and Health education.

Immunization: Two types of vaccines are available against cholera-parenteral and oral vaccines.

a. *Parenteral vaccine:* It is a heat killed, phenol preserved vaccine. Each dose of 0.5 mL contains 3000 million, killed organisms each, of Inaba and Ogawa serotypes of classical vibrios 01, providing cross immunity against Eltor vibrios also.

Primary immunization consists of 2 doses, each of 0.5 mL deep IM with an interval of 4 to 6 weeks. Half of this dose for children below 10 years. Infants need not immunized. Immunity is developed after about 15 days and lasts for hardly 5 to 6 months. Protective value is 50 percent.

Limitations: Use of this vaccine after the outbreak of cholera does not serve the purpose to control the epidemic because the individual develops the antibodies after 15 days of immunization and since the incubation period of cholera is very short, the individual may develop the disease much before he develops immunity. Thus use of this vaccine after the outbreak of cholera is of no value. It is a waste of money, manpower and material. More than that, it creates a false sense of security about the protection.

However, this vaccine will serve the purpose only when given at least one month before the expected outbreak as in fairs and pilgrimages. Under such circumstances single shot of double the quantity (i.e. 1.0 mL) is given.

However, the best way of control of cholera is by providing chlorinated water supply to the community.

b. *Oral vaccine :* These are two types.
   1. Killed whole cell V. cholerae 01 in combination with a recombinant B-sub unit of cholera toxin (WC/rBS) Given orally in 2 doses with 10 to 15 days apart.

      It confers 50 to 60 percent protection. Immunity lasts for 3 year.
   2. Live attenuated CVD 103-HgR vaccine. It is a single dose vaccine, conferring 80 percent protection. Oral antibiotics are avoided for one week before and one week after the administration of live vaccine.

      World Health Assembly, in 1973, abolished the International Certificate of Vaccination against cholera.

Health Education: This is the most effective prophylactic measure. The community is educated about the following point:

- Routes of transmission of cholera and consequences of dehydration
- To avoid open-air defecation and to use sanitary latrines
- To use boiled and cooled water for drinking purposes
- To use ORT with the onset of diarrhea
- To take prompt treatment for diarrhea
- To adopt personal hygiene by washing hands with soap and water before handling food and after using toilet
- To take cholera vaccine, at least one month before going to pilgrimage center, with single shot of double dose.
- To adopt food hygienic practices
- To control house flies, by keeping the premises clean in and around the houses.

VIRAL HEPATITIS

It is an inflammatory condition of the liver, caused by any one of the heterogeneous group of 'hepatitis-viruses', which currently consists of types A, B, C, D, E and G (Type F has been proved to be a mutant of type B virus believed to cause transfusion associated hepatitis. Therefore type F has been deleted from the list of hepatitis – viruses). Type A and E are transmitted by feco-oral route and Types B, C, D by blood and body fluids. Type G rarely causes hepatitis.

The other viruses which have been implicated in hepatitis are cytomegalo-virus, Epstein-Barr virus, yellow fever virus and rubella virus. Viruses of herpes simplex, varicella and adenoviruses can also cause severe hepatitis in immuno-compromised individuals, but are rare.

Hepatitis A

(Acute infectious hepatitis; Epidemic jaundice; Botkin's disease; MS_1 hepatitis; Australia Antigen Negative hepatitis).

It is an acute, communicable, inflammatory disease of the liver caused by Hepatitis A virus (HAV), transmitted by feco-oral route, clinically characterized by sudden onset of fever, often with chills, malaise, anorexia, nausea, vomiting, pain in right hypochondriac region, onset of icterus, high colored urine, light colored stools, often leading on to hepatic failure in fulminant cases, followed by coma and death. The case fatality rate is extremely low, less than 0.2 percent. However, the mortality becomes very high when it affects pregnant mothers.

Magnitude of the Problem

Hepatitis A is an endemic disease in all the developing countries, because of lack of sanitation and poor hygiene, often giving rise to epidemics. Incidence is very low in developed countries.

In India most HAV infection is acquired during childhood and develop immunity by 10 years of age. Largest outbreak occurred in Delhi, in 1955-56, when more than 40,000 people were affected, because of the contamination of the river Yamuna with the sewage. Eventhough the mortality is very low, incapacitation is very high, resulting in great loss of human resource. Another epidemic occurred in Delhi, in 1970, due to contamination of Okhla water supply.

Agent Factors

Causative agent: It is Hepatitis A Virus (HAV). It is an enterovirus, belonging to the family Picornoviridae. It is an RNA virus, 25 to 28 nm in size, possessing cubic symmetry. It is non-enveloped and single stranded virus. Only one serotype is known.

It withstands heat at 60°C but at 100°C, it is destroyed within a few minutes. It is not affected by chlorine in doses usually employed for chlorination, but inactivated beyond 1 ppm.

The viral particles were first demonstrated in the liver cells, by the workers, in Phoenix laboratory in Arizona. Hence the virus is also called Phoenix antigen, but the name is not continued in the literature.

Formalin and 0.5 percent sodium hypochlorite are effective disinfectants.

Reservoir of infection: Human being is the only known reservoir of infection. There is no animal reservoir. Such a human reservoir may be an active clinical case or a sub-clinical (anicteric) case (which is common among children) or a carrier (healthy or incubatory carrier). Such subclinical cases and carriers are responsible for endemicity of the disease in the community. Subclinical infections are more among children in the ratio 1:10 than among adults, ratio being 1:1, for every clinical case. Chronic carrier state does not exist. Cases constitute the tip of iceberg.

Infective material: It is mainly the feces of the case or the carrier. However, blood is also infective during the period of viremia. Once the jaundice sets in, virus is no longer found in the blood but only in feces for about 2 to 4 weeks.

Period of infectivity: The individual is highly infectious during the last 2 weeks of incubation period and for about 1 week after the onset of the disease. Once the jaundice (icterus) sets in, infectivity is reduced.

Host Factors

Age and sex incidence: Susceptibility for HAV is universal. It can occur in the people of any age group in both the sexes. However, the incidence is high among children of 5 to 15 years age. It is common among children, often among adults and rare among elderly. Infection tends to be mild among children and severe among adults, i.e. severity increases with age.

Immunity: is acquired following an infection. It is type specific and there is no cross-immunity. One attack confers life long immunity. However, second attacks are reported in 5 percent of the cases.

Pregnancy: VHA during pregnancy carries a high mortality. There is no transplacental transmission.

Environmental Factors

Poor standard of living with lack of sanitation and over crowding greatly influence the spread of the disease, resulting in epidemics.

Modes of transmission: The disease is mainly transmitted by feco-oral route, i.e. by the fecal contamination of, water, milk, food, fruits and vegetables. House flies act as mechanical

carriers. The disease is often transmitted directly from the patients to the attendants, when the attendant attends to the toilet of the patient and does not adopt personal hygienic measures (6 Fs).

The disease is also transmitted parenterally through blood and blood-products of the case or through the contaminated needles during the period of viremia. But this is rare, because period of viremia is short.

There is no evidence of transplacental transmission. But may be transmitted through sex among homosexuals, by oral-anal contact.

Pathology and Pathogenesis

Having entered the body through the oral route, viruses enter the circulation resulting in viremia. After circulating for some time, the viruses mainly affect liver. Often they affect kidneys, small intestine and spleen. Essential pathology occurs in the liver. There is degeneration and necrosis of the hepatocytes. It is slight and is seen in the central zone of the lobule. Degeneration is followed by regeneration. Thus recovery is the rule. Cell-cords are disturbed but not the reticular frame work. It is only in fulminant cases there is extensive necrosis of liver lobules, damaging even the reticular frame-work resulting in hepatic failure. When there is degeneration of hepatocytes, liver function is affected resulting in hyperbilirubinemia, giving rise to icterus (jaundice). Because of the inflammation of the liver, there is hepatomegaly, giving rise to pressure effects mainly on stomach.

In the kidneys, there is only interstitial edema but no inflammation.

In the spleen, there is hyperplasia of lymphoid tissue.

In the small-intestine, mucous membrane becomes edematous and there is infiltration of mononuclear cells.

Incubation period: It is 15 to 50 days.

Clinical Features

These occur in three stages—pre-icteric, icteric and convalescent stage.

Pre-icteric stage (Prodromal stage)

This is characterized by sudden onset of fever, often associated with chills, fatigue, malaise, headache, and body ache. Within a day or two, the individual will develop gastro-intestinal symptoms due to pressure effect of enlarged liver over stomach, such as anorexia, nausea and even vomiting, followed by high colored urine, light colored stools, lasting for about 3 to 5 days.

There will be discomfort or pain in the right upper quadrant of abdomen.

Icteric stage

This is characterized by onset of jaundice (yellow coloration of sclera). With the onset of jaundice, fever subsides. Sclera looks yellow and skin looks lemon tinged. Severity of nausea and vomiting decreases. However high colored urine continues for several days.

Jaundice usually reaches maximum by 2 weeks and decreases steadily thereafter. On examination of the abdomen, liver is enlarged, soft and tender, surface is smooth. Spleen may be enlarged.

This stage lasts for 4 to 6 weeks.

Convalescent stage (Stage of recovery)

After about 6 to 8 weeks, the inflammatory process comes down, there is regeneration of liver cells, liver regresses in size, pressure effects are released, appetite improves, icterus disappears, urine and stools become normal. This stage lasts for 2 to 6 weeks.

Only in fulminant cases, there will be hepatic coma and death.

Investigations

- Increase in serum bilirubin level.
- Demonstration of viral particles in the stools, by electron-microscopy.
- Demonstration of a rise in HAV antibody titer.
- Demonstration of bile salts and bile pigments in the urine.

Prevention and Control

Elimination of Reservoirs

This is difficult because of the following reasons:

- There is no treatment.
- The individual will have already spread the disease before clinical diagnosis is made (because the cases will be shedding the virus in last 2 weeks of incubation period and first week of illness).
- There will be existence of large number of subclinical cases acting as carriers. Difficult to identify them.
- Infectivity comes down with the onset of jaundice.
- Isolation of the cases also does not help because of above mentioned reasons.
- However, concurrent disinfection of patient's excreta by using 0.5 percent sodium hypochlorite must be carried out.
- Usually this disease occurs among the people of low socio-economic profile.

Since there is no treatment, the cases are managed as follows:

Management

- Absolute bed-rest is traditional. This prevents the patient from getting fatigue, exhaustion, etc.
- Avoiding fatty and oily foods will prevent the liver from secreting more of bile juice, thereby liver gets rest.
- Energy requirement, therefore, have to be made up with carbohydrate rich diet.

- Symptomatic treatment is given with antipyretics and anti-emetics.
- Antibiotics play no role. However, neomycin can be given in advanced cases.
- Steroids play no role, except that they give symptomatic relief. They do not alter the course of the disease. They are indicated only in advanced cases.
- Fluids and electrolyte balance will have to be maintained.

Breaking the channel of transmission

This is the most important measure in the control of an outbreak of VHA. Since the disease is transmitted by feco-oral route, it can be broken by construction of 'Sanitation barrier', which prevents the access of the pathogens from the feces of the cases to (explained under typhoid fever) the mouths of susceptibles through 6 Fs.

Protection of susceptibles

Susceptibles are protected by immunization and health education.

Immunization

- *Active immunization:* Two types of HAV vaccines are now available, namely inactivated vaccine and live attenuated vaccine.
  i. *Inactivated vaccine*: It is a cell-culture liquid vaccine. The Hepatitis Virus of HM-175 Strain (i.e. 'F' strain) is propagated on Human diploid cells, purified by ultrafiltration technique and inactivated by formaldehyde and adsorbed on aluminium hydroxide. Each 1 mL contains not less than 720 Elisa-units of viral antigens. Dose is 1mL for adults and 0.5 mL for children, given IM in deltoid region. Infants are not given. Primary course consists of 2 doses with 4 to 6 weeks interval, followed by a booster dose after 6 to 12 months. Immunity is type specific and lasts for about 15 to 20 years. There is no cross immunity against other hepatitis viruses.

  It is not known whether this vaccine will protect the individual who is already infected. Storage temp is 2 to 8°C. It is marketed as 'Havrix' **(Fig. 20.41A)**.

  A combination vaccine containing inactivated Hepatitis-A and recombinant Hepatitis-B vaccine has been licensed since 1966 for children in several countries. The schedule of the combined vaccine is 0, 1 and 6 months.

  ii. *Live vaccine:* A live, attenuated freeze dried vaccine, containing H_2 strain of Hepatitis A virus, cultured on Human diploid cells, has been developed in China.

  The diluent is sterile distilled water.

  Single dose of 0.5 mL is recommended to administer subcutaneously, in the deltoid region, for all above one year age.

  This has been found to be safe, highly immunogenic with good tolerability and minimal reactogenicity. Immunity lasts for 15 years. No booster dose is required. Storage temperature is +2°C to +8°C.

  This does not provide cross immunity against other hepatitis viruses like B, C, delta and E viruses.

  Hepatitis A freeze dried vaccine is recommended for both pre-exposure prophylaxis of high risk individuals and post-exposure prophylaxis because of long incubation period (15–50 days).

  It is contraindicated in acute febrile illness. However mild illness is not contraindicated. Marketed as Biovac-A **(Fig. 20.41B)**.

- *Passive immunization:* It is by Human Normal Immunoglobulin. It is prepared from the pooled plasma of multiple donors. Since it is not a specific immunoglobulin, it may not protect the person from getting the disease but it may prevent or modify the course of the disease, resulting in subclinical infection.

  It is recommended for those, who are at risk, such as young close contacts and also travelers, going to endemic areas (i.e.

Fig. 20.41A Hepatitis A vaccine (killed)

Fig. 20.41B Hepatitis A vaccine (live)

post-exposure prophylaxis and pre-exposure prophylaxis respectively). Dose—0.02 mL per kg wt for contacts and 0.02 to 0.05 mL per kg body wt for travelers. Dose is repeated for travelers once in 4 months till they return.

Note: Even though Hepatitis B, C and D are not water-borne diseases, they are described here for the purposes of comparison/convenience to the readers.

Hepatitis B

Synonyms

Serum hepatitis, Australia antigen hepatitis, Hippy hepatitis, Homologous serum jaundice, MS2 hepatitis, Tattoo jaundice.

It is an inflammatory disease of the liver, caused by Hepatitis B virus (HBV), transmitted usually parenterally, and clinically characterized by a long incubation period, prolonged period of illness, often leading on to chronic liver disease such as chronic hepatitis, cirrhosis of liver, in about 5 to 15 percent of the cases it may even lead to primary hepato-cellular carcinoma. CFR is about 15 percent. Thus HBV gives rise to persistent infection, prolonged carrier state and progression to chronic liver disease and even liver cancer. HBV often makes an alliance with delta-virus and results in Delta-hepatitis, a new threat to the world.

Magnitude of the Problem

HBV-infection (disease) is a global problem. It is endemic all over the world. More than 2 billion people worldwide have been infected with HBV and out of them 350 million are chronically infected. The latter are prone to a risk of liver cancer and cirrhosis. Every year one million carriers are dying of these two conditions.

In SEAR countries, more than 30 percent of the population have been infected with HBV infection and there are about 80 million carriers (i.e. 6 percent of total population) and about 15 million people are infected with HBV each year. About 2 lakhs have been dying every year.

In India, the carrier state is varying from 2 to 7 percent of the population. In Africa, it is about 20 percent and in Europe and USA it is 0.1 to 0.6 percent.

World is now divided into three zones based on the prevalence of carrier state as:

1. *Low prevalence zone:* HBV carrier rate is < 2 percent of the population. Countries involved are Nepal, Sri Lanka, Australia West Europe, North America. Childhood infections are infrequent.
2. *Intermediate prevalence zone:* HBV carrier rate is 2 to 7 percent.
   Childhood infections are frequent. Countries involved are Bhutan, India, Indonesia, Maldives, East Europe, Japan.
3. *High prevalence zone:* HBV carrier rate is 7 to 20 percent, childhood infections are highly frequent. The countries involved are Bangladesh, Korea, Myanmar, Thailand, Africa, Russia, China Caribbean.

Agent Factors

Causative agent: HBV is a DNA virus, a member of the family Hepadnaviridae, discovered in 1963, by Blumberg. The virus appears in three morphological forms in the serum:

1. Small spherical particles of about 22 nm diameter size, employed in the preparation of the hepatitis B vaccine.
2. Tubular particles of varying sizes and shapes.
3. Larger, double shelled, spherical particles of 42 nm diameter, named after the discoverer as 'Dane particle.'

Only Dane particle, virion, is infectious and not the other two forms. Antigenically it is a complex virus. It has three distinct, antigens namely outer glycoprotein named as 'Surface antigen' (Australia antigen) (HBs Ag), the inner nucleoprotein as 'Core antigen' (HBc Ag) and the 'e-antigen' (HBe Ag). They stimulate the production of corresponding antibodies, namely surface antibody (anti-HBs), core-antibody (anti-HBc) and 'e-antibody (anti-Hbe) respectively. These antibodies and antigens constitute very useful markers of HBV-infection. Detection of surface-antigen (HBs Ag) in the serum is diagnostic of active HBV-infection. Surface antibodies (anti-HBs) is diagnostic of previous HBV infection or development of immunity or recovery. Thus production of surface antibody is considered to be protective. Core-antigen is associated with DNA-polymerase activity (i.e. viral multiplication). Core antibody (anti-HBc) appears during acute HBV infection and persists in Chronic HBV Carriers, but not in individuals who recover from infection. Its persistence indicates continuation of HBV replication. 'e-antigen' is associated with high infectivity (that means the individual is highly infectious to others). It persists for years among carriers and development of e-antibody (anti-HBe) indicates that the infectivity is reduced and is a sign of good prognosis.

Surface antigen is the first to be detected. It appears during incubation period and persists during acute illness. Usually cleared after 4 to 6 months. The next to appear are core antigen and e-antigen. E-antigen is detected within 3 to 5 days following the appearance of surface antigen. It persists for 2 to 6 weeks.

Those who recover from HBV infection, surface antigen disappears and surface antibody and core-antibody appear. Those who become carriers, surface antigen persists and there is no sero-conversion (that means there is no production of surface antibodies). However, core-antibody will be positive.

Reservoir of infection: Human being is the only known reservoir of infection. Such a reservoir may be a case or a carrier. A case may be an inapparent subclinical case or an active, symptomatic case.

The risk of becoming a carrier is 5 to 10 percent among adults and about 50 percent among infants.

A persistent carrier is a one, who has circulating surface antigen in the blood for more than 6 months. Such carriers constitute the major reservoir of infection. In India, the carrier state varies from 0.6 to 6.0 percent of the population. Most of these carriers are healthy carriers. But they may progress on

to chronic liver damage such as chronic hepatitis, cirrhosis of liver or even primary hepatocellular carcinoma.

The risk factors in carrier state are age, sex, diseases and immunosuppressive therapy.

Age: Earlier the infection acquired during childhood, more likely is the carrier state to develop and young carriers are more infective than aged carriers.

Sex: It is more common among males.

Diseases: Carrier state of HBV is more likely to occur among patients suffering from Down's syndrome, lepromatous leprosy and chronic renal disease.

Immunosuppressive therapy: Persons receiving steroids are also more susceptible to become carriers.

Infective material: Contaminated blood is the main source of infection. However, surface antigen has been found in the body fluids such as saliva, semen, vaginal secretions, urine, cerebrospinal fluid, ascitic fluid and joint fluids. Last three are least infectious.

Immunity: Antibodies are produced about 10 days after the onset of jaundice. The order in which the antibodies produced are core-antibody, e-antibody and lastly surface antibody. The production of surface antibody is considered to be protective. It indicates the recovery from the illness and the development of immunity.

Period of communicability: This varies from several months to several years. In other words, the person is communicable during the last one month of incubation period, during the acute phase of illness and until the surface antigen disappears.

Host Factors

Age incidence: There are two different patterns. In areas of high prevalence, infection is acquired in the early age. In areas of low prevalence, infection is acquired in the later ages.

Sex incidence: Incidence of HBV infection is more among men than among women.

Modes of Transmission

All modes of transmission is possible in Hepatitis B.

- *Parenteral route:* This is the commonest route of transmission. The disease is transmitted through contaminated blood and blood-products through transfusions, dialysis, and also through the use of contaminated needles, syringes, drip-sets, etc.
- *Percutaneous route:* Accidental inoculations can occur during surgical, dental procedures, mass immunizations and traditional tattooing, ear piercing, nose piercing, ritual circumcision, acupuncture, etc. Accidental percutaneous inoculations can occur following the use of contaminated razor, shaving brush, tooth brush, bath brush, etc.
- *Direct contact:* The other possible route of transmission is by direct contact such as by deep kissing and by sexual intercourse. So HBV is often considered as sexually transmitted disease.
- *Vertical transmission :* Transmission of HBV from carrier mothers to their babies is an important factor for the prevalence of the disease in endemic areas. Although HBV can infect the fetus *in utero*, this rarely happens. Transmission of infection appears to occur at birth, as a result of leakage of maternal blood into the baby's circulation or ingestion or accidental inoculation of the blood.

The risk of vertical transmission (or, perinatal transmission) depends upon the proportion of HBe Ag positive carrier mothers, which is about 40 percent in some countries. If the expectant mother is HBV carrier having HBe Ag positive, the infant has a risk as high as 60 to 90 percent of acquiring the infection during perinatal period. Ninety percent of such neonates become chronic carriers of HBs Ag. However, if the mother is HBs Ag positive but HBe Ag negative, the infant has only 8 to 10 percent chances of becoming infected. Infection in the baby is usually anicteric and is recognized by the appearance of surface antigen between 60 and 120 days after birth. Presence of anti-HBe reduces the risk of transmission.

However, hepatitis B does not appear to be transmitted by feco-oral route. Urine is probably not infectious unless contaminated by blood. There is no convincing evidence that air borne infections or mosquitoes and other blood sucking insects transmit the disease.

Other routes: Transmission is possible through breast-milk also. Transmission is also possible from child to child, when there are skin conditions like scabies, impetigo or other injuries. Transmission occurs when they play together or share the same bed. This is called 'horizontal transmission.' This was observed in Nepal.

High-risk groups: The high-risk occupational groups are surgeons, dentists, nurses, lab-technicians, and blood-bank workers. Incidence is also high among homosexuals, sex workers, IV drug abusers and infants of HBV carrier mothers.

Incubation period: 50 to 150 days (Average =100 days)

Clinical features: The onset is insidious with loss of appetite, nausea, vomiting and low grade fever. Often myalgia and arthralgia also occurs. There will be onset of icterus, high colored urine and light colored stools. Hepato-spleenomegaly often occurs.

A syndrome of fever, arthralgia or arthritis, urticarial rashes occur in 10 percent of patients. In children it is called 'Gianothi's syndrome' (Acrodermatitis).

Acute HBV infection among children is rarely symptomatic (i.e. anicteric hepatitis).

During acute infection, HBs Ag becomes detectable, followed by the production of core antibodies (anti-Hbc). During convalescence period, there is a transition period

(window period) when the concentration of HBs Ag declines and concentration of anti-HBs increases.

When there is production of HBs Ag and inadequate production of anti-HBs, it leads to chronic carrier state.

Chronic hepatitis may evolve into persistent hepatitis, or cirrhosis of liver or even primary hepatocellular carcinoma. Thus the clinical features depends upon the stage of the illness.

Laboratory diagnosis: Serum to the examined for useful markers.

- Surface antigen appears early in the disease and disappears soon. There may be a short window period after the infection when HBs Ag may not be detected. In chronic carriers, HBs Ag may persist for several months or even indefinitely
- Surface antibody (anti–HBs) is usually present soon after the onset of jaundice and then persists indefinitely. It indicates good immunity
- Core-antibody (anti–HBc) appears during convalescence.
- The presence of e-antigen (HBe Ag) suggests an infected person with increased risk of transmitting HBV.

Prevention and Control

Elimination of reservoir

This is not possible because there is no treatment.

Blocking the channel of transmission

This is possible in some cases by the following measures:

- Sterilization of syringes, needles, catguts, surgical instruments, etc.
- Avoiding sharing of toothbrush, razors, syringes among drug-abusers, etc.
- Screening of blood donors for HBs Ag
- Avoiding homo-sexuality and multiple sexual partners
- Instructions to the carriers—not to donate blood, not to share their razors, bath brush, tooth–brush, etc. with others, and to use condoms while having sex
- Sterilization of instruments (simple heating over a flame) before adopting procedures like nose piercing, ear pricking, acupuncture and tattooing.

Protection of susceptibles

Active immunization: Four types of vaccines are currently available.

a. *Plasma Derived Vaccine (PDV):* It is a sub unit vaccine, containing surface antigen (HBs Ag). It is prepared from the pooled plasma of HBV – carriers, who are HIV – negative. The surface antigen particles are harvested, purified and the residual virus is inactivated by formalin. The vaccine is safe, effective and is widely used. It is a sterile, liquid vaccine.

b. *Recombinant DNA—yeast derived vaccine:* In this type, the yeast cloned with surface antigens – gene is cultured and the vaccine is prepared. Thus it is a genetically engineered vaccine, manufactured by recombinant DNA – technology. It also contains purified surface antigen. It is also equally safe, effective and immunogenic as that of plasma derived vaccine, but is more costlier than PDV. It is also sterile liquid vaccine.

The regular dosage schedule consists of 3 doses, each of 1.0 mL, containing 20 mcg of HBs Ag for adults, at 0, 1 and 6 months, IM either in deltoid region of arm or anterolateral aspect of thigh. Children below 10 years, including neonates require 0.5 mL, containing 10 mcg. Protective antibody titer is obtained after the third dose and is 95 percent effective. Immunity lasts for about 3 to 5 years. Booster dose once in 5 years.

Rapid schedule is recommended for high-risk individuals such as surgeons, dentists, lab-technician in blood bank, etc. as pre-exposure prophylaxis. The schedule is 0, 1 and 2 with a booster dose at 12 months, followed by a regular booster dose, once in 8 years.

Special dosage schedule is recommended as post-exposure prophylaxis for the newborns, born to HBV carrier mothers and for individuals accidentally exposed to needle-stick injuries or through transfusion, cuts and injuries and also sexual contacts of acute hepatitis B patients. They are given both active and passive immunizations (HBs Ag and HBIg) simultaneously. Such newborns of carrier mothers are given vaccine within 12 hours of birth but not later than 48 hours. HBIg is given at different site, followed by regular dosage schedule. For the other groups, exposed accidentally are also given active and passive immunization simultaneously followed by rapid immunization schedule.

For chronic hemodialysis patients and immuno-compromised patients, primary course consists of 4 doses, each of 40 mcg (double the adult dose), to be administered at intervals of 0, 1, 2 and 6 months, followed by booster dose once in 5 years.

It can be concomitantly given alongwith BCG, DPT, OPV and Measles Vaccine, but on different sites.

The vaccine has no effect on the HBs Ag carriers (i.e. on the already infected individuals). So immunization to the carriers does not serve the purpose.

There is no cross immunity against other hepatitis viruses. However, it protects against delta–hepatitis.

Indian Academy of Pediatrics has recommended Universal Hepatitis B vaccine for infants in all families who can afford it, at 0, 1 and 6 months. It has also recommended the first dose to be given at birth in institutional deliveries, followed by other 2 doses. This may help to break vertical transmission rate and thus reduce the overall carrier pool. Administration of a booster dose just before adolescence may provide protection in later life.

c. *Pentavalent vaccine*
d. *Hexavalent vaccine* (Described under Diphtheria)

Passive immunization: It is by using Hepatitis B immuno-globulin (HBIG). It is a specific immunoglobulin prepared from the immunized persons. It is given for post-exposure

prophylaxis alongwith active immunization (vaccine) for infants of carrier mothers and also for those following an accidental exposure.

Dose is 0.05 to 0.07 mL/kg body weight. Two doses are given with an interval of 4 weeks. It protects for about 3 months. This should be given within 24 hours of exposure, if possible.

The differences between Hepatitis A and B is shown in **Table 20.17**.

Pregnant mother, newborn, hepatitis B vaccine

Immunization of a mother during pregnancy does not protect the fetus against Hepatitis B, unlike with tetanus toxoid. However, it protects the mother. Vaccination to the pregnant mother is recommended only in case of high-risk in pregnancy.

Note on occult HBV infection

Occult HBV infection is defined as the presence of HBV DNA in blood or liver tissue in patients negative for surface antigen and positive for anti HBC, who act as a potential source of HBV infection to the recipients of blood or liver transplantation.

All blood donors with occult HBV infection may not transmit the disease in blood recipients. Factors such as viral load in the donor's blood and immune status of the patient, may play a role in viral transmission.

Screening of blood donors for anti-HBc is not mandatory in many countries including India. Presence of HBV DNA in the blood can be detected by Polymerase Chain Reaction (PCR) method.

Recommendations for India include not transfusing blood with high titer anti-HBc, although the titer is not defined.

Table 20.17 Differences between viral hepatitis A (VHA) and B (VHB)

	VHA	VHB
Synonyms	Acute infectious hepatitis Epidemic jaundice. MS_1 hepatitis	Serum hepatitis. Homologous serum jaundice MS_2 hepatitis
Causative agent	RNA–virus	DNA–virus
Infective material	Mainly stools Often blood in acute stage of viremia	Mainly blood and blood products Often saliva, semen and vaginal secretions
Period of infectivity	Several weeks	Several months to years
High-risk groups	Those who consume fecal contaminated water, food and milk	Commercial sex workers, surgeons, dentists, IV drug abusers, Homosexuals, Blood-bank workers, Hemophiliacs
Seasonal and Cyclic trend	Observed	Not observed
Age incidence	Common among children	Common among adults
Mode of transmission	Feco–oral route (by blood also in acute phase of viremia)	Parental route, percutaneous route, sexual and perinatal route
Incubation period	15–50 days	50–150 days
Onset	Sudden	Insidious
Fever	Common	Uncommon
Illness	Not protracted	Protracted
Epidemics	Common	Uncommon
Carrier state	By feces for several weeks	By blood for several months to years
Complications	Acute fulminant hepatitis	Cirrhosis and Hepatocellular carcinoma
Virus demonstration	Demonstrable in stools in acute phase	Virus not demonstrable, but antigens and antibodies are demonstrable (HBV – markers)
Prevention and control	By construction of sanitation barrier (i.e. Sanitary latrines) supplemented by chlorination of water	By avoiding multiple sexual partners, homosexuals (by adopting safe sex by condoms) By using disposable syringes and needles By screening of blood donors By avoiding sharing of razors, blades and brushes
Immunization Active Passive	 By inactivated, purified cell – culture vaccine (HAVRIX) and by live vaccine (Biovac) By human normal immunoglobulin	 By plasma derived vaccine and yeast cell Derived DNA recombinant vaccine By human specific immunoglobulin

Discarding anti-HBc positive blood would result in high rates of donor rejection. This emphasizes the need for establishing sensitive screening modalities for blood transfusion.

Hepatitis C

Hepatitis C–virus (HCV) was identified in 1989. It is a single stranded RNA virus belonging to flavi-virus group, genus Hepaci-virus. It bears genomic resemblance to pasti-virus but not to hepatitis B or D. Since it neither belongs to type A or nor to type B, it was named as Non-A Non-B virus (NA NB).

This is mainly transmitted through transfusion of blood and blood-products. It may be transmitted sexually and perinatally also. More than 80 percent of post-transfusion hepatitis cases, in some countries have been attributed to HCV. So it is also named as, 'Parenterally transmitted Non-A Non-B Hepatitis (PT–NANB)'. Traditional practices such as circumcision, tattooing and acupuncture can also spread HCV infection. Intravenous drug users who share needles are also at high-risk of infection.

Incubation period is 6 to 8 weeks. Clinically it is characterized by mild illness with insidious onset of jaundice and malaise, milder than that of hepatitis B, and may be even asymptomatic. Asymptomatic cases constitute about 50 percent of the cases. Remaining 50 percent of the cases or even more may deveop chronic liver diseases such as cirrhosis of liver or even hepatocellular carcinoma. It may require about 20 years to develop liver cancer, which is more likely to be among men than among women, predisposed by alcoholism.

Conclusion of Hepatitis C, is by exclusion of type A and type B. Serological tests for anti HCV are now available. However antibodies to HCV may be absent during the acute illness. So it is repeated after 6 months. Positive test confirms the diagnosis. Most of such positive persons are infectious. Therefore screening of blood donors for HCV has been made mandatory for all blood banks, in India, from July 1, 1997.

There is no vaccine and therefore prevention is difficult. Pooled immunoglobulins do not confer passive immunity. Health care workers should stick on to universal precautions as in Hepatitis B prevention and health education programmes are also needed.

Hepatitis D

It is also called 'Delta – Hepatitis'. The hepatitis D virus (HDV) is also a small, circular, single, stranded, RNA virus of about 35 to 38 nm enveloped particle. It is a defective RNA virus, discovered in 1977 by Mario Rizzetto, in Italy, where it is endemic.

Since it is a defective virus, it does not result in a disease by-itself. It piggy-backs with Hepatitis B virus and causes illness, which becomes more severe than that caused by HBV alone. Case fatality is 20 percent.

Since delta-virus requires HB virus to become pathogenic persons immune to HBV are also immune to delta-virus. Thus Hepatitis D can best be prevented by Hepatitis B vaccine.

Hepatitis E

(Enterically transmitted Non-A Non-B Hepatitis)

Hepatitis E virus (HEV) was discovered in 1990, exists in many developing countries including South East Asian Regions, where environmental sanitation is poor. It is essentially feco-orally transmitted water-borne disease.

It is RNA virus of about 30 nm size. It is a member of calciviridae family. HEV is the most common cause of sporadic hepatitis in adults often resulting in epidemics.

First major epidemic was reported from New Delhi, during 1955-56, due to flooding of river Yamuna, resulting in about 30,000 cases. Other two major epidemics occurred in India were one in Karnal 1987 and Kanpur in 1991. China reported about 1,00,000 cases between 1986 and 1988. Since then outbreaks have been reported from SEAR countries. Interestingly young children are often spared in most hepatitis E epidemics.

Incubation period is almost same as that of HAV, i.e. 15 to 60 days (Average = 40 days). Clinically characterized by the same features as those of VHA, followed by recovery, thus proving a self-limiting disease. It lasts for a period of several weeks. No case of chronic disease is reported. Mainly young adults of 15 to 40 years are affected. Among children HEV results in inapparent or mild infections (Anicteric hepatitis).

Disease severity is higher among pregnant women, resulting not only in abortions, still-births and neonatal deaths but also a high fatality of about 80 percent, about 20 percent of them due to development of fulminant hepatic failure.

Hepatitis E virus also enhances the morbidity and mortality in stable cirrhosis.

Though Hepatitis E virus may cause fulminant hepatitis on its own, the risk of developing severe disease is more with combined infections, e.g. hepatitis E and hepatitis A or hepatitis E on hepatitis B.

Diagnosis is made by the level of anti-HEV antibodies in the serum. HEV RNA by polymerase chain reaction is the gold standard for definitive diagnosis but is available only in few reference laboratories.

Treatment is not necessary, recovery is almost complete. Only supportive treatment for fulminant cases among mothers.

Prevention is by sanitation barrier, same as in prevention of Hepatitis A. No vaccine or specific immunoglobulin is available. Maintenance of personal hygiene and use of boiled and cooled water protects the individuals. Vulnerable individuals like pregnant mothers and those with cirrhosis need to be most careful to safeguard against HEV infection.

Hepatitis G

Hepatitis G Virus (HGV) is recently identified in 1996. It belongs to flavivirus group. This has been found to be associated with blood transfusion and IV drug abuse. But it does not appear to cause important liver disease.

POLIOMYELITIS

(Greek: Polio = Gray, Muellos = Marrow)

Poliomyelitis is an acute, highly infectious disease of the children, caused by a virus. Basically it is an infection of the intestine transmitted by feco-oral route, but in about one percent of the cases, it affects the central nervous system also (mainly spinal cord). Clinically it is characterized by sudden onset of fever, associated with constitutional signs and symptoms, followed by the rapid onset of lower motor neuron type of paralysis (flaccidity) either of a group of muscles or of a limb.

History

The disease was first described by Heine in 1840 and by Medin in 1890. Therefore, the disease was also called 'Heine-Medin disease'. The causative virus was identified by Landsteiner and Popper opper in 1909. Later in 1949, the virus was successfully cultivated by Enders, Robbins and Weller who got Nobel Prize. In 1955, Salk prepared an effective killed vaccine which is named after him and in 1957, Sabin prepared a live vaccine, to be used orally, which is named after him as Sabin–vaccine. Introduction of Sabin-vaccine opened a new avenue in the eradication/elimination of this disease in many countries.

Magnitude of the Problem

Before the introduction of the vaccine, poliomyelitis was a global problem. After the introduction of the vaccine and effective immunization program associated with the improvement of sanitation, more than 125 countries have virtually eradicated the disease. In September 1994, the western hemisphere was certified as a region free from poliomyelitis.

In 2003, in Eastern Hemisphere, six countries were identified as Endemic countries, namely India, Pakistan, Afghanistan, Nigeria, Niger and Egypt.

In India, during the century, the incidence of poliomyelitis has come down very much because of effective immunization programme, compared to the last decade. So much so, in 1998, a total of 1934 cases were reported. During 2002, there was a report of 1600 cases, all from North India. During 2003, it came down to 225 cases and during 2004, there were hardly 28 cases from the entire country. Thus, India plays an important role in the global eradication of poliomyelitis, because until and unless the virus is eliminated from the entire world, it cannot be declared as eradicated because of the jet travel days.

Agent Factors

Causative Agent

Causative agent is a RNA virus, belonging to the group Picarnovirus and the family Enterovirus. It is 25 nm in size. Antigenically, there are three types of polio-virus, namely Type 1, Type 2 and Type 3, named respectively after Brunhilde, Lansing and Leon. Type I is responsible to the extent of 80 to 90 percent. Type III causes paralysis less frequently and Type II causes rarely. Thus these strains differ in their invasiveness.

They can survive outside the human body for fairly long periods (4 months in water and 6 months in life). The half-life of the excreted virus in the sewage is only 48 hours and spread of infection through sewage can occur only during this period. Eventhough it can survive outside the human host, it multiplies only in the unimmunized human gut. There is no development of cross-immunity.

They are readily destroyed by heat at 50°C, and inactivated by U-V radiation, formalin, chlorine and drying. Therefore freeze-dried vaccine cannot be prepared. They survive for years at sub-zero temperature.

Reservoir of Infection

Human reservoir is the only host. Therefore, poliomyelitis is a disease of human beings only. There are no animal reservoir. Such a human reservoir may be an active clinical case or a carrier. The carrier of poliomyelitis is a temporary, healthy carrier or incubatory carrier and there is no chronic carrier state. It is estimated that for every clinical case of polio, there are about 1000 subclinical cases among children, some of whom may become carriers and about 75 subclinical cases among adults.

Infective Materials

Infective materials are the throat secretions and feces of a diseased individual in the early stage and only feces in the later stages.

Period of Infectivity

The cases are infectious one week before and about three weeks after the onset of disease.

Host Factors

Age: In India, the incidence is maximum in the age group of 6 months to 3 years.

Sex incidence: It is more among male children compared to female children in the ratio of 3:1.

Immunity

Maternal antibodies protects the child during the first six months of infancy. Immunity is often developed following the subclinical infection. The immunity developed after the clinical infection is fairly good and it is type specific. There is no cross immunity (i.e. the immunity developed with one type of virus does not protect the child against the other).

Environmental Factors

In India, majority of the cases occur during June to September. Lowest transmission season is November to March. Overcrowding, poor sanitation and contamination of food and water are the main favorable factors for the transmission of the virus.

Risk Factors (Provocative Factors)

There are certain factors, which provocate the latent infection of polio-virus resulting in the onset of the disease and paralysis. They are called as provocative factors. They are painful intramuscular injections, fatigue, trauma, exercise and surgical procedures in the head and neck regions, specially during the epidemics of poliomyelitis.

- *Effect of injections:* Injections like DPT, specially during the stage of viremia, increases the vascularity of that part of the spinal cord, subserving the site of injection associated with irritation of injection, predisposing the virus to affect the spinal cord.
- *Effect of fatigue, trauma, exercise:* These factors during the stage of viremia, also predispose for the early onset of the disease.
- *Surgery in head and neck region:* Procedures like tonsillectomy, adenoidectomy, extraction of tooth during epidemics, tend to prevent or reduce the formation of IgA (local antibodies) in the pharynx, thereby allowing the virus to have an easy access to the central nervous system, resulting in bulbar rather than spinal form of poliomyelitis.

Modes of Transmission

In the acute stage of illness, the disease is transmitted by both droplet infection as well as by feco-oral route. After the acute stage, poliomyelitis is transmitted by feco-oral route only, i.e. through 6 F's, i.e. through fecal contamination of fluids (water, milk), foods, fruits and vegetables, fomites (like utensils), fingers (due to lack of personal hygiene) and flies act as mechanical carriers.

Pathology and Pathogenesis

Having entered the body through the pharynx, the virus multiplies in the tonsillopharyngeal tissue and also in the intestinal wall. From these, the virus passes to the respective regional lymphnodes (cervical and mesenteric lymph nodes) where it multiplies and then enter the circulation leading to viremia. The virus is known for its selectivity for nervous tissue, specially spinal cord. This occurs only in 1 percent of infections.

In the spinal cord, the cervical and lumbar enlargements are usually most severely affected. The greatest damage is found in the anterior horn cells (motor cells) of the spinal cord. Once it reaches the nerve cells, it causes rapid and widespread damage. Once a pathology, is a permanent pathology. The damage is asymmetrical and irreversible.

Clinical Spectrum

The different outcomes of the infection is as follows:

- In 95 percent infections, it is only subclinical infections and therefore, they are all asymptomatic or inapparent cases. Recognition is only by rising antibody titer.
- In about 4 percent, there will be mild, self-limiting, non-specific febrile illness. Disease does not progress. It is called minor-illness or abortive poliomyelitis.
- In about 1 percent, there is development of meningitis but no paralysis. It is called 'Non-paralytic poliomyelitis'. The patient will have all features of meningitis, followed by recovery.
- In about less than 1 percent of infection, the condition progresses to 'major illness', wherein the virus invades CNS, specially spinal cord resulting in varied type of paralysis, i.e. called 'paralytic poliomyelitis'.

Clinically paralytic poliomyelitis is characterized by sudden onset of fever and associated symptoms such as headache, vomiting, malaise and anorexia. Next day, fever is associated with severe myalgia (muscular pain) in the limbs, followed by asymmetrically distributed, lower motor neuron type of flaccid paralysis. In mild cases few muscles are paralysed and in severe case, the entire limb is paralysed. Usually one leg is paralyzed. Paralysis continues until the temperature returns to normal. There is no sensory loss. Deep tendon reflexes are diminished or absent. Full extent of paralysis is reached within 2 to 3 days. Residual paralysis is seen at the end of the month **(Fig. 20.42)**.

Very rarely, damage occurs to the brain, resulting in two forms—Polioencephalitis and Bulbar poliomyelitis.

Polioencephalitis

High fever is associated with convulsions, altered consciousness, restlessness, irritability, rapidly followed by coma and death. There may be upper motor neurone type of damage.

Bulbar Poliomyelitis

Characterized by fever, weakness of swallowing and coughing, indicating paralysis of the pharynx. There will be collection of

Fig. 20.42 Paralytic poliomyelitis

mucous and saliva in the throat. Inability to swallow threatens the life. Once the acute stage is passed, recovery in pharyngeal paralysis is good but slow, provided they are kept alive during the first ten days.

Diagnosis

Isolation of wild polio-virus from the stool is the best way to confirm the diagnosis of paralytic poliomyelitis. Virus is not likely to be cultured from throat swab, CSF or blood. A rise in titer of complement fixing antibodies is confirmative.

Management

Since there is no treatment, polio cases require general supportive care and skilled management as follows:

- Isolation–in the isolation ward, because it is infectious.
- Concurrent disinfection of saliva and excreta in 10 percent cresol.
- Absolute bed-rest is essential during the acute phase. There should not be any stress on the affected muscles.
- Expert nursing care with frequent change of postures every 2 to 3 hours.
- Symptomatic treatment with paracetamol to relieve pain and fever.
- Prophylactic oral antibiotics to prevent secondary infection.
- Massage and injections during the acute phase is absolutely contraindicated (i.e. for about 6 weeks).
- Supportive treatment with splints is provided to the limbs to prevent deformity resulting from the action of antagonistic muscles.
- Maintenance of fluids and electrolyte balance done orally and not by infusion.
- Physiotherapy is recommended not in the early stage but only after the acute phase of about 6 weeks, because stress and strain in the acute phase worsens the disease and also wherever the damage is reversible in the spinal cord, the paralyzed muscles recover within about 4 weeks.

Physiotherapy is recommended after the residual paralysis persists, to regain the muscle power. Maximum recovery takes place in the first six months, but slow recovery is continued upto 2 years. However the residual paralysis remains permanently. Physiotherapy is necessary to prevent contractures and deformities. Muscle stimulators can be used. Graded exercises are given.

Hydrotherapy (Treatment in Swimming Pool)

This is of great benefit to the polio patients. The limbs are felt lighter in water and thereby the patients gets great psychological uplift. But actually there is no muscular recovery.

As a part of rehabilitation, the child requires artificial limb, metal calipers or even reconstructive surgery.

Prevention and Control

Since there is no treatment, elimination of reservoir is not possible. Different modes of transmission can be broken by construction of sanitation barrier. However, protection of susceptibles by immunization is the only sole and most effective method of preventing poliomyelitis. Since it is a disease of mainly children and the susceptibility being universal all children must be immunized during their infancy period itself, preferably before 6 months of age.

Immunization

There are two ways of immunization namely—active and passive.

Active Immunization

Two types of vaccines are available, namely—Inactivated Polio Vaccine and Oral Polio Vaccine **(Table 20.18)**.

Inactivated polio vaccine (IPV): It is named after the discoverer Salk, as Salk vaccine. It is a liquid killed vaccine. It contains all the three types of polio-viruses, killed by formalin, to be administered intramuscularly (IMly). Primary course consists of 4 doses, first three doses are given with an interval of 4 to 6 weeks, starting from as early as 6 weeks of infancy and the fourth dose is given about 6 to 12 months after 3rd dose. Immunity lasts for few years. Additional dose is given at the time of school entry and then booster dose is given once in 5 years, till the age of 18 years.

Table 20.18 Differences between IPV and OPV

IPV	OPV
• Salk-vaccine—A killed vaccine	Sabin-vaccine—A live vaccine
• Given IMly	Given orally
• Provides only systemic immunity	Provides both local and systemic immunity
• Prevents the disease but does not prevent the re-infection of the gut by wild polio virus	Not only prevents the disease but also prevents the intestinal re-infection by wild polio virus
• Does not help in the development of herd immunity	Helps in the development of herd immunity
• Neither useful in controlling the epidemics of polio nor in the eradication of polio	Not only useful in controlling the epidemics but also in the eradication of poliomyelitis
• Administration is costly	Administration is easy, cheap
• Requires the services of a trained person	Does not require the services of a trained person
• Immunity is shorter (about 5 yrs)	Immunity is lifelong with multiple doses
• Vaccine associated paralysis does not occur	Vaccine associated paralysis can occur
• Stringent conditions are not required to maintain cold-chain	Stringent conditions are required to maintain cold-chain

IPV stimulates the production of only systemic (humoral) antibodies but not intestinal or local immunity. Thereby eventhough the child is protected against poliomyelitis, the wild viruses can still multiply in the intestine and be a source of infection to others.

Merits

- Since it is not a live vaccine, vaccine associated paralysis do not occur
- It is safe for elderly persons and pregnant mothers
- It is also safe for immunocompromised persons such as those who are on steroids or radiotherapy.

Demerits

- Hardly 50 percent effective.
- IPV is not recommended during epidemics of polio because immunity is not developed with only one dose.
- Injections are not advised during epidemics because of provocative paralysis.
- Does not provide gut immunity.
- Does not provide life long immunity.
- Booster doses are required once in 5 years.

Modified IPV: It is a more stable and a potent vaccine, can be combined with DPT to prepare a quadruple vaccine, to simplify the schedule.

Oral polio vaccine: Oral polio vaccine (OPV) is named after the discoverer Sabin as Sabin vaccine. It is a live, liquid vaccine, containing attenuated all the three types of polio viruses. So it is also called as 'Trivalent-vaccine'. Thus the child is protected against all the three types of viruses, simultaneously, which is of great administrative convenience **(Fig. 20.43)**.

Composition

Each dose of 2 drops contains 3,00,000 $TCID_{50}$ of Type I virus, 1,00,000 $TCID_{50}$ of Type II virus and 3,00,000 $TCID_{50}$ of Type III virus (TCID = Tissue culture infective dose).

Route

OPV is given orally in the form of 2 drops per dose.

Schedule

Under the National Universal Immunization Programme, 4 doses of OPV, are recommended as follows.

Zero dose—at birth, alongwith BCG
First dose—at 6 weeks
Second dose—at 10 weeks
Third dose—at 14 weeks; all three alongwith DPT.

Indian Academy of Pediatrics recommends one more dose at 9th month alongwith Measles vaccine.

One booster dose of OPV is recommended during 18th month. Three doses confer 85 percent protection, 4 doses confer 90 percent protection and 5 doses confer 95 percent

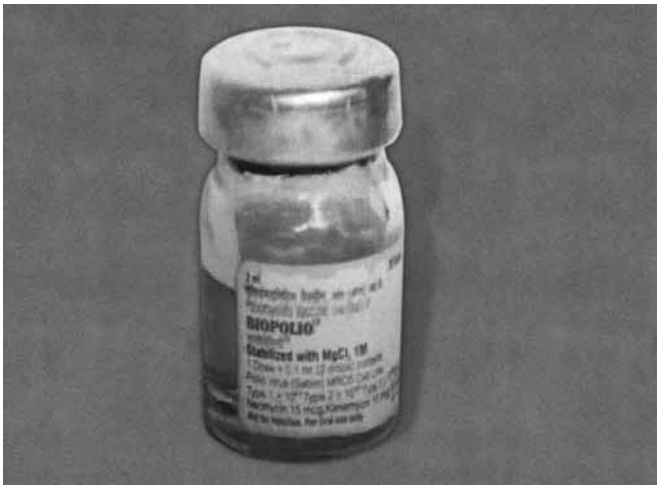


Fig. 20.43 Oral polio vaccine (Sabin vaccine)

protection. Thus multiple doses induce higher and life-long immunity.

The dose given at-birth is an optional but preferable. The option is that it is recommended for institutional deliveries. It is called 'Zero-dose' because it is given before the recommended first dose and also because it results in the development of gut-immunity only and not systemic immunity. The subsequent three doses help in the development of both local gut immunity and also systemic immunity. Out of three serotypes in OPV, only one serotype is able to get a foothold in the intestine and does not allow other two types for multiplication. Therefore to ensure seroconversion against all the three serotypes, multiple doses of OPV are required.

Mechanism of Protection

After administering the vaccine orally, the live attenuated viruses, multiply in the intestinal epithelial cells. Thus OPV administration mimicks the natural route of infection, the antigenic stimulus becomes much more than what is administered, thereby the production of antibodies will also be more and immunity lasts longer. As long as it is in the intestinal epithelial cells, it helps in the development of intestinal local immunity by the production of IgA and when it enters the circulation, stimulates the production of humoral, systemic immunity with IgG. Thus there is double benefit.

Advantages of Oral Polio Vaccine

- There is development of both local and systemic immunity
- When the immunized child drinks contaminated water containing wild polio-virus, it is acted upon by the IgA of the gut and is converted into attenuated, non-pathogenic, vaccine progeny virus, which when enters the mouth of the susceptible child, induces immunity indirectly, thus helps in the development of herd immunity in the community.
- If all the children are immunized simultaneously, and not even a single child is left, the vaccine virus completely replaces the wild polio virus from the entire nature, thus OPV helps in eradication of the poliomyelitis (Unimmunized gut is a must for the wild virus to multiply).
- It is the vaccine of choice during the epidemics
- Administration is simple, easy, given orally and not painful and not expensive
- Does not require the services of a trained personnel.

Associated Risk

OPV being live vaccine, as the viruses are multiplying in the intestine, specially the Type III virus produces a new mutant strain, which actually results in the disease. It is called vaccine associated paralytic poliomyelitis. It is rare, one in one-million vaccinees. This risk is more among adults than among children.

Contraindications

Contraindications are acute febrile illness, diarrheal disease, children on steroid therapy, etc. However, mild fever, mild diarrhea are not contraindications. Malnourished children require immunization most. However, there are no contra-indications under the National Pulse Polio Program.

Storage

- *Stabilized vaccine* (*OPV stabilized with* $MgCl_2$): It retains the potency of the vaccine at 4°C for one year and for one month at room temperature
- *Non-stabilized vaccine:* This always has to be stored at sub zero temperature from the time and place of manufacture to the time and place of its use, i.e. cold-chain has to be maintained.

Instructions to the Mother

- Hot fluids like milk, coffee or tea should not be given to the immunized child for at least half-an hour after the administration of the vaccine, because it may kill the virus. However, breast-milk can be given
- Next due date is given
- Mother must be educated about the importance of completing the schedule.

Reasons of Vaccine Failures

- Incomplete schedule
- Use of date expired vaccine
- Unstability of vaccine
- Lack of maintenance of cold-chain
- Vaccine associated polio-paralysis, due to multiplicity of the strains
- Interference with vaccine uptake by intercurrent entero-virus infection (is not proved).

Passive Immunization

This is done by Human Normal Immunoglobulin. It is recommended for those who are at risk, such as young close contacts who are not immunized before. Dose—0.25 to 0.3 mL per kg body weight. But such contacts must be actively immunized after a few weeks.

But the current widespread practice of active immunization under the National program has virtually eliminated the need for passive immunization.

Vaccine-Vial Monitor

Vaccine-vial monitor (VVM) is a small, square shaped, heat sensitive, white colored, material, placed on an outer circle

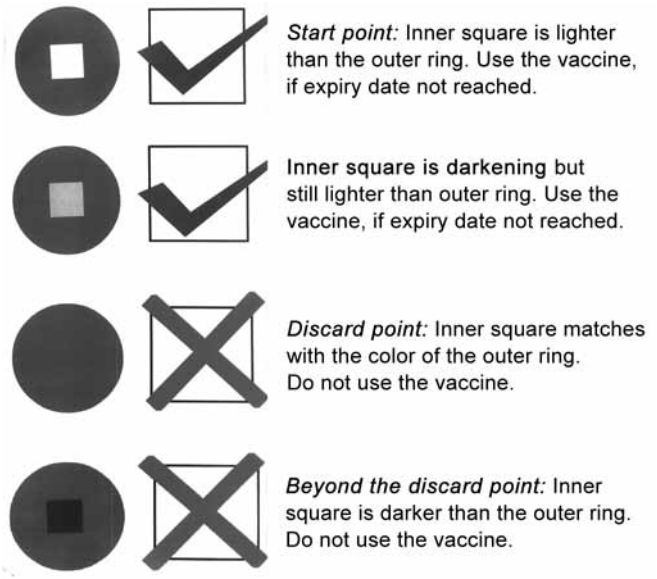


Fig. 20.44 The stages of the VVM

of blue color, printed on the label of the OPV vial. Combined effects of time and temperature cause the Vaccine-vial monitor (VVM) to change its color gradually from the light color at the starting point and becomes darker with exposure to heat. The darkening process is irreversible. The outer colored circle is used as a reference to compare the color of the VVM.

VVM does not directly measure the potency of the vaccine but definitely it gives information about the potency of the vaccine **(Fig. 20.44)**.

How to read VVM?

- Compare the darkness of VVM (inner square) with that of outer circle
- If the inner square is lighter than the outer circle, and the expiry date has not passed, the vaccine may be used
- If the inner square matches with the outer circle or even darker than the outer circle, and even if the expiry date has not passed, the vaccine must not be used. It is considered ineffective vaccine
- If the inner square is lighter than the outer circle and the expiry date has passed, the vaccine should not be used.

Thus VVM enables the health worker to ascertain, whether the vaccine vial is potent or not. This ensures quality assurance of the immunization programme. The use of VVM over the vial has been made mandatory since 1998.

Eradication of Poliomyelitis

Poliomyelitis is said to be eradicated from a country, when zero incidence is maintained for 3 continuous years with the absence of circulating wild polio virus in the environment and the people are free from the fear of getting the disease without immunization.

Poliomyelitis is amenable for eradication because of the favorable epidemiological points as follows (Epidemiological basis)

- Human being is the only reservoir of infection
- There is no animal reservoir state
- There is no chronic carrier state
- Half-life of the excreted wild polio-virus in sewage, is very short (hardly 48 hours). The spread of infection through sewage can only occur during this period
- The available vaccine is a live vaccine, highly potent, cheap, can easily be administered orally and highly safe
- There are no contraindications, under National Program
- OPV helps in the indirect immunization of susceptible children in the community
- It helps in the replacement of the wild virus from the entire nature, by inducing the gut immunity and circulation of the vaccine progeny virus
- Correct and complete dosage schedule confers lifelong immunity.
- Passage through the unimmunized gut is a must for the polio virus to multiply.

Differential Diagnosis of Poliomyelitis

- 'Guillain-Barre' Syndrome **(Table 20.19)**
- Transverse myelitis
- Traumatic neuritis.

Transverse Myelitis

The features are**:**

- Absence of fever
- Symmetrical paralysis of lower limbs usually (paraplegia)
- Marked sensory loss (profound anesthesia)
- Paralysis of legs is followed by loss of control of rectal and bladder sphincters
- Common among children above 4 years of age and adults
- CSF findings are usually normal.

Traumatic Neuritis

- History of having taken IM injection
- Paralysis of the limb is accompanied by the pain
- Knee-jerk is present but ankle-jerk is absent (Leg is involved below the knee)
- Child walks with a foot-drop
- Recovery is gradual with physiotherapy within about 6 months
- Can occur in any age group.

Table 20.19 Differences between poliomyelitis and Guillain-Barre' syndrome

	Poliomyelitis	Guillain-Barre' syndrome
Etiology	Caused by virus	It is a demyelinating disease of the peripheral nervous system
Age group	Common among infants, often up to 5 years	Rare among infants, common between 1 and 4 years age group
Onset	Acute	Chronic (?)
Fever	Just prior to paralysis	2–3 weeks before illness
Paralysis	(Hallmark finding) is flaccid and asymmetrical	Flaccid and symmetrical
Course	Descending (Starts descending from the trunk and moves distally down)	Ascending (Lower limbs first followed by upper limbs)
Cranial nerve involvement	Usually uncommon	Usually common (7th and 9th) (Facial and glossopharyngeal nerves)
Sensory deficit	Absent	Present
CSF findings		
Cells	20–300 WBCs/mm^3	< 10/mm^3
Protein	40–65 mg	Up to 200 mg
Electrophysiology findings		
Nerve conduction velocity	Normal	Reduced
Electromyography	Usually abnormal	Usually normal

Pulse Polio Immunization

The term 'Pulse' has been used to describe the sudden, simultaneous, mass administration of OPV, to all the underfive children of the entire country with a cent-percent coverage, with 2 doses, on the indicated dates, with 6 weeks interval, during the lowest transmission season, October to February, irrespective of their previous immunization status.

- These doses are supplements and not substitute to the routine immunization
- There is no minimal interval between a scheduled dose of OPV and the Pulse Polio Immunization (PPI) dose (That means even if the child had taken its regular scheduled dose on the previous day of PPI-day, it has to be given PPI-dose)
- There are no contraindications for PPI.

This concept of PPI came into vogue because inspite of correct and complete immunization of the children under UIP (Universal Immunization Program) a small percentage (about 10%) of the children are not completely protected. It is not possible to know which child is completely protected and which child is not.

And also since entry of the wild polio virus into an unimmunized gut is a must to continue its progeny, it was felt by Government of India, to ensure that every underfive child in the country is given polio-drops, simultaneously, on the particular indicated dates, so that not even a single unimmunized gut should be available to the wild polio virus, thereby the vaccine virus replaces the wild virus from the entire nature, thus helping in the eradication of poliomyelitis.

PPI was launched in December 1995, when the target age was fixed up to 3 years only. In 1996, the target age was extended to 5 years.

Government of India has committed to sustain and maintain this massive effort until the disease is eradicated.

Eradication of poliomyelitis: Explained under National Program.

DRACUNCULIASIS

Synonyms: Dracontiasis, Dracunculiasis, Guinea Worm Disease

This disease is caused by a nematode, female parasite, Dracunculus-medinensis, transmitted through the vector, Cyclops, which in turn is transmitted by drinking contaminated water containing infected Cyclops. Clinically it is characterized by blister in the leg associated with itching, burning and often secondary infection. Later it may lead to arthralgia and arthritis, disabling the individual temporarily.

Magnitude

A global problem in the developing countries, has been eradicated in the last decade. The disease is now endemic in some countries of Africa, such as Sudan, Nigeria and Ghana. Asia is free from the disease since 2000.

In India, the last reported case was in July 1996. After three years of zero incidence, India was declared free of guineaworm disease in 1999.

Agent Factors

Agent

The adult female guinea-worms are usually found in the subcutaneous tissues, usually of legs. It is a thin, long worm looks like a twine thread, measuring 60 mm to 1 meter in length and 1.5 mm breadth. Body is cylindrical, smooth and milky white in color. The anterior end is round and the posterior end is curved like a hook.

The adult male is about about 20 to 30 mm length and 0.4 mm breath. It dies and disappears after fertilization of the female. Hence it has not yet been recovered from an adult person.

Life Cycle

The worm passes its life cycle in two hosts: man and cyclops.

In Man

He constitutes a definitive host. He harbors the parasite in the subcutaneous tissue usually of legs, often in the back. After fertilization in the deeper connective tissues (not in the intestine) the gravid female takes about 6 months to come to the site of its election, i.e. subcutaneous tissue of the leg, or back, which is liable to come in contact with water and forms a bleb, with its toxin, which later bursts to form an ulcer. When such an infested person gets down in a step-well or pond, or carries water on his back, the contact with water stimulates the worm to protrude its head through the centre of the ulcer reflexly discharges milky fluid containing embryos from the prolapsed uterus into the water.

In Cyclops

The embryos are coiled bodies measuring about 600 μ length and 20 μ in breadth are ingested by the fresh water crustacea belonging to genus Cyclops. If not taken up by the Cyclops, the embryos die. Each Cyclops ingests about 15 to 20 embryos. The embryos penetrate the gut wall of Cyclops, enter the body cavity and develop into larvae and grow for 2 weeks.

When a person drinks water containing infected Cyclops, the Cyclops are killed by gastric hydrochloric acid, larva are released, penetrate the gut wall and enter the connective tissues of the retroperitoneum and grow into adult males and females in 9 to 12 months. Male fertilizes the female and dies and disappears. Cycle is repeated.

Reservoir of Infection

It is an infected person harboring a gravid female parasite (worm). There is no carrier state.

Host Factors

Age and Sex: It is common among adults of both the sexes. Males are frequently affected than females.

Environmental factors: Since the disease is linked with contact with water containing cyclops, the access to water occurs as in step-wells, cisterns, ponds and small tanks, which is common in rural areas. The access to water occurs during washing of feet, taking bath or to collect the water for drinking. This gives an outlet for the embryo to enter water. The cyclops takes up them.

The incidence used to be high during summer, because the quantity of water becomes less with consequent increase in concentration of cyclops.

Social factors: Poverty, illiteracy and the traditional dependence of the people on step wells are important factors in the epidemiology of this disease.

Mode of transmission: It is by drinking water containing infected cyclops (i.e. cyclops containing rhabditiform larvae of guinea-worm).

Incubation Period

Intrinsic incubation period in human being is about one year and the extrinsic incubation period in the cyclops is about 3 to 4 weeks (i.e. the period required by the embryos to grow into larvae in the body of cyclops).

Pathogenic Effects and Clinical Features

The symptoms are manifested during parturition of the female worm and are due to liberation of a toxic substance causing blister and allergic manifestation such as itching and burning. The blister later bursts open to form an ulcer often followed by secondary infection. If the worm gets trauma while coming out or while it is removed, severe tissue reaction can occur. If worm goes deep inside can result in arthralgia and arthritis.

Laboratory Diagnosis

- Detection and identification of a female adult worm in the ulcer, looking like a twine thread. It is removed not by pulling but by wounding round over a small stick of match-box.
- *Detection of embryos:* The affected part is bathed with water to encourage the worm to discharge the embryos. The milky fluid is pipetted out and examined under the microscope for the embryos.
- *Intradermal test:* Injection of dracunculus antigen intradermally causes a wheal to appear within 24 hours in positive cases.
- *Examination of blood:* Reveals eosinophilia.
- *X-ray of the affected part:* It the worm is calcified, X-ray is positive.
- *Examination of water:* From the source in the area for Cyclops.

Management of a Case

Removal of the parasite, followed by metronidazole 250 mg tds for 1 week gives relief.

Nitrothiazole (Ambilhar) has also found to be effective in killing the parasite.

Prevention and Control

This can be done by breaking the link of the chain (Man–Cyclops-Man) by the following measures.

- Treatment of the infected person with a strict instruction not to enter water-body like step-wells or ponds. This prevents the contamination of the water.
- Disinfection (Chlorination) of water for the eradication of cyclops.
- Drinking the water, which is either strained, filtered or boiled at house-hold level.
- Conversion of step-wells into sanitary wells.
- Health education of patients and the people.

National Guinea Worm Eradication Program (1983)

Discussed under National program.

AMOEBIASIS

It is an infection of the large intestine, caused by a protozoan parasite called *Entamoeba histolytica*, often spreading to various other organs like liver, lungs, brain, etc. It is usually transmitted by fecal contaminated water. Clinically it is characterized by pain abdomen, diarrhea and even fulminant dysentry.

Magnitude: It is an endemic disease in all the developing countries including India, because of poor environmental sanitation. It is the third leading cause of parasitic deaths in the world, next to malaria and schistosomiasis. It is estimated that about 12 percent of the world's population (500 million) are infected with an annual mortality of about 70,000 people.

In India, amoebiasis is an endemic disease. The prevalence rate varies from 5 to 50 percent depending upon geographical region (Average – 15%).

Agent Factors

Agent

The causative agent is a protozoal parasite, *Entamoeba-histolytica*. This exists in two forms—vegetative (Trophozoite) and cystic forms. Trophozoites dwell in the lumen and wall of the colon, where they multiply and encyst. It divides by binary fission, grows best in anaerobic conditions. The size of the trophozoite varies from 10 to 50 μ in diameter. They have directional mobility with pseudopodia. In the absence of diarrhea, the trophozoites usually encyst before leaving the gut. The cyst is a round or oval structure of about 10 to 15 μ in size. Immature cysts have only one nucleus and the mature cysts have four nuclei. The cysts are excreted in the stool. They survive for variable period outside the host. Cysts constitute the infective stage of the parasite and are responsible for transmission of the disease.

The ingested cysts release trophozoites, which colonize the large intestine. Some trophozoites invade the bowel and cause ulceration mainly in the cecum and ascending colon and often in sigmoid colon and rectum. Some may enter a vein and reach liver, lungs, brain, etc.

The trophozoites live for a short period outside the body. But they are not the infective forms. The quadrinucleate cysts are infective forms, they live for several days in water, sewage and soil in the presence of moisture and low temperature. The cysts are not affected by chlorine in the routine concentration used for purification of water. However, they are readily killed by heat at 55° C.

Reservoir

Humans are the only reservoir of infection and the susceptibility is universal. Healthy and convalescent carrier state occurs.

Source of Infection

Source of infection is the feces containing the quadrinucleate cysts.

Infective Material

Infective material is the food and water contaminated with feces containing the cysts.

Period of Communicability

Varies from several days or months to several years.

Age and Sex Incidence

No age and sex is bar from the disease.

Environmental Factors

The various factors responsible for the prevalence of the disease are poor sanitation, poor socioeconomic status, overcrowding, lack of protected water supply, irrigation of agricultural fields by sewage, indiscriminate defecation, etc. Hence amoebiasis is often called a 'social disease.'

Mode of Transmission

The disease is transmitted mainly by feco-oral route, i.e. through the fecal contamination of food and water. Food handlers, who are carriers, also constitute an important source. House flies act as mechanical carriers (Vectors). Sexual transmission has also been reported among homosexuals.

Pathology and Pathogenesis

The primary lesions is limited entirely to the large intestine and the secondary or metastatic lesions occur in the liver, lungs and brain.

Intestine

The parasites multiply rapidly, destroy the tissue and even sub-mucous membrane, resulting in necrosis, abscess and ulcers.

Liver

The trophozoites are carried from the base of the amoebic ulcer, through the portal vein, to the liver, where they multiply, result in enlargement of liver (amoebic hepatitis) and later results in necrosis and amoebic liver abscess. Usually abscess is located in the postero-superior surface of the right lobe of the liver.

Lungs

Even though rare, lungs are also affected which the trophozoites from the gut wall, pass through pulmonary capillaries via portal vein, resulting in lung-abscess. Lungs can also be affected as a complication of liver abscess. Thus, pulmonary amoebiasis may be primary or secondary.

Brain

This is very rare. Cerebral amoebiasis can occur as a complication of hepatic abscess or pulmonary abscess.

Incubation Period

Incubation period is about 1 week to 3 weeks.

Clinical Features

Intestinal Amoebiasis

Starts gradually with mild abdominal discomfort, pain, diarrhea, with or without blood and mucus, usually associated with tenesmus. Fever may be present. Abdomen is tender, liver is slightly enlarged and tender. In fulminant colitis, all these features are sudden and severe.

Amoebic Liver Abscess

Insidious in onset. Pain and tenderness in the right hypochondrium. Pain is often referred to right shoulder due to irritation of phrenic nerve. It may be to left shoulder in a left lobe involvement. Fever is of high grade, associated with nausea, anorexia, and vomiting. Jaundice is unusual.

Usually there is single abscess. It may rupture in the peritoneum, pleural cavity or the pericardial cavity. On aspiration, the fluid is odorless, typically described as chocolate syrup/anchovy sauce.

Investigations

Examination of Stool

Macroscopic (Naked eye): An offensive, dark brown semifluid, stool, mixed with blood and mucus indicates amoebic dysentery.

Microscopic examination: Fresh sample of stool should be examined. Three types of mounts are prepared.

1. With normal saline: Amebic trophozoites are easily recognized by their characteristic movement.
2. With iodine plus saline: This helps to distinguish from other parasites.
3. With methylene blue: To stain leukocytes and To differentiate from amebae.

(Thus a stained preparation is rarely called for).

Examination of the Blood

Shows moderate leukocytosis.

Serological Tests

Serological tests are often negative. If positive, gives a clue about extraintestinal amoebiasis.

Liver Aspirate

'Pus' is not of suppuration but a mixture of sloughed liver tissue and blood. So thick in consistency and chocolate colored, bacteriologically sterile. Trophozoites are not generally found or sparse but can be demonstrated only in the material from wall of the abscess, i.e. about 4 to 5 days after the evacuation of the abscess.

Treatment

- *Luminal amebicides:* Act only on the parasites of the intestinal lumen, e.g. diloxanide furoate (500 mg tid × 10 days), iodoquinol and paramomycin.
- *Tissue amebicides:* They are effective in the treatment of invasive amebiasis, e.g. metronidazole, tinidazole, secnidazole, followed by diloxanide furoate. The same drugs have to be used after draining the liver abscess.

Prevention and Control

Elimination of Reservoirs

- By effective treatment of cases and carriers.
- Carriers working in food and water establishments should abstain from working till they are cured. They are also given education about the periodontal examination and maintenance of high standard of personal hygiene.

Breaking the Channel of Transmission

Since the disease is transmitted by feco-oral route, it is broken by construction of sanitation barrier (sanitary latrine and motivating the people to use it) supplemented by provision of protected water supply. Cysts are not killed by chlorine in the concentration used for disinfection of water. Sand-filters are quite effective in removing amebic cysts. Therefore water filtration and boiling are more effective than chlorination of water.

Food hygienic measures include disinfection of fruits and vegetables with 5 to 10 percent acqueous solution of acetic acid or full strength of vinegar.

House flies to be controlled by keeping the premises clean in and around the houses.

Protection of Susceptibles

- *By health education*: The people are made water conscious, latrine conscious and health conscious.
- At present, no vaccine is available. Studies have shown that purified antigens (amebic proteins) are the viable candidates for vaccine development.

GIARDIASIS

It is an acute or chronic diarrheal disease, caused by a flagellated, protozoal parasite, *Giardia-lamblia*, transmitted by feco-oral route through contaminated water. The public health importance lies in the fact that it can lead to malabsorption and growth retardation among children and is often responsible for traveller's diarrhea.

Magnitude: Giardiasis is worldwide in distribution. The prevalence rate is about 2 to 5 percent in the developed countries and about 20 to 30 percent in the developing countries.

In India, the prevalence rate among school children has been found to vary from 35 to 75 percent.

Agent Factors

Agent

The causative agent is a flagellated, protozoal parasite called 'Giardia lamblia' (synonyms = *Giardia* duodenalis). It exists in two phases: trophozoite and cysts.

Trophozoite

Usually it colonizes in the duodenum. It has a spear shaped body, dorsal surface is convex and ventral surface is concave with a sucking disc. Size of the trophozoite is 14 μ long and 7 μ broad. It is bilaterally symmetrical and all the organs are paired (such as two axostyles, two nuclei and four pairs of flagella). An acid environment causes the parasite to encyst.

Cyst

It is oval shaped, measuring 12 μ long and 7 μ broad. It has a median body with four nuclei.

Life cycle

The trophozoite multiplies in the duodenum by binary fission. When the condition is unfavorable, encystment occurs in the large intestine. The cell divides into two within the cyst. The cysts are excreted in the feces and survives for several weeks or months in the cool environment. The cysts constitutes the infective stage of the parasite. It is transmitted feco-orally through the contaminated water or food. Within 30 minutes of ingestion, the cyst hatches out two trophozoites, which then multiply in enormous numbers and colonize in the duodenum and the cycle continues.

Reservoirs

Humans are the reservoirs. Some of the domestic animals have been found to be infected, such as cats, dogs, as well as sheep and cattle. They may be a source of infection for humans.

Mode of Transmission

Feco-oral route through contaminated food and water is the main mode of transmission. Person to person transmission occurs in groups with oral-anal sexual contact among children in day-care centers, male homosexuals and in custodial institutions.

Host Factors

Age incidence: Giardiasis can occur in any age group. But is more common among children, specially below 5 years.

Sex incidence: It is equal in both the sexes.

Nutritional status: It is four times more among malnourished children, compared to healthy counterpart.

Environmental factors: Favorable environmental factors are lack of protected water supply, lack of sanitary disposal of excreta, lack of personal hygiene and over-crowding.

Pathogenicity: With the help of sucking disc, the parasite attaches itself on the intestinal epithelial cells and leads

to malabsorption of fat, resulting in steatorrhea (passage of stools with loss of fat). The parasite is also capable of producing, harm by its toxic effect (allergy), traumatic and irritative effect as well as by diverting the nutrients.

Incubation Period

Ranges from 3 to 20 days (Average = 1 week).

Clinical Features

Vary from asymptomatic to acute or chronic features.

- *Asymptomatic cases*: These are silent cases. They constitute the majority, specially in endemic areas. They act as carriers.
- *Acute cases*: They will have watery diarrhea, mild to severe, often with bulky, greasy, frothy, malodorous stools, free from blood and mucus, associated with upper abdominal pain, discomfort, distension, anorexia, weakness and excessive flatus. Rarely fever. Majority recover but about 30 to 40 percent cases become chronic.
- *Chronic cases:* Chronic diarrhea with steatorrhea and profound weight loss is the feature. Fat malabsorption, Vitamin B_{12} and Vitamin A deficiency can occur.

Complications

Include retardation of growth and development among children and malnutrition.

Diagnosis

It is by identifying cysts or trophozoites in the freshly passed stools.

Treatment

Giardiasis is usually self limiting but the administration of anti-giardial drug reduces the severity of symptoms and the duration of illness. Three major groups of drugs are used for the treatment, as follows.

1. *Nitroimidazole*:
   - Metronidazole—400 mg, thrice a day for 5 days.
   - Tinidazole—2 g, single dose
2. *Acidine*:
   - Mepacrine—100 mg, thrice a day for 5 to 7 days.
3. *Nitrofurans*:
   - Furazolidine—100 mg, four times a day for 7 to 10 days.

Prevention and Control

Control measures include treatment of the cases and screening of the family members for the treatment of cyst passers. Preventive measures are provision of protected water supply by filtration and chlorination, sanitary disposal of excreta and maintenance of personal hygiene.

BIBLIOGRAPHY

1. Ghai OP. Understanding and Managing Acute Diarrhoea in Infants and Young Children.
2. GOI Surveillance of Acute Flaccid Paralysis. Field Guide. MCH Division, MOHFW, New Delhi.
3. GOI. Pulse Polio Immunization in India. Operational Guide 2003-04. Child Health Division, Dept of Family Welfare, New Delhi.
4. GOI. Pulse Polio Immunization in India; Operational Guide. MCH Division, Dept of Family Welfare, New Delhi, 1996.
5. Indian Council of Medical Research. Viral Hepatitis. Proceedings of the Task Force, held on Jan 8, 1980.
6. MMA Faridi, et al. Immunogenicity and Safety of Live Attenuated Hepatitis A Vaccine. A Multicentric Study. Indian Pediatrics. 2009;46:29-34.
7. Mohammed Asim, et al. Significance of anti HBc Screening of Blood Donors and its Association with Hepatitis B Virus Infection: Implications for Blood Transfusion. IJM Res 2010;132:312-7.
8. Prathap Chandran. National Polio Surveillance Project. AFP Surveillance in India. Implementing the Plan of Action.
9. Sengupta P. Rotavirus. The Challenges Ahead. IJCM. 2009;34(4): 279-81.
10. WHO. Guidelines for Cholera Control. WHO/CDD/SER/80.4 Geneva, 1980.
11. WHO. Programme for Control of Diarrhoeal Diseases; Managmeent of the Patient with Diarrhoea. 1992.
12. WHO. Tech Rep Ser No.691, 1983.
13. WHO. Tech Rep Ser No.693, 1983.
14. WHO. The Management of Diarrhoea and Use of Oral Rehydration Therapy; A Joint WHO/UNICEF Statement, Geneva, 1983.

SOIL-BORNE DISEASES

Soil-borne diseases are ascariasis, tetanus, gas gangrene, ancylostomiasis, anthrax, maligant edema trichuriasis, strongyloides stercoralis, aspergillosis, coccidioidomycosis and mycetoma.

ASCARIASIS

Roundworm infestation is the most common and most widespread worm infestation in all tropical countries, transmitted feco-orally through the soil, common among children, affecting the nutritional status, growth and development and often causing intestinal obstruction. It occurs in persons with unhygienic habits.

Agent Factors

Agent

The adult worm is cylindrical, resembling earth-worm, lives in the small intestine. It is light brown in color, female measuring 25 to 40 cm by 0.5 cm size (longer and stouter than male), and the male measuring 15 to 25 cm by 0.3 cm size. The body fluid of the worm contains a substance, called ascaron or ascarase, protein in nature which is allergic to man. Life span is one year. The female worm lays about 2 lakhs eggs everyday. The eggs are liberated by both fertilized and unfertilized worm. The fertilized eggs are oval, brownish with tansluscent shell with an outer rugose coat, having an unsegmented ovum inside with a clear crescentic area of each pole. They float in saturated salt solution. The unfertilized eggs (i.e. eggs of unfertilized worm) are elliptical, brownish, have thin shell with an atrophied ovum inside and do not float in saturated salt solution.

Life Cycle

Takes place in only one host, i.e. human being. The eggs are passed in the feces and develop into rhabditiform larvae in the soil within about 10 to 40 days and become infective.

Children while playing in the contaminated soil, ingest the eggs, which pass into the duodenum, where egg-shell splits and larvae come out. They burrow the mucous membrane of the gut, pass into the portal vein and reach liver, where they take rest for about 4 days. From the liver, they pass via the right heart and enter pulmonary circulation, where they grow for 10 to 15 days moult twice. Breaking the capillary wall, reach the pulmonary alveoli, crawl up the trachea, larynx and pharynx and are once more swallowed. They reach the duodenum, moult once again and grow into adult males and females in about 10 weeks, time. The gravid females begin to discharge eggs in the stool within about 2 months from the time of infection.

Reservoir

Human being is the only reservoir of infection.

Host Factors

Age incidence: It is maximum among children of 2 to 10 years age.

Sex incidence: It is equal in both boys and girls.

Environmental Factors

The black cotton–clay soil harbors the eggs well. The indiscriminate defection, especially by the children around the houses, poor sewage disposal facilities, facilitates survival and maturation of eggs.

Mode of Transmission

It is mainly by feco-oral route, through the contaminated soil, which is usual among children while playing in the soil. The eggs can also be ingested through raw vegetables cultivated in a sewage irrigated area. It is also common among children who develop perversion of eating mud (pica). The infestation can also occur by drinking fecal contaminated water.

Inhalation of eggs can occur through dust. The eggs hatch on moist mucous surface of upper air passage and the larvae may directly penetrate into the blood stream and reach various viscera, where they fail to grow and die.

Incubation Period

It is about 2 to 3 months from the time of ingesting eggs to the liberation of eggs by adult female worm.

Clinical Features

There are grouped into two groups—those produced by migrating larvae and those produced by the adult worms.

a. *Due to migrating larvae*: From the pulmonary capillaries to alveoli.
   Symptoms of pneumonia, such as fever, cough, breathlessness occur. It is called *Ascaris pneumonia* or Loeffler's syndrome. Urticarial rash and eosinophilia also occur. Sputum is often blood tinged and may contain ascaris larvae.
b. *Due to adult worms*:
   - It robs the host of its nutrition (i.e. Spoliative action) and predisposes for malnutrition and retarded growth and development among children.

- The toxic action of the ascaron (ascarase), body fluid of the worms when absorbed into the circulation results in typhoid like fever, urticaria, edema of the face, conjunctivitis and irritation of upper respiratory tract.
- The adult worms often results in intussusception or they may pass through the ulcers into the peritoneal cavity. Large number of worms also result in intestinal obstruction, an acute surgical emergency.
- The worms may migrate upwards and be vomited. (Ectopic ascariasis) or they may accidentally enter the respiratory tract at night and may result in suffocation.
- At times, a worm can enter appendix and cause appendicitis.
- Biliary obstruction and liver abscess may occur.

Laboratory Diagnosis

Direct Evidences

- Administration of an anthelmintic leads to expulsion of the worms.
- Administration of barium emulsion, being ingested by the worms in 4 to 6 hours, casts string like shadows in the X-ray.
- Microscopic examination of a saline emulsion of stool for eggs.

Indirect Evidences

- Blood examination reveals eosinophilia.
- 'Scratch test' with powdered ascaris antigen has been found to be positive dermal allergic reaction.

Treatment: The drugs are effective only against adult worms.

Drug of choice is piperazine citrate, 75 mg/kg. Other drugs are albendazole–200 mg for children below 10 years and 400 mg for adults.

Mebendazole–100 mg twice daily for 3 days.

Levamisole–150 mg for adults and 50 mg for children, single dose.

Pyrental pamoate–10 mg/kg, single dose.

Prevention and Control

- *Elimination of reservoir:* By periodical deworming of children.
- Breaking the channel of transmission:
  - By avoiding indiscriminate defecation
  - By using sanitary latrines and sanitary disposal of sewage
  - By provision of protected water supply
  - By disinfection of raw vegetables
  - By control of house flies
  - By maintaining personal hygiene by trimming the nails
- Protection of susceptibles:
  - By the use of soap to wash hands before eating the food and after using the toilet.
  - By health education.

ANCYLOSTOMIASIS

It is an infestation caused by the parasite hookworm, *Ancylostoma duodenale* or *Necator americanus*. It is common among children and adults, transmitted percutaneously through the fecal contaminated soil. Clinically, characterized by anemia and all consequences of anemia, depending upon the severity.

Distribution

The disease is widely distributed in all the tropical and sub-tropical countries between the parallel 36° N to 30° S, of the equator, where the atmospheric temperature and humidity are favorable, i.e. in Asia, Africa, Central and South America.

In India, *Necator americanus* is predominant in South India and *Ancylostoma duodenale* in North India. More than 20 crore people are estimated to be infected in India. Heavily infested states are Assam, West Bengal, Bihar, Odisha, Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra. Another species called *Ancylostoma ceylanicum* a hookworm of cats, has been isolated from a village in Kolkata in West Bengal.

'Chandler's index' is an indicator used to assess the severity of the public health problem of ancylostomiasis based on the average number of hookworm eggs per gram of stools.

Average no. of eggs/g of stools	Public health importance of hookworm infection
< 200	Not of much importance
200–250	Indicates potential danger
250–300	Indicates minor public health problem
> 300	Major public health problem

Chandler's index not only helps to assess the severity of health problem but also helps to evaluate the control measures of ancylostomiasis following mass treatment.

Agent Factors

Agent

The causative agent is a hookworm parasite. Two species are important, namely *Ancylostoma duodenale* and *Necator*

americanus. The former is larger, thicker and more pathogenic than the latter. The adult parasites live in the small intestine of the human beings, mainly in the jejunum, often in duodenum.

The adult parasite is a small grayish white or brown, cylindrical worm with the anterior end bent like a hook, is able to suck 0.2 mL blood/day, by attaching themselves to the villi. The male worm measures about 8 to 10 mm length and female being longer, about 11 to 13 mm. The life span is about 3 years. The gravid female of *Ancylostoma duodenale* lays about 30,000 eggs per day and *N. americanus* about 9,000 eggs per day, which are passed out in the stool. Each egg is oval, measuring about 65 × 40 µ (length and breadth), colorless, surrounded by a transparent hyaline membrane, floats in saturated solution of common salt. The segmented ovum contains 4 blastomeres and has a clear space between the egg-shell and the segmented ovum.

Life Cycle

Human being is the only definitive host. No intermediate host. Life cycle of both the worms are similar. Eggs are laid in unsegmented stage. Segmentation occurs while passing through the gut. Eggs when passed out in the feces are still not infective to man. In the soil (clay, moist soil), the eggs hatch within 24 to 48 hours and rhabditiform larvae, (one larva from each egg) are released, moult twice and develop into filariform larvae on 4th or 5th day, each measuring about 500µ in length, which are infective to man. They remain viable in the soil for several days **(Fig. 20.45)**.

These infective forms live in the soil or grass up to about one month, waiting for a host. When a person walks barefoot on the contaminated soil, they penetrate the skin of the feet and gain entrance inside the body to reach the sub-cutaneous tissue, from where they pass via, the lymphatics and venous circulation, reach the pulmonary capillaries via the right heart. From the pulmonary capillaries they enter the alveoli and ascend up the bronchi and trachea. As they crawl over the epiglottis, they are swallowed and they reach the small intestine and become sexually mature by one month and the cycle continues.

The interval between the entrance of infective filariform larvae and the first appearance of eggs in the feces, is called 'Pre-patent period', and that is about 6 weeks in ancylostomiasis.

The common sites of the entry of the larvae are the thin skin between the toes or the dorsum of the feet. However, the skin of the hands may be the portal of entry among the gardners, who handle raw manure contaminated with feces, and also among miners.

Exceptionally, the infective larvae enter the body by ingestion, bypassing the development in the lungs.

Reservoir

Human being is the only reservoir of infection.

Age and Sex Incidence

Highest incidence is reported among 15 to 25 year age group. However, it can occur in any age group of both the sexes.

Occupation

The incidence is high among the farmers, because of their contact with the soil. Thus, more common in rural areas than urban areas.

Environmental Factors

There are many environmental factors which favor the growth and development of larvae and are responsible for the prevalence of the disease in the country, such as:

Soil: It must be light, porous, warm with dampness, holding sufficient moisture with decaying vegetation.

Temperature: Of 22 to 32°C is favorable for larvae. Below 15°C, the eggs fail to grow and above 45°C, it is lethal.

Oxygen: It is necessary for the larvae. In black cotton soil, the larvae do not grow because oxygenation is poor in such soil. Loose porous soil helps in oxygenation.

Rainfall and moisture: Rainfall spread over long period is favorable to maintain favorable condition in the soil.

Human habits: Like indiscriminate defecation and walking barefoot, spreading raw organic manure in the fields, children playing in the contaminated soil, etc.

Predisposing factors are poverty, illiteracy, ignorance, lack of sanitation, improper drainage of sewage, low standard of living, etc. are all contributory factors.

Modes of transmission: The disease is transmitted mainly by the percutaneous route. The infective larvae penetrate the thin skin of the feet, between the toes.

Transmission is also possible orally by ingestion of filariform larvae through the contaminated fruits and vegetables, grown over the sewage irrigated areas. Transmission can also occur through water containing infective larvae, but not common.

Pathogenic Effects and Clinical Features

This can be discussed under two heads. Those caused by larvae and those caused by adult worms.

- *Effects caused by larvae*:
  - *In the skin:* Itching and dermatitis at the site of entry; creeping eruption (i.e. reddish itchy papule) all along the path traversed by the larvae
  - *In the lungs:* Bronchitis, bronchopneumonia, eosinophilia may occur while migrating from pulmonary capillaries into the alveoli.

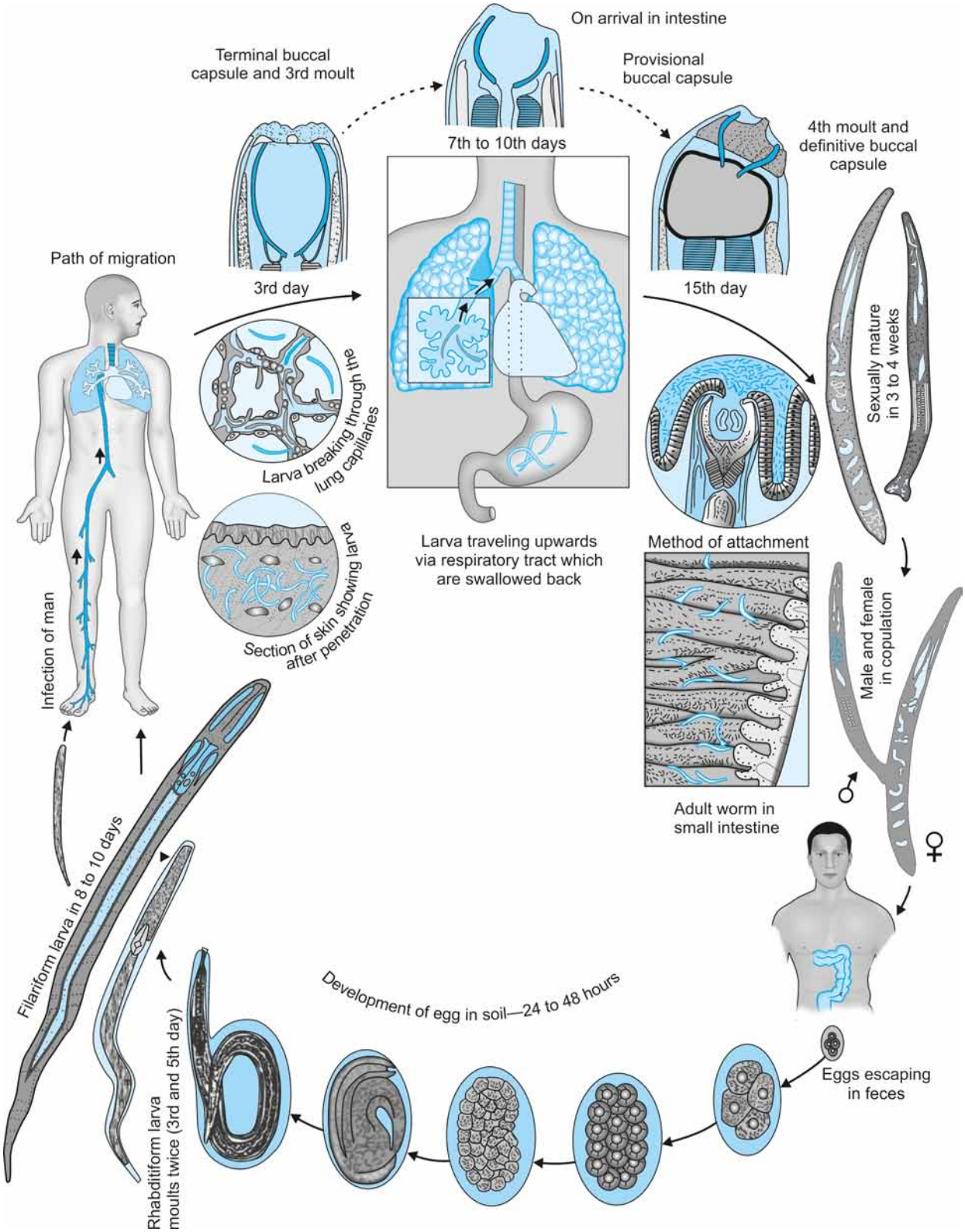


Fig. 20.45 Life cycle of *Ancylostoma duodenale*

- *Effects caused by adult hookworms*: Since the adult worm feeds on the blood of the host, at the rate of 0.2 mL/worm/day by *A. duodenale* and 0.03 mL/worm/day by *N. americanus*, the clinical effects are all due to chronic blood loss, resulting in anemia. Chronic blood loss also results from chronic hemorrhages from the punctured sites.

Associated deficiency of iron in the food results in microcytic hypochromic anemia and that of folic acid and Vitamin B_{12} results in macrocytic type of anemia and deficiency of both results in dimorphic anemia.

Adult worms also result in loss of blood plasma into the small intestine, leading to hypoproteinemia.

Clinical Features of Hookworm Infestation

These are grouped into two groups:

1. *Intestinal manifestations due to parasites*: Dyspepsia, epigastric pain, often perverted taste for soil, mud or lime (pica or geophagy) and varying degrees of acidity.
2. *General manifestations due to anemia*: The patient looks pale, plumpy with puffy face, protuberant abdomen with pedal edema. The hairs are dry and lustreless, skin looks sallow, lower eyelids are swollen, the eyes, lips and tongue are extremely pale, the nails are spoon shaped (Koilonychia). The patient will have cough, breathlessness, fatigue, exhaustion, with or without fever. Pulse is rapid and weak, blood pressure becomes low, hemic murmur (soft systolic) better heard over the pulmonary area indicating hyperkinetic circulatory state, ultimately leading to circulatory failure.

Laboratory Diagnosis

By examination of stool and blood.

Examination of Stool

Macroscopic exam: For adult hookworm, which is about 1 cm size.

Microscopic exam: For ancylostoma ova (confirmative)
- For occult blood
- For Charcot-Leyden crystals (often positive)

Examination of Blood

- Hb percent—decreased (this helps for treatment purpose)
- RBC count—decreased
- Eosinophil count—increased
- Peripheral smear—shows microcytic/macrocytic dimorphic hypochromic picture (due to deficiency of iron/folic acid or vitamin B_{12}/both respectively).

Prevention and Control

Elimination of Reservoir

This consists of treatment of the cases. Treatment depends upon the severity of anemia as follows:

a. Mild cases of anemia (Hb% between 80 and 60%)
   Anthelmintic treatment plus oral iron therapy ($FeSO_4$).
   The various anthelmintic drugs available and the dosage is as follows:
   Albendazole—400 mg single dose
   Mebendazole—100 mg twice daily for 3 days
   Levamizole—150 mg for adults and 50 mg for children, single dose
   Pyrantel palmoate—10 mg per kg body wt daily for 3 days
b. Moderately severe cases of anemia (Hb% between 60 and 40%)
   Anemia is corrected first with parenteral iron therapy and when Hb level improves beyond 50 percent, anthelminitic drug is given, because the patient cannot tolerate the drug if the Hb level is below 50 percent.
c. Severe cases of anemia (Hb% below 40%)
   i. If associated with cardiac failure, failure must be treated first with digoxin, lasix and potassium salts alongwith packed cell transfusion followed by anthelmintic treatment.
   ii. If not associated with cardiac failure, whole blood transfusion is given followed by anthelmintic drug.

Blocking the Channel of Transmission

Since ancylostomiasis is a soil-borne disease, measures are taken to prevent fecal contamination of the soil by the following measures:

- Construction and use of sanitary latrines
- Avoiding open air, indiscriminate defecation
- Sanitary disposal of sewage
- Avoiding the use of untreated sewage as fertilizer.

Protection of Susceptibles

It is by health education aimed at:

- Promoting the use of sanitary latrines
- Prevention of soil pollution
- Use of protective foot-wear
- Use of thick gloves while handling the manure.

TETANUS

It is an acute infectious disease, caused by the bacilli *Clostridium tetani* transmitted percutaneously in the form of spores, through the wound, from the contaminated soil, dust

and inanimate objects including instruments. Clinically, it is characterized by fever, difficulty in opening the mouth (lock-jaw), painful rigidity of all the skeletal muscles of the body, often punctuated by paroxysms of severe painful convulsions. Case fatality is very high, varying from 40 to 80 percent.

History

Kitasato isolated the bacilli in pure culture form in 1889. He extracted the tetanus toxin in 1890 and anti-toxin 1891.

Magnitude of the Problem

Tetanus is totally controlled in all the developed countries because of effective immunization program. However, it continues to be a major public health problem in all the developing countries including India.

In India, tetanus is considered as one of the six major killer diseases of children. Neonatal tetanus constitutes one of the important causes of infant mortality in our country, next to Measles, so much so, even with expert treatment, the case fatality rate is 80 to 90 percent. Annual incidence of neonatal tetanus (NNT) has been declining with the intensification of Universal Immunization Programme (i.e. immunization of the pregnant mothers with two doses of tetanus toxoid).

Elimination of NNT is set as one of the goals of UIP. NNT is said to be eliminated from an area when the immunization coverage among pregnant mothers with two doses of tetanus toxoid is more than 90 percent; percentage of deliveries conducted by trained person is more than 75 percent and the incidence of NNT is less than 0.1 per 1000 livebirths.

Agent Factors

Causative Agent

The pathogen is *Clostridium tetani*, a gram-positive, anaerobic, spore forming bacillus, of about 2 to 5 μ in length. It is a commensal of the herbivorous animals. It lives and multiplies in the intestine of those animals and is excreted in the dung. In the external environment, they convert themselves into a resting stage, i.e. spores, which look like 'drum-sticks' or 'cloves' or 'tennis racket' under the microscope. The animals ingest them while grazing the grass. In the gut, in the presence of warmth and absence of oxygen, the spores germinate into vegetative forms and multiply. There is no autolysis in the gut of animals.

The spores are highly resistant to disinfectants, antibiotics and heat. They survive for years in the dust and soil. They are ubiquitous and found everywhere. They are destroyed by autoclaving (at 120°C × 20 mt) and by gamma radiation. However, vegetative forms are sensitive to heat and anti-biotics, specially penicillin.

The spores enter the human body, percutaneously through the wound, contaminated with soil or dust. Following secondary infection of the wound and formation of purulent material, under favorable conditions (i.e. presence of warmth and absence of oxygen), the spores germinate into vegetative forms (bacilli) and on autolysis they produce exotoxin (tetanospasmin), highly lethal, which is responsible for the pathology and pathogenesis of the disease. The non pathogenic exotoxin produced is tetano-lysin.

Vegetative forms v/s spores of *Cl. tetani* is shown in the **Table 20.20**.

Reservoir of Infection

Chief reservoirs are herbivorous animals like horses, cattle, sheep, goat, etc. The pathogens live and multiply in the intestine of these animals. However, animals do not suffer from tetanus.

When the organisms are excreted and are converted into spores, they are disseminated widely by the wind and thus they are found everywhere in the soil, dust, objects, including rusted instruments, etc. which constitute the source of infection. Thus herbivorous animals are the reservoirs of vegetative forms and soil is the reservoir of spores. There is no human reservoirs, but only cases. A case of tetanus is not infectious to others.

Table 20.20 Vegetative forms v/s spores of *Clostridium tetani*

Vegetative forms	Spores
Found in the gut of herbivorous animals	Found in soil, dust and inanimate objects including instruments
Active stage	Resting stage
They multiply	They do not multiply
Herbivorous animals are the reservoirs	Soil, dung and contaminated instruments are the reservoirs and the source of infection
They do not undergo germination	They germinate into vegetative forms under favorable conditions (i.e. presence of warmth and absence of oxygen)
They undergo autolysis and produce toxin	They do not undergo autolysis
They are sensitive to heat and antibiotics (penicillin)	They are resistant to heat and antibiotics
They are easily destroyed by heat, antibiotics and disinfectants	They are destroyed only by autoclaving and gamma radiation

Age Incidence

People of all the age group are susceptible to tetanus. Thus susceptibility is universal. However, incidence is high among young children and adults, because they are more prone for injuries and accidents.

In developing countries, the incidence is high among the newborns also because of lack of aseptic precautions while conducting the delivery at home and the practice of brutal habits of cutting the umbilical cord with knife and application of cowdung to the umbilical stump to stop bleeding.

Sex Incidence

Incidence is more among men than among women because men are more prone for injuries. However, it is more among women in the reproductive age group, because of criminal abortions and unsafe deliveries.

Occupation

Tetanus is not an occupational disease. However, it is more among agricultural workers because of their contact with the soil, animal dung and sustaining injuries in the fields.

Other high-risk groups are soldiers, policemen, sportsmen, industrial workers, *chappal* repairers, people having live-stocks at home, etc.

Immunity

It is acquired by humoral antibodies. Immunity acquired following active immunization lasts longer than that produced by natural disease. Therefore, active immunization is a must for a patient after recovery from tetanus (After clinical recovery, the patient becomes susceptible again for tetanus).

Mode of Transmission

It is by percutaneous route. Spores are the infective forms. They enter the body only through the wounds, including microscopic injuries, through dust, soil contaminated dressings, instruments, etc. Spores and the vegetative forms never enter the body through the healthy skin. However, spores can enter through the cut end of the umbilical cord in a newborn.

The pathogen never spreads from person to person. There is a portal of entry, site of election and no portal of exit. Therefore, tetanus is a classical example of 'Dead-end' infection.

The common tetanus prone injuries are pin prick, thorn prick, needle prick, prick by rusted iron materials, bullet wounds, bull-gores, stab injuries, lacerated injuries following accidents in roads and industries, postpartum or postabortal uterus, burns, boils, carbuncles, septic skin lesions, human bites, animal bites, stings, frostbites, tissue-necrosis, gangrene, procedures like dental extractions, unsterile surgery, unsafe deliveries, and conditions like scabies, chronic suppurative otitis-media, etc. Thus, in short, any injury including unnoticed wound is a tetanus prone injury.

Pathology and Pathogenesis

Spores enter the body percutaneously through the wound and lodge in the wound. Following secondary infection of the wound by streptococci and staphylococci, there will be formation of purulent material in the wound, which results in the presence of warmth and absence of oxygen, which is a very favorable environment for the spores to germinate into vegetative forms. Then they start multiplying and on autolysis, they produce exotoxin, one of the highly lethal product. The human lethal dose is hardly 0.1 to 0.2 mg.

The exotoxin then enters the circulation resulting in toxemia. After circulation, the toxin gets fixed into the anterior horn cells of the entire spinal cord, starting from the cervical part. Once the toxin gets fixed up in the spinal cord, no amount of antitoxin can neutralize it. The toxin blocks the inhibition of spinal reflexes. The patient becomes highly sensitive to sensory stimuli, such as touch, pain, hot and cold. Any sensory disturbance results in severe painful convulsions.

The toxin looses its toxicity by itself after several weeks.

Incubation Period

Varies from 3 days to 30 days (Average = 1 to 2 weeks).

Clinical Features

There is sudden onset of fever, which increases day by day. It is associated with prodromal symptoms like headache, body ache, anorexia and malaise. Meanwhile patient will have difficulty in opening the mouth because of painful spasm of masseter muscles. This characteristic early feature is called 'Lock jaw' (Trismus). Because of difficulty in opening the mouth, the patient is partially starving. As the condition progresses, the muscles of the face undergo painful spasms giving rise to typical grisy face, as it happens while looking at the bright sun. This feature is called 'Risus sardonicus'. Later, the muscles of the neck become rigid (neck rigidity), followed by muscles of the back and extremities. Thus all the skeletal muscles of the body are affected. The entire body becomes stiff. There will be hyperextension of the neck, vertebral column and extremities later, giving rise to a position of rainbow, called 'Opisthotonus position' **(Fig. 20.46)**.

Patient becomes so sensitive that even slight sensory disturbance like touch, pain, cold drought of air is sufficient to result in severe, painful, exhaustive convulsions. Between the convulsions, the muscles are not totally relaxed but remain rigid (i.e. partial contraction persists). Many times these

Fig. 20.46 Opisthotonus position

convulsions result in tear of the muscles and even fracture of the vertebrae.

Patient remains mentally clear and conscious of pain persists throughout the period of illness. Convulsions occur in paroxysms. Following convulsions, there will be rise of temperature. Patient may die of continuous, painful, exhaustive convulsions, asphyxia or aspiration pneumonia.

Differential Diagnosis

- *Meningitis:* Patient is mentally not clear; Examination of cerebrospinal fluid (CSF) helps in diagnosis.
- *Status epilepticus:* Patient will have a history of epilepsy.
- *Tetany:* Patient will have carpo-pedal spasm.
- *Strychnine poisoning:* Muscles are completely relaxed between convulsions.

Treatment

- Hospitalization is a must because patient cannot be managed at home.
- Isolation ward should be away from the general ward. Atmosphere of calm and quietness is of paramount importance. Often they are admitted in darkroom.
- Wound is cleaned and debridement done (i.e. removal of the pus, slough, necrotic tissue, dust and dirt to prevent anaerobic environment). Followed by dressing of the wound.
- Human tetanus immunoglobulin (hTIG), a specific antibody preparation is given intramuscularly, to neutralize the circulating toxins. Dose—250 to 500 IU.
- Antibiotics are given to destroy and control the vegetative forms. Penicillin is the drug of choice. It is started with short and quick acting benzyl penicillin, 5 to 10 lakhs intramuscularly, 6th hourly for 5 days, followed by procaine penicillin 4 L, daily. Antibiotics not only helps in treating the disease but also helps in healing of the wound and prevention of pneumonia.
- Sedatives like chlorpromazine and/or diazepam and/or babiturates are given to prevent rigidity and convulsions.
- Anti-convulsants like diazepam are given during convulsions.
- Fluids and electrolyte balance is maintained by tube-feeding.
- Expert nursing care is of supreme importance because the patient is highly sensitive to sensory stimuli (Clothes are stripped, change of posture, change of linen, continuous catheterization for drainage of urine, prevention of aspiration pneumonia and bed-sores are all important).
- Antipyretics are given to control the body temperature.

After recovery from the disease, the patient must be actively immunized with a complete course of tetanus toxoid because the infective dose of the toxin to produce the disease is not sufficient to produce protective antibody titer.

Clinical Types of Tetanus

- *Traumatic tetanus*: This is the commonest type, occurring following an injury/wound and not caring for it or caring unhygienically.
- *Neonatal tetanus*: It is also called tetanus neonatorum. It is occurring in the newborn baby following infection of the umbilical stump due to lack of aseptic precautions while conducting the delivery, predisposed by lack of immunization of the mother with tetanus toxoid during pregnancy.
- *Puerperal tetanus*: This occurs usually following unsafe delivery or criminal abortion predisposed by lack of immunization with tetanus toxoid during pregnancy. The route of entry of pathogen is through the vagina. The post-abortal uterus is a favorable site for germination of spores.
- *Otogenic tetanus*: This occurs following suppurative, otitis-media, predisposed by cleaning of the ear by contaminated objects like pencil, match-stick, safety-pin, hair-pin, etc. Thus otitis media is an important focus of infection.
- *Idiopathic tetanus*: This is also called 'cryptogenic tetanus'. This is concluded, when all the above types are excluded. Probably microscopic unnoticed trauma is the cause.

Prognosis

This depends upon the following factors:

- *Incubation period*: Shorter the incubation period, worse is the prognosis.
- *Age*: Prognosis is worse among neonates and elderly.
- *Interval between trismus and first convulsion*: If less than 48 hours, worse is the prognosis.
- *Dental gap*: More the gap between the jaws, better is the prognosis.

Prevention and Control

Prevention and control of tetanus is by primary prevention.

Health Promotion

- Health education of the people about mode of transmission of tetanus and its complications.
- People are also educated about caring the wound hygienically.
- High-risk people and all expectant mothers are motivated for immunization.
- All hospital procedures are conducted under meticulous care, caution and technique of aseptic precautions.
- All pregnant women must be motivated for institutional deliveries.

Specific Protection

This is done by immunization—active and passive.

Active immunization: For this purpose, vaccines are grouped into two groups:

a. *Combined vaccines*
   Ex. DPT (Trivalent vaccine, triple antigen)
   DT (Bivalent vaccine); Tetravalent (DPT + Hib) and Pentavalent vaccines (DPT + Hib + HB_SAg) and hexavalent vaccines described under diphtheria.

b. *Monovalent vaccines*
   Ex: Purified toxoid adsorbed on aluminum phosphate (PTAP) (TT)
   Alum precipitated toxoid (APT)
   Formol toxoid (FT)
   PTAP is widely used among the monovalent vaccines **(Fig. 20.47)**.
   DPT is used for infants and children below 2 years of age.
   Dosage schedule is described below:
   DT is used for children between 2 and 5 years of age.
   TT is used for all above 5 years of age.
   Each dose of the vaccine, irrespective of the type, is 0.5 mL, given deep intramuscularly.

Fig. 20.47 Purified toxoid adsorbed on aluminum phosphate (PTAP)

Passive immunization: This is done by readymade antibody preparations. There are two types namely Equine preparation called 'Anti-tetanus serum' (ATS) and human preparation called Human tetanus immunoglobulin (hTIG).

Guidelines for the Prevention of Tetanus in the Community

Passive immunization is given for those who are at risk such as those who have sustained injury and not immunized before. For such high-risk individuals, passive immunization is followed by active immunization also.

ATS: This is prepared from hyperimmunized horses. It may result in reaction. Therefore, test dose is a must. Dose—1500 IU. Passive immunity lasts for 10 to 15 days only.

HTIG: This is prepared from the plasma of immunized persons. Therefore, it is very safe and immunity also lasts for about one month, but it is costly. Dose—250 to 500 IU. It is a specific immunoglobulin. No chances of reaction with this.

This is grouped under two headings:

1. Basic prophylactic measures
2. Prophylactic measures in the event of injury.

Basic prophylactic measures

a. *For infants and children below two years*: Primary course of 3 doses of DPT are given, one each, at 6th week, 10th week and 14th week respectively, with a booster dose during 18th month. Each dose of 0.5 mL intramuscularly.

b. *For preschool children (Toddlers, 2–5 years)*: If they are completely immunized with the primary course during infancy, they require one booster dose during 18th month and second booster dose would be with DT and not DPT during 5th year.
   If they are not immunized during infancy, require only two doses of DT with 4 to 6 weeks interval as the primary course (not with DPT) followed by a booster dose with DT during 5th year.

c. *For adults*: All above 5 years require a schedule of 4 doses of tetanus toxoid with 6 weeks interval between the first two doses, 6 months interval between the second and third dose, 6 years interval between the third and fourth dose and booster doses subsequently once in 10 years.

d. *For pregnant mothers*: All pregnant mothers also require 4 doses of tetanus toxoid to protect against tetanus, but they require at least 2 doses of TT with 4 weeks interval to prevent neonatal tetanus, first dose in the first ante-natal check-up and second dose after 4 weeks. If the pregnant mother has conceived within the past 5 years of previous pregnancy with 2 doses of TT, now requires only one dose of TT as booster dose.

Golden rule: No pregnant mother should be deprived of at least one dose of tetanus toxoid.

Prophylactic measures in the event of injury

Following measures are adopted:

a. *Cleaning and wound debridement*: Debridement means removal of slough, necrotic tissue, purulent material, dirt, etc. Then the wound is washed with hydrogen peroxide followed by dressing with an antibiotic. This prevents the anaerobic environment in the wound and thus prevents germination of spores into vegetative forms.

b. *Prophylactic antibiotics*: Such as long acting penicillin (Benzathine penicillin) 24 lakhs, not only prevents secondary infection of the wound but also prevents tetanus for about one month by destroying the vegetative forms as soon as they are germinated from spores. However, the limitations of the antibiotic to protect against tetanus are:
   - It does not protect for more than one month
   - It is very painful injection
   - It often results in reactions.

c. *Immunization against tetanus*: The schedule depends upon the immunization status as follows:
   - *Totally immunized:* Within the past 5 years ..... Nothing required
   - *Totally immunized:* More than 5 years ago but less than 10 years .... Requires 1 BD (TT)
   - *Totally immunized:* More than 10 years ago ..... Require TIG + 1 BD of TT.
   - Not immunized or immunization status is unknown ..... Require TIG + complete course of TT.

NEONATAL TETANUS

Neonatal tetanus (NNT) is the occurrence of tetanus in a newborn baby. It is also called tetanus neonatorum. NNT constitutes one of important preventable causes of infant mortality in India.

Extent of the Problem

Before launching National Immunization Program, roughly 3.5 lakh children died annually due to NNT (i.e. nearly 30 percent of neonatal deaths were due to tetanus) compared to developed countries, this is about 50 times higher. During 1990s mortality due to NNT was 3/1000 live-births and during 1997, it was reduced to 2.3/1000 live-births.

The decline was mainly due to increase in immunization coverage of pregnant mothers with tetanus toxoid and also due to training of traditional birth attendants (TBAs) to conduct safe delivery.

During 1989, recognizing the magnitude of NNT incidence as well as the preventable nature, World Health Assembly resolved to eliminate NNT by 1995, by aiming to reduce the incidence rate to less than 0.1 per 1000 live-births for each health block. This goal was reaffirmed in 1999 and a new target date was set for elimination of NNT by the year 2005.

Public Health Importance

- NNT constitutes an important cause of preventable infant mortality in our country.
- Incidence of NNT is about 2.3 per 1000 livebirths (1997)
- It carries a very high mortality.
- Case fatality rate is more than 90 percent.
- NNT is easily preventable.
- Elimination of NNT is set as one of the goals of UIP.

NNT is said to be eliminated from an area, when the immunization coverage among pregnant mothers with two doses of TT is more than 90 percent and the percentage of deliveries conducted by trained *dais* is more than 75 percent and the incidence rate is less than 0.1 per 1000 livebirths.

Etiology: The causative agent is the spores of *Clostridium tetani*.

Route of entry: Spores enter through the cut end of umbilical cord.

Predisposing Factors

- Lack of immunization with tetanus toxoid during pregnancy.
- Lack of hygienic environment during delivery.
- Lack of aseptic precautions while conducting delivery.
- Brutal habits of cutting the umbilical cord with rusted blade or knife, followed by application of cow-dung to the umbilical cord to control bleeding.
- Use of dirty cloth to cover umbilical cord.

Pathology and Pathogenesis

Spores having entered the body through the umbilical stump, results in inflammatory process, which provides a favorable environment, such as presence of warmth and absence of oxygen, for the spores to germinate into vegetative forms, which later multiply and on autolysis, they produce exotoxin, which enters the circulation, resulting in toxemia and ultimately lodge in the anterior horn cells of spinal cord and blocks the inhibition of spinal reflexes.

Clinical Features

The newborn is apparently normal at birth, starts fever after 3 to 4 days, stops taking feeds from 5th day, develops convulsions from 6th day and most children die on 8th day. Therefore, NNT is known as 8th day disease in Punjab **(Fig. 20.48)**.

Fig. 20.48 Neonatal tetanus with tongue depressor

Elimination of Neonatal Tetanus

For the purposes of neonatal tetanus (NNT) elimination, districts have been classified into three categories depending upon the TT immunization coverage of expectant mothers, incidence rate of NNT and the percentage of deliveries conducted by trained persons, as follows:

NNT high-risk districts:

- Incidence rate of NNT is > 1 per 1000 live-births.

  Or
- TT_2 coverage is < 70 percent

  Or
- Attended deliveries is < 50 percent.

NNT control districts:

- Incidence rate is < 1 per 1000 live-births
- TT_2 coverage is > 70 percent
- Attended deliveries is > 50 percent.

NNT elimination districts:

- Incidence rate is < 0.1 per 1000 live-births
- TT_2 coverage is > 90 percent
- Attended deliveries is > 75 percent.

Strategies for the Elimination of NNT

- Hundred percent coverage of expected mothers with two doses of TT.
- Training of traditional birth attendants in conducting safe deliveries by observing '5 cleans'. (Clean surface, clean hands, clean razer blade, clean ligatures and clean cord-stump).
- Extensive information, education and communication (IEC) efforts for the promotion of safe deliveries at home by the distribution of 'disposable delivery kit' (DDK) to the pregnant mother in the last antenatal check-up.
- Providing facilities for clean and safe deliveries in all the PHCs and subcenters.
- Ensuring essential newborn care, with a special reference to umbilical cord.

Note: Occurrence of a case of NNT is a failure of health care delivery system and it should trigger all the above action plans in that area.

Golden rule: No mother should be deprived of at least one dose of tetanus toxoid during pregnancy.

Reporting of NNT cases from all the hospitals has been made mandatory. Monthly report must be sent to the chief medical officer of the district. Even the 'nil' report has to be sent. Line-listing of the cases are submitted to enable identification of high-risk pockets, for specific interventions.

BIBLIOGRAPHY

1. Chatterjee KD. Parasitology in Relation to Clinical Medicine. 17th Edn. 1969.
2. Control of Ascariasis. Tech Rep Ser No. 379, 1967.
3. Chowdhury AB. Am J Trop Med Hyg 1972;21:300.
4. UNICEF, WHO, UNFPA. Maternal and Neonatal tetanus Elimination by 2005. Strategie for achieving and maintaining elimination. New York: UNICEF;2000.

VECTOR-BORNE DISEASES

MALARIA

(Mala = Bad; Aria = Air)

In ancient Italy, people associated this disease with bad air. Hence the name. Malaria is a communicable disease caused by protozoal parasite, of the genus *Plasmodium*, transmitted from person to person, by the bite of infected, female, anophelin mosquito. Clinically, the disease is characterized by episodes of fever with rigors, followed by profuse sweating and headache. Repeated episodes occur with definite intermittent periodicity depending upon the species of the parasite and results in enlargement of the spleen and secondary anemia. Mortality is not high but it produces incapacitation affecting the human resources of the country which ultimately affects the progress of the nation, socially and economically.

History

Malaria is known since ancient times. Hippocrates in 5th century BC was the first person to describe features of malaria. *Charaka* and *Sushrutha* also gave the descriptions of the disease and associated the disease with the bites of

the mosquitoes. But in ancient Italy, people associated this disease with bad air.

In 1880, Laveron, a French army surgeon, discovered the malarial parasite in human red cells and got Nobel Prize.

In 1891, Romanowski, in Russia, developed a new method of staining the blood films to study the parasites.

In 1894, Manson hypothesized that mosquitoes transmit the disease.

In 1897, Ronald Ross confirmed the same. He studied the development of parasite in the body of the female anopheline mosquito, growing as oocyst on the stomach wall (at Secunderabad in AP).

In 1898, three Italian scientists namely Bignami, Bastianelli, and Grassi demonstrated the sporozoites in the salivary glands of anopheline mosquitoes.

In 1939, Paul Muller, discovered the insecticidal property of DDT. This opened a new avenue in the control of malaria in the world.

In 1945, Venezuela was the first country to launch Eradication Program against malaria.

In 1953, Government of India, launched National Malaria Control Program (NMCP).

In 1958, NMCP was converted into National Malaria Eradication Program (NMEP).

In 1977, NMEP was revised and upgraded and was called as 'Modified Plan of Operation of Malaria Control (MPO)'.

In 1995, accelerated malaria action program was taken up in high-risk areas.

In 1999, National program was renamed as 'National Anti-Malaria Program'.

Since 2003-04, the national program against malaria is included under National Vector Borne Diseases Control Program (NVBDCP).

Magnitude

Malaria is a global problem, about 100 countries are malarious, about half of which are in sub-Saharan Africa, most of them being caused by *Plasmodium falciparum*. Malaria has been killing about 1.4 million people worldwide, every year, of whom about 1 million people are under-fives, most of them dying from cerebral malaria. Anemia constitutes about 25 percent of total deaths from malaria.

In South East Asia Region (SEAR), except Maldives, all countries have indigenous malaria transmission, caused mainly by *Plasmodium vivax* and often by *Pl. falciparum*, which carries high mortality. Added to this, is the threat of drug resistant *Pl. falciparum*, which has increased the morbidity and mortality.

In India, since 1997, with the launching of MPO, there was a constant decline of malaria incidence. During 2003, about 1.65 million cases were reported with 943 deaths. However, malaria has remained as an endemic disease in the country. North-Eastern states contribute to about 10 percent of total cases and about 14 percent of total deaths due to malaria because of topography and climatic conditions being favorable for malaria transmission.

Trend of Malaria

1953: Cases were 7.5 crores and deaths were 8 lakhs. NMCP was launched.
1958: Incidence was reduced to 2 million. The program was upgraded to NMEP.
1961: Incidence of malaria was decreased to hardly 50,000 cases.
1966: There was resurgence of malaria. 'Roll Back Malaria'. Malaria came back with greater force. Vector developed resistance to DDT and parasites developed resistance to drugs, so much so that total number of cases went up to 1.4 lakhs.
1976: The incidence went up to 64 lakhs and 59 deaths.
1977: Modified Plan of Operation of Malaria Control was started.
1984: Incidence of malaria dropped to 21 lakhs.
2003: Cases reported were 16.5 lakhs and 943 deaths.

Agent Factors

Agent

Malaria is caused by four species of protozoal parasite, belonging to the genus *Plasmodium*. They are *Pl. vivax, Pl. falciparum, Pl. malariae* and *Pl. ovale,* out of which *Pl. vivax* is responsible for about 70 percent of the cases, *Pl. falciparum* for about 25 to 30 percent, 4 to 8 percent due to mixed infections, *Pl. malariae* for less than 1 percent infections in India. The largest focus of *Pl. malariae* are in Tumkur and Hassan district of Karnataka. *Pl. ovale* rarely affects human beings and is confined to Africa and Vietnam.

Life History

The parasite undergoes development in 2 hosts, man and mosquito; man is the intermediate host, in whom asexual phase of development takes place and female anopheline mosquito in which sexual phase of the development takes place.

a. **Cycle in man (asexual phase):** This begins when an infected female anopheline mosquito bites a person and inoculates sporozoites. Majority of these infective forms (sporozoites) are destroyed by phagocytes but a few reach the liver within about an hour, thus disappear from the circulation. In the hepatocytes (Hepatic stage) the sporozoites develop into schizonts in about 2 weeks, which later burst open and release merozoites (cryptozoites).

In *Pl. falciparum*, a single schizont releases about 40,000 (cryptozoites) merozoites and all the schizont's rupture simultaneously, where as in *Pl. vivax* and others, a single

schizont releases about 10,000 to 15,000 merozoites and all the schizonts do not rupture simultaneously, thus giving rise to 'Persistent tissue phase' (Exo-erythrocytic phase), which become the seeds of future relapse. Thus there is no relapse in *Pl. falciparum. Pl. vivax* and ovale continue to relapse for 2 to 3 years and *Pl. malariae* for 10 to 15 years.

Erythrocytic phase: The merozoites (cryptozoites) releasing from the hepatic schizonts majority are destroyed by the phagocytes. The remaining enter RBCs and undergo development into trophozoite, schizont and merozoites. Once the cryptozoites enter the erythrocytes, they do not reinvade the liver. When the erythrocytes rupture, the merozoites are released, which infest fresh RBCs and the cycle continues till the immune response in the host is developed and this stage is slowed down. The duration of erythrocytic stage is 2 days in *Pl. vivax*, *Pl. falciparum* and *Pl. ovale* and is 3 days in *Pl. malariae*.

Gametogony: Once the immunity is developed, the merozoites do not reinvade the erythrocytes but undergo development into male and female gametocytes, which are the sexual forms and are the infective forms to the mosquito.

The period between the entrance of the sporozoites and the appearance of gametocytes in the blood, is called 'Pre-patent period'. It is about 3 weeks.

b. **Cycle in mosquito (Sexual phase) (Sporogony):** The cycle in the female anopheline mosquito begins when it bites an infected person and sucks the blood containing male and female gametocytes. The first stage of development takes place in the stomach of the mosquito. The male gametocytes undergo exflagellation and become male-gamete (or micro-gamete) and the female gametocytes undergo maturation and become female gamete (or macro-gamete). Then by a process of chemotaxis, micro-gametes are attracted towards macro-gametes and one of micro-gametes causes fertilization of the female gamete, resulting in 'Zygote'. The zygote develops spikes around it and becomes motile. It is called 'Ookinite'. This penetrates the stomach wall, comes to the outer surface and develops into 'Oocyst', inside which numerous sporozoites develop. When the oocyst matures, it bursts open releasing sporozoites, which migrate to the salivary glands of the mosquito. The mosquito is now said to have become infective. Once it becomes infective, it remains infective throughout its life. Whomsoever it bites, spreads the disease. The period required for the parasite to undergo development and multiplication (i.e. cyclo-propagative type of biological transmission) from the stage of gametocytes to sporozoites is about 10 to 20 days, is called 'Extrinsic incubation period'. This depends upon the atmospheric temperature and humidity.

Reservoir of infection

There is only human reservoir and no animal reservoir, except Chimpanzes in Africa, which carry *Pl. malariae*. A reservoir may be a case or a carrier. A carrier is one who is having gametocytes circulating in the blood. Children are more likely to be gametocyte carriers than adults.

The criteria to call a person as malaria carrier are:

- He/she should have both the sexes of the gametocytes in the blood
- The gametocytes must be matured
- They must be viable
- They must be present in sufficient numbers (density) (at least 12 per Cu mm of blood).

Host Factors

Age incidence: No age is bar from malaria. However, newborns are resistant to *Pl. falciparum* because of high concentration of fetal hemoglobin, which suppresses the development of *Pl. falciparum*. Young children have been identified as high-risk group.

Sex incidence: It is more among men than women because of outdoor life and are less clothed than women.

Pregnancy: Pregnancy increases the risk and severity of malaria, so much so, it may result in abortion or still-birth or premature delivery.

Occupation: Malaria is not an occupational disease, but it is more among rural people, because of agricultural occupation.

Predisposing Factors

Poor standard of housing with ill-lighting and ill-ventilation favor the mosquito to rest. Human activities such as industrialization, urbanization, irrigation and agricultural activities, deforestration, etc. favor the breeding places for the mosquitoes (such as burrow pits, garden pools, irrigation channels, etc.) which in turn increase malaria problem. So malaria consequent to such human activities is called 'man made malaria'. Habits of sleeping out-doors have also increased the incidence of the disease.

Environmental Factors

These have been favorable for the prevalence of malaria in India.

Season: Incidence is high between July to November because atmospheric temperature is low and humidity is high.

Atmospheric temperature: Favorable temperature for the development of parasite inside the body of the vector is between 20° and 30°C. Beyond this range it is not favorable.

Humidity: A relative humidity of 60 percent and above is favorable for the mosquitoes to live longer.

Rainfall: Rainfall not only favors by increasing the humidity but also provides breeding places for mosquitoes. However heavy rain may flush out the breeding places.

Altitude: Altitude above 2500 meters is unfavorable for the survival of the mosquitoes. So malaria is rare in Nepal.

Vectors of malaria: Female anopheles mosquitoes are the chief vectors. Important species in India are *An. culicifacies*, *An. fluviatilis*, *An. stephensi*, *An. minimus*, *An. philippinensis*, *An. sundaicus*, and *An. maculatus*. Out of these, *An. culicifacies* are the important vectors in rural areas, *An. stephensi* in urban areas and *An. fluviatitis* in foot-hill areas.

Breeding habits: Anopheline female mosquito breeds in fresh water as in ponds, cisterns, wells, over-head tanks, pools, etc. anti-larval measures have to be carried out only in such breeding places.

Feeding habits: Anopheline female mosquitoes feed on human blood (anthrophilic). Blood meal is a must for laying eggs. Male mosquitoes do not transmit the disease because they do not bite. They feed on plant and fruit juice. Female mosquitoes bite during night times.

Resting habits: Most of these vectors rest indoors, after blood meal (endophily). Few rest outdoors (exophily). Therefore anti-adult measures are carried out indoors.

Density: Mosquitoes should be present in adequate density (above the critical level) for active transmission of the disease. This varies from species to species.

Mode of transmission: Malaria is transmitted usually from person to person by the bite of infected, female, anopheline mosquito (The mosquito is said to have become infective, only when it contains sporozoites in the salivary glands). However, it is also transmitted accidentally through contaminated syringes and needles among addicts. Vertical transmission from infected pregnant mother to the fetus (congenital malaria) can occur but very rare.

Incubation Period

It is the period between the bite of the mosquito, (inoculation of the sporozoite) and the onset of first symptom, i.e. fever. This period varies depending upon the parasite as follows:

Pl. vivax—14 days
Pl. falciparum—12 days
Pl. malariae—28 days
Pl. ovale—17 days.

Clinical Features

Clinically, there are four types of malaria and the features depends upon the type of the parasite causing the disease.

a. **Benign tertian malaria (Vivax malaria):** This is caused by *Pl.vivax*. This is the most common type occurring. In a classical case the features occur in three stages, namely cold stage, hot stage and sweating stage.

Cold stage: This is characterized by sudden onset of fever with rigors and sensation of extreme cold. Frequently the teeth chatter. Patient desires to cover with several blankets. There will be severe headache and often vomiting. Shivering lasts for about 15 to 30 minutes.

Hot stage: This is the next stage, characterized by high fever 103 to 104°F. The patient feels burning hot and removes the blankets and removes his clothes also. Headache persists, vomiting can occur. This stage lasts for 2 to 6 hours.

Sweating stage (stage of diaphoretica): In this stage, fever comes down by itself associated with profuse sweating. Following sweating, patients feels comfortable and falls asleep due to exhaustion. This stage lasts for 2 to 4 hours. Next day the patient feels normal and attends to duties.

In vivax-malaria, fever reappears every third day. Rupture of red cells and release of merozoites is associated with rigors. Repeated episodes result in spleenomegaly and secondary anemia.

b. **Malignant tertian malaria (*Falciparum* malaria):** This is caused by *Pl. falciparum*. There is gradual rise of temperature, increasing daily, becomes high and almost continuous. Cold, hot and sweating stages rarely occur. But vomiting and headache are common. This condition is highly fatal because of the following complications:
   - *Cerebral malaria:* Characterized by high fever, convulsions, paralysis, delirium, stupor, coma and death.
   - *Black-water fever:* Characterized by fever and black colored urine due to hemolysis of RBCs and hemoglobinuria.
   - *Algid malaria:* Characterized by features of shock.
   - *Septicemic malaria*: Characterized by features of septicemia and circulatory failure.

c. **Quartan malaria:** This is caused by *Pl. malariae*. Fever appears once in 4 days.

d. **Ovale malaria:** This is cause by *Pl. ovale*, common only in Africa.

Investigations: Blood smear for malarial parasites (MP)

- Thick blood smear shows whether the slide is positive for MP or not.
- Thin smear shows the species of the MP and the stage of the development in the red cells.

Measurement of Malaria (Malariometry)

Malariometry is necessary to know the magnitude of the problem for implementing the control measures. Malaria in an area can be measured by prevalence and incidence rates (i.e. Epidemiological parameters) and also by Entamological parameters (i.e. Vector indices), together called 'malariometric indicators'.

Prevalence Rates of Malaria

These indicators were employed during pre-eradication era. The following indices (indicators) were employed:

- **Child spleen rate:** Percentage of children between 2 and 10 years of age, showing enlargement of the spleen. Adults are excluded because spleenomegaly may occur due to the reasons other than malaria. Depending upon the spleen rate, the country was classified into hypoendemic (< 10%), mesoendemic (11–50%), hyperendemic (51–75%) and holoendemic (> 75%) areas.
- **Average enlarged spleen:** This is still a refined indicator, denoting the average size of the enlarged spleen.
- **Child parasite rate:** Percentage of children between 2 and 10 years of age positive for MP in their blood smears.
- **Parasite density index:** It is the average number of malarial parasites per cu mm of blood estimated from all the positive slides.
- **Infant parasite rate:** It is the percentage of infants positive for MP in their blood films. This is considered as the most sensitive indicator, because it indicates active transmission of malaria in the community. If this is 'zero' for three consecutive years in an area, it is considered as absence of malaria transmission, eventhough anopheline mosquitoes remain (i.e. Anophelism without malaria).
- **Proportional case rate:** It is the percentage of the out patients attending the hospitals and dispensaries, clinically diagnosed as malaria. This is a crude indicator because the cases are not related to their time and place of distribution.

Incidence Rates of Malaria

These indicators are currently employed.

- **Annual blood examination rate (ABER):** It is the percentage of the population examined for peripheral blood smear during a given year. It is estimated as follows: MP = Malarial Parasites.

$$\text{ABER} = \frac{\text{Number of slides examined for MP in a year}}{\text{Total population}} \times 100$$

Government of India, under MPO, fixed a minimum of ABER of 10 percent per year. This is an index of operational efficiency (i.e. quality of case detection). This influences the Annual Parasite Incidence. If blood examination is done monthly, it is called 'monthly blood examination rate' (MBER). This is used to compare with the previous months of the same year or same months of the previous years to analyze the 'trend' of the fever rate in the community.

- **Annual parasite incidence (API):** It is the number of new confirmed cases of malaria occurring in an area during a given year and confirmed by blood smear examination and is expressed per 1000 population.

  (Total no. of blood smears +ve for MP in a year)

$$\text{API} = \frac{\text{Confirmed cases during a given year}}{\text{Total population (under surveillance)}} \times 1000$$

This is a sophisticated indicator to measure malaria. Based on this, India was redefined, under the Modified Plan of Operation of Malaria Control, into two areas, for spray operations.

Area with API < 2

Area with API > 2

Accuracy of API depends upon the efficiency (adequacy) of ABER.

- **Annual *falciparum* incidence (AFI):** It is confirmed new cases of falciparum malaria per 1000 population, during a given year.
- ***Plasmodium falciparum* percentage (PF%):** It is the percentage of positive blood smears, positive for *Pl. falciparum*. This gives information about the incidence of *falciparum* malaria in relation to total case load of malaria.

$$\text{PF\%} = \frac{\text{Total no. of blood smears +ve for } \textit{Pl. falciparum}}{\text{Total number of blood smears +ve for MP}} \times 100$$

- **Slide positivity rate (SPR):** It is the percentage of slides (smears) found positive for malarial parasites, irrespective of type of species.

$$\text{Slide positively} = \frac{\text{Total no. of blood smears positive for MP}}{\text{Total no. of blood smears examined}} \times 100$$

This gives information about the parasite load in the community.

- **Slide falciparum rate (SFR):** It is the percentage of slides (smears) positive for *Plasmodium falciparum* parasites.

$$\text{SFR} = \frac{\text{Total no. of blood smears +ve for } \textit{Pl. falciparum}}{\text{Total no. of blood smears examined}} \times 100$$

SFR pinpoints the areas of *Pl. falciparum* preponderance and indicates the necessity for intensification of control measures on priority basis, because of its danger.

SPR and SFR provide information on the trend of malaria transmission by comparing the data with previous years.

Entomological Parameters (Vector Indices)

- **Adult vector density (Mosquito density):** It is the number of mosquitoes per man-hour catch.
- **Human blood index:** It is the percentage of female anopheline mosquitoes containing human blood in the stomach. It indicates the degree of anthrophilism.
- **Sporozoite rate:** It is the percentage of female anopheline mosquitoes containing sporozoites in their salivary glands.
- **Biting density (Man biting rate):** It is the average incidence of anopheline bites per day per person. It is determined by catching the vectors using a human–bait.
- **Inoculation rate:** It is the product of biting density and the sporozoite rate.

Prevention and Control

- Elimination of reservoirs
- Breaking the channel of transmission
- Protection of susceptibles.

Elimination of Reservoirs

This consists of making the infectious cases noninfectious by giving treatment.

The treatment consists of presumptive treatment, radical treatment and mass treatment. The current treatment, under the National Antimalaria Program, since 1999, is as follows:

Presumptive treatment: All fever cases attending hospitals for the treatment, are assumed to be the cases of malaria and treated accordingly, depending upon whether that area is a low-risk area or high-risk area which is so classified depending upon the following criteria.

Criteria to consider as a high-risk area:

- Average slide positivity rate (SPR) of the last three years is 5 percent or more.
- *Pl. falciparum* proportion is 30 percent or more provided the SPR is 3 percent or more during any of the last 3 years.
- An area having a focus of chloroquine resistant *Pl. falciparum*.
- Deaths due to *falciparum* malaria, during any of the last 3 years.

The doses are mentioned for adults.

In *low-risk areas*: Treatment is given irrespective of the type of malaria.

Day–1, Chloroquine 600 mg, single dose, no further treatment.

In *high-risk areas*:

Day 1, Chloroquine 600 mg + Primaquine 45 mg
Day 2, Chloroquine 600 mg
Day 3, Chloroquine 300 mg.

Note: No primaquine for pregnant women and infants.

- Presumptive treatment to be given only after taking the blood smears.
- Drug to be taken in single dose after food.
- Dose is proportionately less for children. 10 mg per kg body weight for chloroquine and 0.75 mg per kg for primaquine.

Radical treatment: This is given for those, whose blood smear report comes as positive for malarial parasites. Dosage depends upon the type of malaria.

In *low-risk areas*:

For *vivax malaria*—Chloroquine 600 mg single dose + 15 mg primaquine on 1 day.

Followed by only primaquine 15 mg daily for another 4 days.

For falciparum malaria: Chloroquine 600 mg single dose plus primaquine 45 mg single dose on 1st day followed by Chloroquine 600 mg on 2nd day and 300 mg in 3rd day.

In *high-risk areas*:

For vivax malaria: Only primaquine 15 mg daily for 5 days (Because chloroquine has already been given under presumptive treatment).

For falciparum malaria: No further treatment is required (Because chloroquine and primaquine has already been given under presumptive treatment).

For resistant cases (Cases resistant to chloroquine): (Because chloroquine and primaquine has already been given under presumptive treatment).

For vivax malaria: A single dose combination of Sulphadoxine (1500 mg) plus pyrimethamine (75 mg), is not effective.

For falciparum malaria: Single dose of the combination of sulphadoxine 1500 mg and pyrimethamine 75 mg on first day, followed by primaquine 45 mg on the second day. These drugs are not given on the same day due to precipitation of hemolytic crisis among glucose-6-phosphate dehydragenase (G6PD) cases.

Cases resistant to above drugs and are severe and complicated, are hospitalized for the treatment as under:

- Quinine dihydrochloride inj, intravenously in 5 percent dextrose solution, over 4 hours, dose 10 mg per kg body weight. This is continued 8th hourly, till the patient regains consciousness. Thereafter same dose is given orally for 7 days.
- *Other drugs are mefloquine:* 750 mg, to be used only in *Pl. falciparum* cases, only with ring stage in the blood smear report.

Artemisinin: 10 mg per kg body weight, once a day for 5 days.

Artesunate: 01 mg per kg body weight, two doses on the first day with 6 hours interval, thereafter once a day for 4 days.

Artemether: 1.6 mg per kg body weight, administered similar to Artesunate.

Artether: 150 mg intramuscularly daily for 3 days.

Mass treatment: This is recommended in highly endemic areas, where API is more than 5 per 1000 population. This will be more effective, when supplemented by anti-mosquito measures.

Chemoprophylaxis: With the development of drug resistance, this has become unreliable. However, it may be recommended for the following groups. Drug recommended is chloroquine.

- Travelers from non-malarious areas to malarious areas
- Military and paramilitary persons moving into malarious areas
- Pregnant women living in endemic and hyperendemic areas.

Revised National Drug Policy (2010) for Treatment of Malaria: Described under National Health Program.

Breaking the Channel of Transmission

This measure consists of control of vectors. The different methods of control of vectors are:

a. Antiadult measures
b. Antilarval measures.

a. **Antiadult measures:**
This consists of spraying the insecticides:
   i. **Residual spraying:** This consists of spraying of indoor surfaces of houses, cattle sheds with residual insecticides like DDT, malathion, fenitrothion. Since there has been the development of resistance to DDT, organophosphorus compounds like malathion and fenitrothion are being increasingly used.
   Suspension of malathion is prepared by adding 2 kg of 25 percent malathion powder in 10 liters of water and sprayed over 250 sq m area. This provides a dosage of 2 g per sq meter area, after spraying in two coats.
   ii. **Space spraying:** This consists of out-door spraying of the insecticides. The technology is that the insecticide (malathion) is sprayed in the form of fog or mist by ultra low volume thermal fogging method by using agricultural aircraft or by using ground equipment, fitted over a vehicle. This method controls the vectors quickly.

b. **Antilarval measures:**
This consists of bioenvironmental control strategy components are:
   - Source reduction.
   - Environmental modification and manipulation.
   - Biological control.
     i. **Source reduction:** This consists of elimination of nonessential water bodies, which includes periodical emptying of domestic water container, sealing of water tanks, filling pot holes, puddles, burrow–pits and canalizing drains so that water does not stagnate.
     ii. **Environmental modification and manipulation:** This consists of leveling of land or filling of depressions and making of soakage pits help in prevention of mosquito breeding.
     iii. **Biological control:** Mosquitoes (Larvae) can also be controlled by employing their natural enemies such as fish, bacteriae and fungi.
   - **Larvivorous fish:** Use of larvivorous fish are the most promising ones. The use of such fish is easy, practical and cheap. Their small size helps to move easily among the weeds. The best known are *Gambusia affinis* and *Lebister reticulates* (often known as *Barbados millions*). Other fish which can also be employed is *Poecilia reticulata*. For maximum efficacy, removal of predacious fish, if present, in the water body is a must. About 5 fish per sq meter of water surface should be released.
   - **Use of bacteriae (i.e. Biocides):** The best known biocides are *Bacillus sphaericus* and *Bacillus thuringiensis*. They kill the mosquito larvae. However, these biocides should not be used for larval control in potable water, i.e. drinking water collections.

The suspension of these bacteriae-powder is prepared and sprayed using knap-sack sprayers, once in 2 to 3 weeks.
Other biological agents are:

- *Notonectids:* These are acquatic insects, voraciously feed on larvae in ponds and rice fields.
- *Hydra:* These are coelenterates useful as mosquito predators.
- *Flatworms:* Planaria are the flatworms which feeds on larvae.
- *Fungi:* Culicinomyces, coelomomyces, hegenidium, leptolegnias metarhizium are considerably effective against larvae.
- *Nematodes: Ramanomermis culicivorax* and *R. iyengari* are presenting under trial.
- *Viruses:* Polyhedrosis viruses and indoviruses are presently under trial. At present, apart from Larvivorous fish none is considered operational as a replacement, for insecticide because of the difficulties involved in mass rearing technique of these predators.

Biocontrol methods are better than insecticidal methods because they do not cause chemical pollution.

Integrated control: In order to reduce too much dependence on residual insecticides, emphasis has been laid on 'integrated vector control', which includes bioenvironmental and personal protection measures, so that the vectors can be controlled effectively. Thus, integrated control is an approach, considering more than one method, whether directed only against larvae or adults or both.

Personal Protection

These measures are directed against mosquito bites:

a. **Bednets:** Nylon nets are preferred over cotton nets, because of their durability and longer stay of insecticide on nylon fiber. They are impregnated with an insecticide either one g of deltamethrin or 0.5 g of cyfluthrin or 0.25 g of lambda cyhalothrin per square meter of mosquito-net. The impregnated net will have efficacy for 6 months when not washed.
b. **Use of mosquito repellents:** They are applied on the skin. They repell the mosquitoes by their smell and protect the individual from the mosquito bites. Diethyl-toluaminde (DEET) has been found to be very effective. Other repellents are Indalone, Dimethyl phthalate, Dimethyl carbate, Ethyl hexanediol, etc. However these repellents are effective for short period of 8 to 10 hours.
c. **Malaria vaccines:** They are under trial. Following are the types:

i. **Asexual blood stage vaccines (merozoite vaccine):** They are prepared from the polypeptides of the merozoites (blood stages) of *Pl. falciparum* present in man. They prevent the RBCs alone from being infected.
ii. **Sporozoite vaccines:** They are prepared from the antigens of sporozoites. They are expected to prevent both the liver cells and RBCs from being infected.
iii. **Gamete vaccines:** They are prepared from gametes. The mosquito picks up the antibodies produced in the person, when it bites the vaccinee. These antibodies prevent the fertilization of gametes inside the body of the mosquito and thus arrests further development. But the vaccinee is not prevented from getting infected.
iv. **A synthetic cocktail vaccine:** This vaccine for *P. falciparum* is called 'PfS 66'. It is formulated as a peptide–alum combination. It has been found to be 30 percent effective.
v. **Transmission blocking vaccine:** Like 'PfS 25', it is also under trial.

National Antimalaria Program

Described under National Programs.

LYMPHATIC FILARIASIS

'Filar' means thread-like. Lymphatic filariasis is a disease caused by three lymphatic dwelling nematode (thread like) parasites, viz *Wuchereria bancrofti*, *Brugia malayii* and *Brugia timori*, the former being the most widespread parasite. Therefore, the disease is also called 'Wuchereriasis' (Bancroftian filariasis). The disease is transmitted from person to person by the bite of the infective, female, mosquitoes. *W. bancrofti* is transmitted by *Culex mosquito*, *Brugia malayii* by *Mansonia mosquito* and *B. timori* by either mansonia or Anopheline mosquito.

Clinically, the disease is characterized by manifestations ranging from asymptomatic to acute and chronic features like fever, lymphangitis, lymphadenitis, lymph-varix, elephantiasis of the affected part (like leg, arm or genitals) and often hypersensitivity state of loss of respiratory function due to tropical pulmonary eosinophilia or an atypical form such as filarial arthritis.

Eventhough it is not a fatal disease, the public health importance lies in the fact that it causes considerable suffering, deformity and disability. Filariasis is one of the leading causes of disability in the world, next to leprosy.

History

Lymphatic filariasis was the first disease proved to be transmitted by mosquitoes. The different mile-stones are:

In 1709, Clark in Cochin gave the name 'Malabar legs'.

In 1863, Demarquay was the first person to find the prelarvae (microfilariae) of the parasite in the hydrocoele fluid of man.

In 1866, Wucherer found microfilariae in chylous urine.

In 1872, Lewis, in Calcutta, found them in the human blood.

In 1876, Bancroft, in Australia, found the adult female parasites. Hence the name *Wuchereria bancrofti*.

In 1878, Manson, in China, studied the development of larvae (microfilariae) in the body of female culex mosquitoes. He also discovered the phenomenon of 'periodicity'.

In 1927, Bruge found the microfilariae of *Brugia malayi* in Indonesia.

In 1940, Rao and Maplestone, in India, discovered the adult parasites of *B. malayi*.

In 1946, Diethyl carbamazine (Hetrazan) drug was discovered, which opened a new avenue in the control of this disease.

In 1955, Government of India launched a national program called 'National Filariasis Control Program (NFCP)'.

In 2002, elimination of lymphatic filariasis was set as a goal in National Health Policy 2002.

In 2004, Mass Drug Administration of DEC is resolved to eliminate lymphatic filariasis by the year 2015.

Current Filariasis Situation

Filariasis is a global problem. More than one billion (>100 crores) people are at risk in about 80 countries and over 120 million have already been affected by it, including about 40 million of these who are seriously incapacitated and disfigured by the disease.

India contributes to more than one-third of the global lymphatic filariasis problem. There are about 6 million attacks per year (Acute cases). We have 7.5 million lymphoedema cases, 13 million hydrocoele cases, 31.6 million microfilaria carriers and 20 million chronic cases 420 million people are living in endemic areas. Disease is endemic in 8 states of our country. Heavily infected areas are Uttar Pradesh, Bihar, Jharkhand, Andhra Pradesh, Odisha, Tamil Nadu, Kerala and Gujarat. Bancroftian filariasis is predominant (98%) in India, whereas Malayan filariasis is restricted to central Kerala (i.e. caused by *Brugia malayi*). In Karnataka, eight districts namely Gulbarga, Bidar, Bijapur, Raichur, Bagalkot, Uttar Kannada, (North-Canara) Dakshina–Kannada (South-Canara) and Udupi are endemic to this disease.

Socioeconomic Burden

Since filariasis causes a long-term suffering by producing physical deformity, it affects the human resource of the country as well as social and economic burden not only to the individuals but also to the family and country at large. It has been estimated that the annual economic loss due to filariasis is about ₹ 5000 crores. This reflects the commitment by the government for its control.

Lymphatic filariasis is a social problem, an economic problem and a health problem. It is a social problem because it carries 'Social stigma.' It is an economic problem because total annual economic loss is ₹ 5000 crores. It is a health problem because it results in disability and deformity.

Brugian or Malayan filariasis is restricted to Shertallai region of Kerala, which is considered as 'Hot-bed' of filariasis. This region is wedged between Arabian sea and Vembanad lake. The ponds, canals and channels are heavily infested with acquatic plants which are excellent hosts for breeding of Mansonia mosquitoes. People think that these hydrophytes are good manure for coconut trees and cleans the water. This ignorance has been responsible for the prevalence of this disease. The elephantiasis of the legs in this region is referred to as 'Shertallai-legs.'

Agent Factors

Lymphatic filariasis is caused by three types of parasites namely *Wuchereria bancrofti*, *Brugia malayii* and *Brugia timori* (Other parasites belonging to the same family filarioidea, but result in nonlymphatic filariasis are *Onchocerca volvulus*, *Loa-loa, Mansonella ozzardi, Acanthocheilonema perstans, A. streptocerca*. They are not found in India. The last two are nonpathogenic).

Habitat: The adult worms are found in the lymphatic vessels and lymph nodes of man only. They are long thread or hair-like, transparent nematodes (Nematode means cylindrical like; Filar, means thread like). Female is longer than male (10 and 4 cm respectively). Lifespan of the adult parasite is about 4 to 5 years.

Life cycle: The parasite passes its life cycle in two hosts, man and mosquito, respectively. They are definitive and intermediate hosts.

In man: The male parasite fertilizes the female and dies. The gravid female discharges, as many as, 50,000 microfilariae (mf) per day, into the circulation via lymphatics. These microfilariae are all sheathed embryos, circulating in the blood. The life span of mf is about one year. They are taken up by the female culex mosquito when it feeds on human blood. The time required for the microfilariae to develop into adult parasite is about 1 year. The microfilariae constitute the infective forms to the mosquito.

In mosquito: The ingested, sheathed, microfilariae cast off their sheaths (exsheathing) in the stomach of the mosquito and first stage larva comes out and penetrate the gut wall within one or two hours and migrate to the thoracic muscles, where they take rest and begin to grow and develop into second stage larvae (sausage shaped, short and thick forms).

On 10th or 11th day, it moults, becomes thin and long and develops into third stage larva, which is infective to man. It enters the proboscis sheath of the mosquito on about 14th day. Now the mosquito is said to have become infective to man.

It is to be noted that one microfilaria develops into one infective larva and that there no multiplication. It is an example of 'cyclo-development' type of biological transmission. The time required by the parasite to undergo development, from the time of entrance by the microfilariae till they develop into third stage larvae, is called 'Extrinsic incubation period,' which is about 10 to 14 days for *W. bancrofti* and 7 to 10 days for *Brugia malayii* and *B. timori*. This period depends upon atmospheric temperature and humidity.

When the infected mosquito bites the human being, the third stage infective larvae enter the lymphatic channels, reach the inguinal, scrotal and abdominal lymphatics and grow into adults. They become sexually mature after about 6 to 18 months and the cycle continues.

The period between the entrance of infective, third stage larvae in a man and the appearance of microfilariae in the peripheral blood, is called 'Pre-patent period' which is about 9 months for *W. bancrofti* and 3 months for *B. malayii*.

Periodicity: The manifestations of *W. bancrofti* show marked nocturnal periodicity, i.e they appear in large number at night between 10 pm and 4 am in the peripheral circulation. During day time, they retire principally inside the capillaries of the lungs, heart, kidneys. The mechanism of nocturnal periodicity is related to the night feeding habits of the culex mosquito.

In Pacific islands, *Mf. bancrofti* does not exhibit any periodicity (Non-periodic), i.e. they are found in the peripheral blood both during day and night. It is also called 'Diurnal subperiodicity,' because the vector Aedes feeds by day also.

Reservoir of Infection

There are no animal reservoirs for *W. bancrofti* infection. However, cats, dogs and monkeys are the reservoirs for *B. malayii*. These animals acquire infection from man but do not transmit to human beings.

Among the human reservoirs, there are both cases and carriers. A carrier is a one who is having circulating microfilariae in the peripheral blood. Those with advanced chronic stage of illness are often negative for microfilariae. That means only acute cases and carriers are the sources of infection.

Host Factors

Age incidence: People of all the age group are susceptible to the disease. However, the incidence is high in the age group of 20 to 30 years. Not all those who are infected will develop the disease. Only a small percentage will develop the disease. Some become carriers.

Sex incidence: Filariasis is more among men than among women, because they are less clothed and more exposed to the risk.

Social Factors

There are many social factors responsible for the prevalence of this disease, such as industrialization, urbanization, migration of the people, poverty, eruption of slums, poor sanitation, etc. which favor the breeding places of the mosquito.

Environmental Factors

Climate: This is important because the atmospheric temperature between 25° and 35°C favors the development of parasites in the body of the vector, culex mosquito and the relative humidity of 70 percent favors the mosquito to survive longer.

Drainage of sewage: Since sewage water is an excellent breeding place for the *Culex* mosquitoes, improper drainage of sewage favors the prevalence of the disease in the area.

Vectors

Female mosquitoes are the only known vectors of lymphatic filariasis. Different mosquitoes act as vectors in different areas of the world. Anopheles is the important vector in Indonesia, Malaysia, China and Korea. *Aedes* is the chief vector in Phillipines, America, China, and Japan.

In India, the chief vector is female *Culex quinquefasciatus* for Bancroftian filariasis and female *Mansonoides annulifera* and *M. uniformis* for Malayan (i.e. Brugian) filariasis.

- *Culex quinquefasciatus:* This breeds predominantly in organically contaminated water like sewage, sullage water, septic tank, soakage pit drains, pit latrines, etc. This is active during night times and transmits Bancroftian filariasis.
- *Mansonia (Mansonoides):* This breeds in water containing aquatic plants such as *Pistia–stratiotes, Eichornia* and *Salvinia*. In the absence of these plants, mansonia mosquitoes do not breed.

The diurnal–subperiodic form of Bancroftian filariasis transmitted by *Aedes niveus* (finalaya) is prevalent only in Nicobar group of Islands. This mosquito breeds primarily in tree holes and bites humans and animals during day time.

Mode of Transmission

The disease is transmitted by the bite of infected, female, vector mosquito.

Pathogenesis

When the mosquito bites the human being, the infective larvae are not directly inoculated into the blood stream, but they are deposited, usually in pairs, on the skin, near the site of puncture. Later they enter the lymphatic system either due to attraction by the warmth of the skin or they penetrate on their own through the punctured skin and finally reach the lymphatic system, resulting in lymphangitis. However following repeated infections, there will be hyperplasia of subcutaneous tissue, thickening of skin and fibrosis of lymphatics, resulting in obstruction of lymph flow leading to lymph varix and chronic lymph-edema (i.e. elephantiasis). It does not pit on pressure. In such advanced stage microfilariae are rarely found in peripheral circulation (Recent thought is that there is no fibrosis of lymphatics, but valvular damage in the lymphatics results in lymph stasis).

Incubation period: It is the period between the successful entry of the infective larvae and the appearance of first clinical symptom or sign in the individual. It varies from 8 to 16 months (Average—1 year).

Clinical Features

Not all those bitten by infected female mosquitoes will develop the disease. Only a small percentage will develop the clinical features. The clinical spectrum of lymphatic filariasis are as follows:

- **Asymptomatic amicrofilaremia:** These are the people, who neither have symptoms nor have demonstrable microfilariae in the blood smear. They may be infected or may not be infected.
- **Asymptomatic microfilaremia:** These are the people who do not have any recognizable clinical features (symptoms) but their (night time) blood is positive for microfilariae. That means they are carriers and act as a source of infection in the community.
- **Acute filariasis:** This is characterized by recurrent attacks of fever, associated with lymphadenitis and lymphangitis. It is mainly because of infection of the lymphatics by the adult worms. They also constitute a source of infection to others.
- **Chronic filariasis:** It requires about 10 to 15 years to develop fibrosis and obstruction of lymphatics resulting in permanent damage characterized by lymph-edema of various parts of the body, i.e. elephantiasis of leg, genitals, breasts, hydrocoele, lymph varix, chyluria, etc. They are not infectious to others **(Fig. 20.49)**.

Differences are as follows:

Bancroftian filariasis	**Brugian filariasis**
• Recurrent attacks of fever is less frequent.	It is more frequent.
• Genitalia is affected.	Genitalia not affected.
• In chronic cases the entire limb (leg and thigh) is affected.	Entire limb is not affected. Leg below knee or arm below elbow is affected.

- **Occult filariasis (Cryptic filariasis):** This is caused by human or nonhuman filarial parasites. It is believed to result from a hypersensitivity reaction of the host to microfilariae, resulting in 'tropical pulmonary eosinophilia', characterized by paroxysmal nocturnal cough,

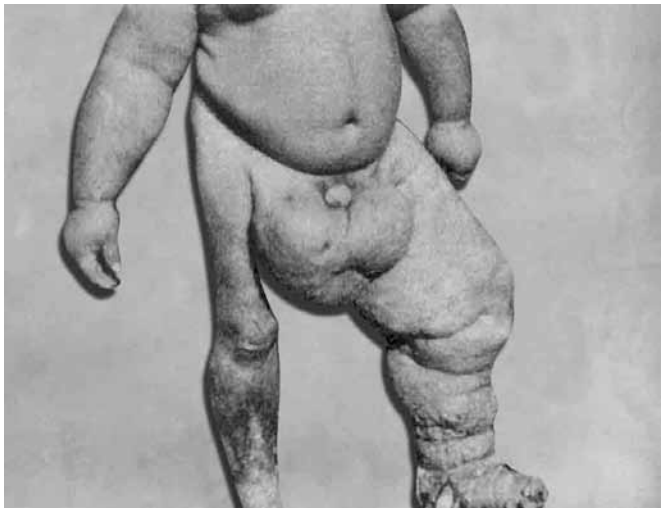


Fig. 20.49 Chronic filariasis

breathlessness, wheezing, miliary infiltration of the lungs giving a radiological picture of diffuse patchy infiltration of the lungs, may be associated with lymphadenopathy and hepatospleenomegaly. Microfilariae are almost never present in the blood but absolute eosinophil count is very much increased. The syndrome responds well to treatment with diethyl carbamazine citrate (DEC). If not treated results in interstitial fibrosis of lungs, leading on to chronic obstructive pulmonary disease (COPD) and respiratory failure. The disease is called 'Occult filariasis' because microfilariae are not present in the blood (though they can be demonstrated in the tissues like liver, lungs and spleen).

Filaria Survey

This survey is done to know the magnitude of the problem and also to evaluate the control measures. There are two types—routine survey and evaluation survey, the former requires 5 to 7 percent of the total population and the latter at least 20 percent of the population, as recommended by National Institute of Communicable Disease (NICD), Delhi. The sample must be random, representative of all the ages and both the sexes.

The different components of filarial survey are:

- Blood survey
- Clinical survey
- Entomological survey
- Skin and serological tests
- Xenodiagnosis.

Mass Blood Survey

The sample size of the population is subjected for taking thick blood smear during night between 8.00 pm and 12.00 midnight because of nocturnal periodicity of the microfilariae. They are all serially numbered and recorded in the register with name, age, sex and other data. Next day the smears are dehemoglobinized, dried, fixed with methyl alcohol, dried and then stained with Giemsa stain, washed and dried, looked for microfilariae under oil-immersion.

Diethyl carbamazine provocative test: In this test, the adult person is given 100 mg of DEC (50 mg for children) orally during day time and the smear is taken after 30 to 45 minutes. The drug provokes the hidden microfilariae in the lung capillaries to invade the peripheral circulation. This method should be adopted for those people who are reluctant to get examined during night times.

Concentration techniques: These are most sensitive and expensive methods, reserved for special purposes such as detection of carriers with low density microfilaremia. This not only helps in detection of carriers but also helps in evaluation of treatment, and also as a research tool.

- **Membrane filtration technique:** Blood is drawn from vein, mixed with anticoagulant, forced through the pores of membrane filter. Microfilariae, are caught upon the filter as residue, which is taken, stained and examined.
- **Knott's concentration technique:** In this method, membrane filters are not used. But 1 mL of venous blood is mixed with 10 mL of dilute formalin, then centrifused for 5 minutes and the sediment is examined for microfilariae.

Clinical Survey

As the blood is collected, the people are examined clinically for the various signs and symptoms of lymphatic filariasis and recorded.

Entomological Survey

This consists of making a survey to know the breeding places of the mosquitoes and their bionomics.

Xenodiagnosis

This consists of collection of mosquitoes and their larvae. Further mosquitoes are dissected to detect filarial larvae.

Method of collection of mosquitoes: Using human or animal bait.

A person is made to sleep inside a bigger, outer curtain with a flap opened on one side to allow mosquitoes to get inside the curtain. He is protected with another inner smaller mosquito-curtain so that he is not bitten by the mosquitoes. At certain intervals (1 or 2 hrs) the flap of the outer curtain is closed and all the mosquitoes resting inside are collected by using special pipette. It is expressed as number of mosquitoes per ten man hour catch. That means 10 persons exposed for 1 hour or 5 persons exposed for 2 hours or 1 person exposed for 10 hours.

The mosquitoes are carefully maintained alive for 10 to 14 days in a clean paper cup covered with a gauze. The

mosquitoes are allowed to feed on a cotton wool soaked in sugar solution and placed over the gauze. Cotton pad is changed once in 2 to 3 days. After 14 days (of extrinsic incubation period) the mosquitoes are identified, killed by chloroform vapor and dissected for filarial larvae. The data is anlayzed and expressed as filarial indices.

Method of collection of larvae of mosquitoes: The larvae are collected either by dipping a bowl or by using a nylon net attached to an iron ring or by pipetting. In case of Mansonia larvae, the acquatic plant is uprooted and shaken in a bucket of water so that the larvae are detached. If sodium hydroxide is added to the water, it helps in detachment of the larvae and helps easy collection.

Skin and Serological Tests

Allergic tests are intradermal tests and eosinophil count. Serological tests are immunological tests (antifilarial antibody titer test) and compliment fixation tests.

Filarial Indices

The data collected by filaria survey is analysed and expressed as filarial indices (indicators) which are grouped into three groups—namely Clinical, parasitological and vector (entomological) indicators.

a. **Clinical indices:** (i) Incidence of acute lymphangitis, lymphadenitis, epididymo-orchitis, (ii) prevalence of chronic cases of lymphedema, elephantiasis, hydrocoele, chyluria, etc.
b. **Parasitological indices:** These are:
   - *Microfilaria rate:* It is the percentage of the people among the population sample, showing blood smear positive for microfilariae. Those areas showing more than 5 percent were brought under operational component of National Filaria Control Program.
   - *Microfilarial density:* It is the number of micro-filariae per unit volume of blood (i.e. 20 cu mm = 4 to 5 drops of blood). This indicates the intensity of infection.
   - *Filarial disease rate:* It is the percentage of the people showing the clinical manifestations of the disease.
   - *Filarial endemicity rate:* It is the percentage of the people showing either microfilariae in the blood or clinical manifestations or both. Based on this, the country was divided into the following types of areas.
     < 5 percent—low endemicity,
     5 to 10 percent—moderate endemicity,
     10 to 30 percent—high endemicity
     > 30 percent—hyperendemicity.
   - *Average infestation rate:* It is the average number of microfilariae per positive slide. It indicates the prevalence of microfilaremia in the population.
c. **Vector indices (entomological indicators):** These are:
   - Vectors density per 10 man-hour catch.
   - Percentage of mosquitoes positive for larvae (all stages).
   - Percentage of mosquitoes positive for infective stage of larvae.
   - Annual biting rate.
   - Types of larval breeding places.

All these above indicators help in assessing the magnitude of the problem and also help in evaluation of control measures (By doing before and after implementing the control measures).

Newer Diagnostic Modalities

Newer diagnostic modalities: There are two types:
1. Demonstration of adult parasite in ultrasonography of lymphatics.
2. Lymphoscintigram using gamma camera with tracer Tc 99 nanocolloid, a ratio active label.

Control of Lymphatic Filariasis

This is done by three measures:
1. Elimination of reservoirs.
2. Breaking the channel of transmission.
3. Protection of susceptibles.

Elimination of Reservoirs (i.e. Control of Parasites)

This is done by chemotherapy. There are two methods—selective treatment and mass treatment. The drug of choice is diethyl-carbamazine (DEC). This is the only drug available currently for the treatment of lymphatic filariasis.

The drug is safe, effective and cheap. It kills almost all microfilariae. But its effect on the adult parasites is uncertain and also it has no effect on the infective stage of the larvae.

Selective treatment: This is given for those who have developed clinical manifestations and/or microfilaremia. This is recommended in low endemic areas. Recommended dose of DEC for Bancroftian filariasis is 6 mg per kg body weight per day, orally for 12 days, perferably in divided doses, after meals. (Total dose = 72 mg per kg body weight). The dose for *Brugian filariasis* is smaller, i.e. 3 to 6 mg per kg body weight per day, orally, for 10 days (Total dose = 30 to 40 mg per kg body weight).

Smaller dose is recommended because *B. malayii* parasites are more susceptible to DEC than *W. bancrofti*.

Repeated courses of treatment may be necessary to achieve radical cure. The drug is rapidly absorbed and rapidly excreted from the body, mainly through the kidneys. A repeat course may be initiated about 2 weeks after the last dose of the previous course. In endemic areas treatment must be repeated once in two years because microfilaria clearance is not

complete and also people are at risk of re-infection. Thus single course of DEC is very effective even two years after treatment.

Side effects: These are grouped into three groups—general, local, and allergic. First two occur with or without fever. These effects are less severe and less likely to occur in Bancroftian filariasis than in Brugian filariasis (i.e. treatment of Brugian filariasis is associated with more severe side effects).

General reactions: These are headache, bodyache, dizziness, anorexia, nausea, vomiting, malaise, urticaria and often bronchial asthma. General reactions and fever are positively associated with microfilaremia. Last for few hours.

Local reactions: These are lymphadenitis, funiculitis, epididymitis, orchitis, lymphangitis and transient lymphedema. These are due to the presence of adult worms in the lymphatic tissues. Local reactions last for about 3 days.

Allergic reactions: These occur due to destruction of microfilariae and adult worms. It could be due to drug itself. Features of allergic reactions are urticaria, pruritus, fever, arthritis, arthralgia, attacks of branchial asthma.

Both general and local reactions will disappear spontaneously and usually it is not necessary to interrupt treatment. The reactions can be treated with antihistamines and/or antipyretics.

Results of Treatment

- The level of microfilaremia is greatly reduced or even eliminated.
- The frequency of further attacks of acute filariasis is reduced.
- There is reversal of early lymphedema, early chyluria and early hydrocoele.

Mass treatment: In this type, a full course of DEC is given to almost every one in the community, irrespective of their symptoms. This is indicated in high and hyperendemic areas. This requires intensive efforts of educating the people for their cooperation. Single dose is recommended by International Task Force (WHO) in high and hyperendmic areas every year, for all except for children below 2 years, pregnant women and very sick patients.

Advantages of mass treatment

- It is as effective as 12 days therapy for public health measure.
- It is cost effective.
- It avoids the cost of blood examination.
- It improves the patient–drug compliance.
- It has eliminated lymphatic filariasis in other countries.
- It can be integrated into primary health care system.

Objectives of mass treatment

- To reduce morbidity by treating the cases
- To reduce transmission by treating carriers of microfilariae
- To interrupt transmission by elimination of parasites from the human population.

DEC medicated salt : Using DEC medicated salt is a special from of mass treatment, using low dose over a long period of time. This will be more useful after the initial reduction of the prevalence achieved by mass treatment.

Common salt is fortified with 1 to 4 g of DEC per kg of salt. Distribution of such a salt over a period of 6 to 9 months has been found to be very simple, safe, cheap and effective means of control of filariasis. But still this is not practiced because:

- LF is not endemic in all the states.
- Salt is already fortified with iodine.
- Consumption of salt varies from person to person.

Ivermectin: It is a broad spectrum antibiotic, having an effect of anthelmintic against nematodes also. It causes gradual decrease in microfilaria level over 2 to 4 weeks to 20 percent of pretreatment level. Dosage in 200 to 400 mcg/kg body weight, shows maximum effects. This low level of microfilaria is sustained for several months after which microfilaremia can increase. Reaction can occur due to destruction of microfilariae. Thus this drug also has proved to be equally effective.

Ivermectin is given in African countries, because of prevalence of *Onchocerca volvulus*. Ivermectin is not recommended in India.

Morbidity management of lymphatic filarasis

This consists of prophylactic measures to prevent secondary infections of the affected limb of the patients, because filarial patients with damaged lymphatic vessels will have more bacteriae on the skin. The associated multiple skin lesions, slow lymph fluid movement and the reduced ability of the lymph nodes to filter the bacteriae cause inflammation characteristic of an acute attack, which further damage the tiny lymphatic vessels in the skin, reducing their ability to drain fluid. This viscious cycle continues, aggravating the condition of the patient.

So high standard of personal hygiene and treatment of entry lesions are important prophylactic measures to reduce or prevent the frequency of acute attacks, which indicates that the patient is improving.

The morbidity management consists of the following measures:

1. *Washing the legs:* This consists of washing the affected limb, from the highest point of the swelling, with the soap and luke warm water (not hot water) down the limb, cleaning gently between the skin folds and between toes, paying particular attention to the entry lesions. Cleaning should not be done with brushes as they can damage the skin. Unaffected limb should also be washed. Washing and drying should be done daily ideally at night.

   Drying should be done by patting the area lightly with a clean soft towel and not by rubbing. Wet area promotes secondary infection with bacteriae and fungi.

   Entry lesions are most frequently found between the toes and deep skin folds and around the toe nails. They are cleaned gently using a small cloth or cotton swab.

After cleaning, antifungal and antibacterial creams are used.

2. Foot end should be elevated while sleeping, as it facilitates circulation. A pillow is placed under the knee for support. Cardiac patients should not elevate their legs unless advised by the doctor.
3. Exercise is useful because it helps by pumping the fluid and improves lymph drainage. However exercise is contraindicated during acute attacks. Besides walking for short distance, standing on toes exercise and flexion and extension of ankles in sitting position and circle exercise in lying position, will facilitate lymph drainage.
4. Footwear should be worn to prevent injuries. It should not be too tight.

Management of an acute attack

An acute attack is painful. It is associated with fever, body ache and pain in the affected leg. Oral antibiotics are given along with analgesics, antipyretics and anti-inflammatory drugs. A cloth soaked in cold water, is placed around the leg, to relieve pain. The leg can as well be soaked in a bucket of cold water. The leg is washed gently with soap and water. After drying, cream is applied to entry lesions. Foot end can be elevated to the comfortable level. Patient should drink plenty of water.

Exercise is contraindicated during an acute attack because it is painful.

Besides annual single dose administration of DEC for 4 to 6 consecutive years to the eligible population, morbidity management is also an important component to alleviate or prevent disability due to lymphatic filariasis. Hydrocele is one of the most common manifestations seen. Surgical management of hydroceles not only gives great relief to the patients but also augments community compliance for success of elimination of lymphatic filariasis in the country.

Breaking the Channel of Transmission

This consists of control of vectors, i.e. *Culex* and *Mansonoides* mosquitoes. The standard approaches for the control of vectors are antilarval measures and anti-adult measures. This will be more effective, when used in conjunction with mass treatment.

***Anti-larval measures*:** By physical, chemical and biological methods.

- *Physical method:* Consists of elimination of breeding places by providing underground drainage system for the sanitary disposal of sewage which is the breeding place for culex mosquitoes. Removal of acquatic plants helps in the control of mansonoides. Other engineering measures include filling up of ditches, cesspools, drainage of stagnant water, etc.
- *Chemical method:* Consists of application of larvicides over the breeding places. Before applying larvicides, the breeding places should be cleared of scum and vegetations so as to maximize the efficiency. The larvae are generally resistant to organo-chlorine larvicides such as mosquito larvicidal oil (MLO) and Pyrosene Oil–E. (The later is pyrethrum based) but not to organo-phosphorus compounds such as temephos, fenthion, fenitrothion and chlorpyrifos. They are applied once a week to control culex larvae.

  Phenoxylene–30 or Shellweed killer–D, a herbicide used to destroy acquatic vegetation to control mansonoides larvae.
- *Biological method:* Consists of using larvivorous fish such as *Gambusia affinis*, policilia reticulata and also use of biocides such as using *Bacillus sphaericus* and *B. thuringensis*, the former being effective against larvae of *Culex* and mansonia mosquitoes and latter against larvae of *Aedes* and anopheline mosquitoes.

Anti-adult measures: Use of insecticides to control culex mosquitoes, in turn to control filariasis is limited because the vectors do not rest indoors and requires long and continuous efforts. However pyrethrum as a space spray still holds good, but it requires frequent spraying. Next better is malathion spray.

Protection of Susceptibles

By personal prophylaxis and health education.

- **Personal prophylaxis:** This consists of protecting the individuals from mosquito bites, which is a most effective measure, by the use of mosquito curtains. A simple and new method is the treatment of mosquito nets with a residual pyrethroid insecticide, such as permethrin or delta-methrin, i.e. by soaking the net in a solution of insecticide and allowed to dry. The effect of the insecticide lasts for more than 6 months. The mosquito seeking the blood meal, when rests on the net, comes in contact with a lethal dose.
- **Health education:** The community at large has to be educated about the hazards of the disease, modes of transmission, importance of sanitation, cooperation in the night blood surveys, importance of taking complete treatment, use of mosquito nets and their co-operation in carrying out antimosquito measures.

Integrated Vector Control

Since it is very difficult to control mosquitoes by application of any one method, an integrated or combined approach is needed to control filariasis by applying all the methods simultaneously.

Note: The factors which favor the success of control of filariasis are:

- The parasites do not multiply in the vector
- The infective larvae do not multiply in the human host

Since the life cycle of the parasite is quite long and since the parasite neither multiplies in the definitive host nor in

the intermediate host, the parasite does not cause explosive outbreak/epidemic of the disease. Therefore, control of filariasis is relatively easy.

National Filaria Control Program

Described under National Programs.

PLAGUE

It is an acute, communicable disease, primarily a zoonotic disease, disease of rodents, specially of rats, caused by bacilli *Yersinia pestis*. It is transmitted from the rodents to the human beings accidentally by the bite of infected rat-flea, an ectoparasite of rats. Clinically, it is characterized by fever, suppurative enlargement of lymph nodes often followed by septicemia (septicemic plague) and pneumonia (pneumonic-plague). Pneumonic plague carries high mortality.

History

Plague is not a new disease. It is present from time immemorial. The association of this disease with rats is mentioned in *Bhagwat Puran* (a book written about 1500 to 800 BC) stating that as soon as dead rats are seen the residence should be immediately vacated. Down the ages, plague was known as '*Mahamari*', the great killer.

Plague has dogged the man's foot-steps and it has taken a heavy toll of human lives. Three great pandemics have been authentically recorded. The first was recorded in 6th century (Justinian plague) which resulted in about 100 million deaths. The second was in 14th century and claimed about 25 million lives (Black-death), wiping out half of population of Europe. The third started in China during 19th century and reached all parts of the world by 20th century. It was in this pandemic that Yersin and Kitasato identified the causative organism (in 1894). Plague reached India in 1895 to 1996.

During early part of 20th century in India, plague constituted a serious problem and many epidemics occurred. In the middle of the century, as a result of large scale application of DDT to control malaria, simultaneously rat-fleas were also destroyed thereby plague was brought under control automatically. India became free from human plague during 1966 to 1967. The incidence was nil till 1994, when an epidemic was reported from Surat of Gujarat. Recently in 2002 cases were reported from Himachal Pradesh. These facts emphasize the need for continued surveillance of plague in India.

One common observation made during these epidemics was that plague following natural calamities like floods, which results in death of rats. The rat fleas leave their host and seek human beings for their blood meal. The first sign of plague epidemic is the appearance of dead rats. The phenomenon of 'Rat-fall' occur, i.e. rats fall from rafters and die on the floor. Rat-fall is a sign of imminent outbreak among human population.

Thus, plague spells disaster and fatality. It sparks off in us a hidden fear and induces us to flee from it. It is a costly national disaster. The rats cause economic avalanche.

Agent Factors

Agent

The etiological agent is a bacillus *Pasteurella pestis*, named after Yersin and Kitasato, who discovered it in 1894. So it is also called as '*Yersinia pestis*.' It is gm –ve, non-motile, nonspore forming, cocco-bacillus, giving a 'safety-pin' appearance and exhibits 'bipolar' staining with Giemsa or Wayson's stain. It grows readily on ordinary culture media in 48 hours and is seen as 'beaten-copper' appearance. It produces both exotoxin, endotoxin and fraction 1 antigen, which are not easily destroyed by the body's defence mechanisms.

These bacilli can survive and multiply in the dust or soil of the burrows of the rat, where the microclimate is favorable for them. These bacilli can easily be destroyed by sunlight and disinfectants like 5 to 10 percent cresol. They can also be easily destroyed by drugs like sulphonamides, tetracycline and streptomycin.

Reservoir

Reservoir state is found among both rodent animals and human beings.

Animal reservoir: Among the rodent animals, there are two forms—Sylvan form and urban form.

Sylvan form: Wild rodents constitute the reservoirs. They constitute the natural foci and are the sources for epidemics, i.e. epizootic cycle. During epizootic, the susceptible wild rats are all killed (Natural focus is an area where disease persists).

However, during interepizootic period, the wild rats remain susceptible to infection but not the disease. Other wild rodents like squirrel, rabbits and wild carnivores eating infected rodents may also act as a source of infection.

It is called 'Sylvatic plague.' Tatera-indica (wild rodent) and *Bandicoota bengalensis* are the main reservoirs. They pass the infection to commensal rodents through peridomestic rodents. Those wild rodents, which are immune to plague, act as carriers and maintain enzootic cycle in natural foci.

Urban form: In this type, commensal infected rodents constitute the reservoir. Important species are Rattus-rattus and Rattus-norvegicus.

Rattus-norvegicus is the sewer rat (brown). It is a great traveler. It lives alongwith rat-fleas on cargo ships and thus spreads the disease among rats from one port to another port, all over the world, resulting in pandemics. These live close and interbreed with wild rodents and also domestic rodents. Thus

sewer rat gets the infection from wild rodents and spreads to domestic rodents, Rattus-rattus (black-rat).

Rattus-rattus live in human dwellings and result in 'Domestic-plague,' which in turn has a potential for producing epidemic.

Human reservoir: Only the cases of pneumonic plague constitute the source of infection to others and not the cases of bubonic plague and septicemic plague. There is no carrier state of plague among human population.

Infected rat-fleas also act as a source of infection.

Host Factors

Age and sex incidence: No age and sex is bar from the disease. Plague can occur among people of all ages and both the sexes. Susceptibility is universal.

Immunity: There is no natural immunity. Immunity after recovery lasts for a short period. Thus susceptibility is universal.

Movement of people: In these days of jet travel, it is possible for a person to get the disease thousands of miles away in a place, where plague is not suspected at all.

Occupation: Plague is not an occupational disease, but it often occurs among those who enter forests for hunting, grazing, cultivation, harvesting, deforestation, etc. predisposing for contact with natural foci.

Environmental Factors

Season: In north India 'plague-season' starts from September to May and in south India, there is no definite season, because of topographic and climatic conditions. However, any environmental condition that disturbs the rodent's natural environment like floods is a potential source of plague in humans.

Temperature and humidity: An atmospheric temperature of 30°C and a relative humidity of 60 percent and above are considered favorable for the spread of plague, because this favors the survival of the vectors and the development of bacilli in the vectors.

Rain fall: Heavy rain-fall tends to flood the rat burrows and controls plague.

Natural calamities: Like earthquake, floods, war, etc. predispose for epidemics.

Housing conditions: Poor housing conditions favor the breeding of rats.

Vectors: The most common and most efficient vector of plague is rat flea, *Xenopsylla cheopis*. Other less efficient species of rat fleas are *X. astia* and *X. brasiliensis*. Human flea, Pulex irritans, may transmit the disease. In South India, *Styvalius ahale* is the efficient vector. Both the sexes of the rat flea bite and transmit the disease.

These vectors are bilaterally compressed, wingless insects, the shape helping the vectors to move easily among the hairs of the rats. They are blood sucking ectoparasites. When the rat dies of plague, the parasites leave the host and go in search of other rodents and bite the human beings accidentally. A flea ingests about 0.5 cu mm of blood, containing about 5,000 plague bacilli, which multiply in the proventriculus of the gut and are excreted or regurgitated by the bite. Thus, fleas act as 'Amplifier-vectors.' After reaching an optimum number, the flea is said to have become infective. The time required for the bacilli, from the time of its entrance till it reaches optimum number, is called 'Extrinsic incubation period' and that is about 10 days. Once the flea becomes infective, it remains infective for the rest of its life. Whomsoever it bites, spreads the disease. The infected fleas may live up to an year.

There are two types of infected fleas—blocked flea and partially blocked flea.

Blocked flea: It is one in which the proventriculus is fully blocked by a mass of plague bacilli, leaving the stomach empty and leading the flea to starvation. Such a blocked flea, facing starvation and death, makes frantic efforts to release the block by biting. While doing so it regurgitates some plague bacilli into the wound. This is the common mode of transmission. Such a blocked flea is an efficient transmitter of the disease.

Partially blocked flea: It is one wherein the proventriculus is only partially blocked with *Pl. bacilli*, leaving a canal in the center. From the epidemiological point of view, a partially blocked flea is more dangerous than a totally blocked flea because it survives longer and can bite more number of persons and also the blood is regurgitated with greater force and large number of bacilli will enter into the wound.

Flea Indices

These are the indicators which not only help in measuring the density of vectors but also to evaluate the control measures of plague in an area.

- *General flea index (Total flea index):* It is the average number of fleas, of all species, found per rat.
- *Specific flea index (Species index):* For example, *cheopis* index—it is the average number of *X. cheopis* per rat. This is a more significant index than general flea index.

The normal general flea index is 4 (3 to 5). *X. cheopis* index of more than 1 is indicative of possible outbreak of plague and warranting suitable advance antiplague measures to be instituted. After implementing control measures, again *X. cheopis* index is estimated. It must be always less than 1.

Other indicators of less important are:

- *Specific percentage of fleas:* It is the percentage of fleas of different species found on rats.
- *Burrow index:* It is the average number of fleas per rodent burrow.

Modes of Transmission

- Most common method of transmission of plague is by the bite of infective blocked flea from wild rodent to peridomestic rodents and to domestic rodents and humans. However, humans can get it from wild rodents, when they enter forests and bitten by fleas.
- Bubonic plague is not transmitted from man to man because fleas cannot bite and suck the fluid from the buboes, which are in the closed parts of the body. Therefore bubonic-plague is a 'Dead-end' infection in man.
- However pneumonic plague is transmitted from man to man by droplet infection.
- Domestic cats eat infected rodents, develop pneumonic plague and spread to humans by droplet infection.
- Contact transmission is possible from handling infected animals (rats) or infected material like pus from buboes.
- Percutaneous transmission is possible following scratching over the dried feces of rat-fleas, enabling the inoculation of plague bacilli through the abrasions.
- Aerosol transmission is also possible by inhalation of infected dust, (containing plague bacilli), of the burrows of the rodents, resulting in primary pneumonic plague. This is a suggested form of biological warfare (Bioterrorism).

Pathology and Pathogenesis

From the site of bite by rat flea, the bacilli reach regional lymph nodes, where inflammatory reaction occurs resulting in suppurative enlargement. The bacilli are locked up in buboes. If they enter directly into the circulation, bypassing the lymphatics, results in septicemia. The bacilli release exotoxin, endotoxin and fraction 1 antigens. These result in intravascular damage, hemorrhages in almost all viscera with parenchymatous degeneration. When they lodge in the lungs, there will be congestion, hemorrhages in lungs, resulting in pneumonic-plague. Associated with that there will be features of toxemia. They often reach meninges, resulting in meningitis-plague.

Incubation Period

It is 2 to 8 days in bubonic and septicemic plague and 1 to 3 days in pneumonic plague.

Clinical Features

The spectrum of plague is of the following types mainly: Bubonic plague, septicemic plague and pneumonic plague.

Bubonic Plague (Zoonotic Plague)

This is the commonest type and constitutes 75 percent of the cases. The illness starts with sudden onset of fever often associated with chills, headache, bodyache, and extreme prostration. Sordes appear on teeth, lips and nostrils. Thirst is intense and voice is reduced to whisper. Often there is delirium. Vomiting may often occur.

Regional lymph nodes of the site of bite are enlarged, painful and tender (Buboes). Since the frequent site of bite is on the lower extremities, inguinal buboes of that side is common. Less often in the axilla or neck.

In favorable cases, temperature falls, buboes burst releasing foul smelling pus followed by contracture and fibrosis of lymphatic tissue.

Bubonic plague is not infectious to others.

Septicemic Plague (Pestis Siderans)

This occurs in about 20 percent of cases, when the organisms enter directly into the circulation. This is severe and dangerous type. There will be features of septicemia such as high fever, palor, prostration, apathy, delirium followed by stupor, coma and death. There are hemorrhages in the viscera.

Pneumonic Plague (Demic Plague)

This occurs in about 5 to 10 percent of cases. Patient will have all features of pneumonia, such as high fever, cough, dyspnea, sputum, frothy and blood-tinged (In lobar pneumonia, the sputum is rusty and viscid). Clouding of consciousness is marked. Moist rales are audible in the base of the lungs. Cyanosis is developed later because of poor oxygenation of blood. Pleural effusion is usually present. Later delirium sets in, patient becomes stuporous, develops coma and thus dies within 4 to 5 days.

This is highly infectious type.

Meningitis Plague

Meninges are involved as a complication in 1 or 2 percent of cases. Patient will have all features of meningitis.

Mortality of plague is very high during epidemics, varying from 60 to 90 percent. Modern treatment has reduced the mortality.

Laboratory Investigations

Staining: Smears of bubo-fluid or sputum, stained with Giemsa stain or Wayson's stain to look for bipolar stained bacilli.

Culture: Of sputum, blood or bubo-fluid to look for colonies of 'beaten-copper' appearance.

Serology: This test is done for antibody titer.

Leukocyte count: There will be associated leukocytosis. (>20,000 cells/cu mm).

Animal inoculation: This is done is guinea-pigs or mice. They die of plague.

Prevention and Control

This consists of following three major procedures:
1. Elimination of reservoirs.
2. Breaking the channel of transmission.
3. Protection of susceptibles.

Elimination of Reservoirs

- Human reservoirs and animal reservoirs (Rodents).
- Elimination or control of human reservoirs (cases) by the following measures:
  - *Early diagnosis*: 'Rat-falls' (death of rats) provide a warning signal of imminent outbreak.
    Large number of people suffering from fever and painful enlargement of lymph-nodes (buboes) helps to make a clinical (community) diagnosis.
  - *Notification :* The information of occurrence of case/cases is notified to the concerned health authorities as early as possible, so that control measures will be implemented.
  - *Isolation:* It is necessary for cases of pneumonic plague only, because of its infectiousness. They constitute medical emergency. Period of isolation should be at least for 5 full days of chemotherapy.
  - *Concurrent disinfection:* Of sputum and patient's belongings must be disinfected. Five percent cresol is used.
  - *Chemotherapy*: Drug of choice is tetracycline 2 g a day for 10 days (500 mg 6th hourly). Sulphonamides is next best.
    Injection streptomycin, is also very effective antibiotic. But it may result in massive destruction of *Pl. bacilli*, release of endotoxin and further complications. So not preferred. Dose 30 mg/kg body wt/for 10 days.
    Chloramphenicol is good in plague meningitis because it can pass through the blood brain barrier.

Control of animal reservoirs (Rodents): Control of wild rodents is neither practicable nor feasible. Commensal rodents can be controlled as follows:
- *Trapping of rats:* It is done by using poisonous baits containing arsenic, warfarin (an anticoagulant) or zinc – oxide. But fleas escape. So not a good method.
- *Cyanogas fumigation:* This is a very effective method. This is done by using cyanogas pump. Calcium–cyanide, a white powder when pumped into the burrows of the rats and closed with mud, comes in contact with moisture, releases hydrocyanic acid, which when inhaled is lethal. This method not only destroys rats but also rat-fleas. But the disadvantages are:
  - It has to be carried out frequently, because the effect does not last longer.
  - Rats living in the roof escape.
  - Persons doing this work are at risk.
- Sulfur dioxide fumigation is also effective.
- *Use of DDT or BHC:* Since DDT is not very effective, 10 percent be insufflated into the burrows of the rats and sprinkled all along the rat-runs (the passage where usually the rats run). The residual effects lasts for 3 to 6 months. Powders containing 1.5 percent Dieldrin or 2 percent Aldrin applied to rat holes and rat-runs remain active for 9 to 12 weeks. This helps to control rat-fleas.
- *Construction of rat-proof godowns:*
  - The door must be made of metal.
  - There must be projection of 5 feet called 'ledge' to prevent rats climbing up.
  - Ventilators must have mesh.

Breaking the Channel of Transmission

- Droplet mode of transmission from cases of pneumonic plague can be prevented by concurrent disinfection of patient's sputum in 5 to 10 percent cresol.
- Vectors (Rat-fleas) can be controlled by cyanogas fumigation and insufflation of burrows of the rats with DDT or BHC.

Protection of Susceptibles

It is by chemoprophylaxis and immunoprophylaxis.

Chemoprophylaxis: This consists of administration of drugs for those who are at risk of plague such as family contacts, medical and nursing staff attending the patients. Drug of choice is tetracycline, 500 mg, 6th hourly, for 1 week.

Alternative drug is sulphonamide, 3 to 5 g, daily, for 1 week.

Susceptible persons also have to be protected by wearing gowns, gloves and masks.

Immunoprophylaxis (Vaccination): Killed vaccine is available, developed by Haffkine (1897) modified by Sokhey. It is a formalin killed vaccine. Each mL consists of 2000 million killed, *Y. pestis* bacilli. Primary course for adult male consists of 2 doses, 1.0 mL and 1.5 mL with an interval of 1 to 2 weeks, given subcutaneously (and 0.75 mL and 1.0 mL for adults female and proportionately less for children and infants below 6 months do not require vaccination). Vaccination after the outbreak of plague is useless.

However, during the fear of outbreak at least one week before, only one dose, of double the routine dose, (i.e. 3 mL for adult male) is recommended.

Immunity develops after 1 week of inoculation and lasts for 6 months. Booster doses are recommended once in 6 months regularly for those who are at risk such as geologists, biologists and anthropologists.

Immunization is also recommended for travelers to hyperendemic areas. It is 50 percent protective.

Since the vaccine provides only tissue immunity and not humoral immunity, it is not protective against pneumonic plague. Pregnancy is a contraindication because of its potential risk to result in abortions or fetal damage.

- **Other measures of control are:**
  - Surveillance of susceptible areas
  - Health education of the people about the sanitation in and around the houses, not to keep food grains in open containers, not to sleep on the floor, not to go to jungle areas and about their cooperation to inform about rat-falls, so that control measures can be undertaken.

    Note : Plague is now no more a quarantinable disease.

LEISHMANIASES

Leishmaniases are a group of protozoal parasitic diseases, caused by the parasite belonging to the genus *Leishmania*. They are transmitted to man by the bite of female infected sand-fly, of the genus *Phlebotomus*.

Clinically, mainly there are two types of Leishmaniasis-visceral and cutaneous.

Visceral leishmaniasis, also known as, Indian kala-azar, is caused by *Leishmania donovani*.

Cutaneous leishmaniases are of three types:

1. Oriental sore caused by *L. tropica*.
2. Espundia or Nasopharyngeal leishmaniais or Muco-cutaneous leishmaniasis caused by *L.brasiliensis*.
3. Dermal leishmanoid (or Post-kala-azar dermal leishmaniasis with non-ulcerative skin lesions) a late sequel to visceral leishmaniasis, caused by *L. donovani*.

Leishmaniases are considered to be zoonotic diseases, the infection being maintained in endemic areas in dogs, wild rodents and other mammals. However visceral leishmaniasis (Indian Kala-azar) is considered to be non-zoonotic disease because no animal reservoir of this parasite is known to exist.

The word 'kala-azar' has been derived from two Indian words, Kala and Azar meaning, 'black sickness', an illness in which the color (pigmentation) of the skin turns black. The word 'Kala' also means 'deadly', thereby indicating that it is a fatal illness.

Similarly, the parasite *Leishmania donovani* is named after two persons, namely Leishman from London (May 1903) and Donovan from Chennai in July, 1903.

Visceral Leishmaniasis

It is a chronic parasitic disease caused by the protozoal parasite *Leishmania donovani*, transmitted by the bite of infected female sand-fly (*Phlebotomus papatasi*). Clinically characterized by fever, malaise, anemia, massive spleenomegaly, often hepatomegaly and emaciation. The skin over the entire body becomes dark. Hair tends to be brittle and falls out.

If left untreated, death occurs within 2 years, due to complications such as amoebiasis, bacillary dysentery, pneumonia, tuberculosis, cancrum oris and other septic infections.

Magnitude of the Problem

Visceral leishmaniasis is a global problem. It is endemic in India, China, Africa, Southern Europe, South America, Mediterranean countries and Bangladesh. Ninety percent of the cases occur in India, Bangladesh and Brazil.

Globally there are about 13 million cases and every year about 1.8 million new cases are added.

Kala-azar (KA) often occurs as an opportunistic disease in AIDS.

In India, KA is endemic in Bihar, West Bengal, Odisha, Assam, Uttar Pradesh and Tamil Nadu (more along the coasts of rivers Ganges and Brahmaputra). An epidemic occurred in Bihar in 1977 due to migration of infected people.

KA which was almost controlled during NMEP by DDT spraying, which simultaneously controlled sandflies also, re-emerged during 1986 with 17,806 cases with 72 deaths to 77,102 during 1992 with 1419 deaths.

Agent Factors

The *L. donovani* parasites are the causative agents. They are intracellular parasites. They infect and divide within macrophages of the host (man). Essentially it is parasite of the RE system.

L.tropica is the causative agent of cutaneous leishmaniasis (oriental sore) and *L. braziliensis* is the causative agent of mucocutaneous leishmaniasis (Espundia).

However this distinction is not absolute. Visceral form may result in cutaneous form and vice versa.

The parasite *L. donovani* exists in 2 forms—leishmanial form (amastigote) or aflagellar stage occurring in vertebrate host such as man, dog and hamster. They are found in RE cells and identified as leishmania bodies. The other form is leptomonad form (promastigote) or flagellar stage found in the gut of sandfly.

Life Cycle

The life cycle begins when a female sandfly bites KA patient, sucks blood containing aflagellar or amastigote of leishmanial forms. In the midgut of sandfly these develop into leptomonad forms, which multiply into enormous number of flagellates. They tend to spread towards the anterior part of the alimentary canal (pharynx or buccal cavity). Salivary glands are not infected unlike in mosquitoes.

After the extrinsic incubation period of about 9 days, the transmission is effected through the bite of the infected female sandfly and inoculating lepomonad forms into the skin. They develop into leishmanial forms, inside the RE cells, multiplies by binary fission, till the cell eventually ruptures and releases the parasites. Some invade fresh RE cells, while some are free circulating. Thus RE cells are progressively infected. Some of

free forms are phagocytosed by macrophages while other free forms are sucked by sandflies.

Reservoir of Infection

Canines are the reservoirs (dogs, jackals, foxes) in Mediterranean areas, Brazil and China. Canine leishmaniasis does not exist in India, where human kala-azar is endemic. Hence in India man is the only reservoir/source of infection. In Kenya (Africa), gerbils and ground squirrels are the reservoirs of infection.

Host Factors

- *Age incidence:* Incidence of KA in India is maximum in the age group of 5 to 10 years. However, it can occur in any age group.
- *Sex incidence:* It is twice more common among men than among women.
- *Migration of people:* Favors the spread of the disease.
- *Socioeconomic status:* KA is a disease of the poor, because of the poor living condition.

Environmental Factors

- *Altitude:* KA does not occur in high altitudes above 600 meters of sea level because sandflies are not found in such height. So KA is confined to plains.
- *Season:* Incidence is high during and after rainy season.
- *Area:* Usually KA is a disease of rural areas because of the prevailing predisposing factors.
- *Project works:* The disease is linked to deforestation, dam construction, irrigation, urbanization, migration of laborers and such others.

Miscellaneous Factors

Malnutrition and AIDS predispose to leishmaniasis.

Mode of Transmission

The disease is transmitted by the bite of infected, female, sandfly of the genus *Phlebotomus*. *P. argentipes* is highly anthrophilic (Cutaneous leishmanisis is transmitted by *P. papatasi* and *P. sergenti*). Transmission may also take place by contamination of the bite wound, when the insect is crushed by slapping during the act of feeding. Transmission can also occur by blood transfusion.

Incubation Period

Extrinsic incubation period is 6 to 9 days in sand-fly and intrinsic incubation period is about 3 to 6 months in human beings. It may even extend to one year.

Clinical Features

i. **Visceral leishmaniasis:**
   - *Fever:* This is the early symptom. It may be continuous or remittent, later becoming intermittent. Sometimes it shows double peak in 24 hours.
   - *Spleenomegaly:* This is progressive and is the most striking feature. It may even fill up the entire abdomen.
   - *Liver:* This is often enlarged.
   - *General appearance:* When the disease is fully established, the person looks weak and emaciated. The skin all over the body becomes dry and darker. Hence the name 'Kala-azar' (black illness). He becomes anemic. If left untreated, KA carries high mortality.

ii. **Post-kala-azar dermal leishmaniasis (PKDL):**
This occurs after one or two years of apparent cure of visceral leishmaniasis, characterized by nonulcerative, nodular, cutaneous lesions. It develops in about 10 percent of the KA cases. It is prevalent chiefly in Bengal and less so in Assam and Tamil Nadu. Parasites are numerous in the lesions.

iii. **Oriental sore:**
This type of cutaneous leishmaniasis is caused *Leishmania tropica*.

L.donovani and *L.tropica* are never found together in the same locality. *L.donovani* is usually confined to moist eastern part of India whereas *L.tropica* is limited to dry western part.

Unlike PKDL, oriental sore is characterized by painful ulcers over face, arms and legs, the parts exposed to bites of sandfly. Clinically it is also called tropical sore (Delhi boil), mistaken for leprosy. Transmitted by infected, female, *P. sergenti* in India and *P. papatasi* in North Africa and Central Asia.

iv. **Espundia or mucocutaneous leishmaniasis:**
This is caused by *L. brasiliensis*, transmitted by *P. intermedius*, clinically characterized by ulcers similar to oriental sore, but around the nose and mouth.

Prevention and Control of Kala-azar

- Elimination of reservoirs
- Breaking the channel of transmission
- Protection of susceptible persons.

Elimination of Reservoirs

Since human cases are the only reservoir of KA in India, this measure consists of their detection and treatment. Pentavalent antimony compounds are the drug of choice. They are urea stibamine, amino stiburea, neostibosan, etc. Ideal drug is sodium stibogluconate, 10 mg/kg wt, intramuscularly, for adults, daily for 20 days; 20 mg/kg for children.

Those who do not respond to this drug, are given pentamididine isethionate, 3 mg/kg wt for 10 days. intravenously. This drug is toxic. So the patient requires supervision.

The patient must be re-examined after 3 months and 12 months, to exclude relapse if any.

In the areas, where dogs and rodents are the reservoirs, extensive measures are undertaken to control them.

Breaking the Channel of Transmission

This consists of mainly vector control measures, i.e. control of sandflies. Sandflies are best controlled by DDT spraying in the human dwellings (because they live in the cracks and crevices of the walls of the houses) and cattle sheds. Two rounds of DDT spraying is carried out per year, at the rate of 2 g per sq meter.

Lindane or BHC is the next best if there is development of resistance to DDT.

Insecticidal measure will be more effective when followed by the improvement of sanitation by the following measures:

- Cleanliness in and around the house
- Plastering of walls to close-down the cracks and crevices
- Location of cattle-sheds and poultry away from human habitation.

Protection of Susceptibles

This consists of personal prophylactic measures, such as using mosquito curtains while sleeping, application of repellants, avoiding sleeping on the floor and keeping the house clean.

ARBOVIRAL DISEASES

These are the viral diseases, primarily zoonotic diseases, diseases of vertebrate animals (except O-Nyong nyong fever), transmitted to human beings accidentally by the bite of hematophagous (blood-sucking) arthopods, such as mosquitoes, sand-fly, ticks and mites. Such viruses are called as 'Arboviruses', which are all RNA viruses, showing varied type of morphology, spherical and cylindrical. They are classified into Group A, Group B and other groups. Some are named after the place of isolation and some after the clinical features.

Classification of Arboviruses

Group A Viruses (Alpha Viruses)

Chikungunya-virus, Sindibis-V, Eastern equine encephalomyelitis-V, Western equine encephalomyelitis-V, Venezuelan equine encephalomyelitis-V, O-Nyong-Nyong-V, Mayaro-V, etc.

Group B Viruses (Flavi-viruses)

Yellow fever virus, dengue fever V, Japanese encephalitis-V, Kyasanur forest disease V, OMSK-hemorrhagic fever V, Lassa fever V, Murray-Valley encephalitis V, Louping ill V, Russian spring summer encephalitis V, West-Nile fever V, etc.

Bunyamwera Super Group

Bwamba group, California group, Simbu group, Guama group, Group C, etc.

Others

Umbre, Sathuperi, Chandipura, Chittor, Ganjan, Minnal, Venkatapuram, Dhori, Kaisodi, Sandfly fever, Vellore-virus, etc.

The arboviral diseases are also classified as febrile group of viral diseases, hemorrhagic group of viral diseases and encephalitides group of viral diseases.

YELLOW FEVER

It is an acute communicable disease, caused by an arbo-virus belonging to Castle's group B. Primarily, it is a zoonotic disease, specially the monkeys. Man gets the disease accidentally by the bite of infected, female, aedes mosquito. Clinically it is characterized by fever, toxic jaundice, albuminuria followed by hemorrhagic manifestations such as epistaxis, hematemesis and malaena. Case fatality rate ranges from 30 to 40 percent. It will be high up to 80 percent during epidemics. There is no treatment. Prevention is the only intervention.

Distribution and Extent of the Problem

The disease is not distributed all over the world. It is endemic only in tropical forests of central Africa and northern part of South America between the latitude of 15° north and 10° south and 10° north and 40° south of Equator in Africa and S. America respectively. Currently, the disease is maintained enzootically, often resulting in epidemics among human population.

During 1960, an epidemic occurred in Ethiopia affecting 2,00,000 people resulting in 30,000 deaths. Again during 1978, epidemics occurred in Colombia and Peru in S. America, Gambia and Ghana in Africa.

The disease is not reported from India.

Agent Factors

Agent

The causative agent is a virus, namely Flavo-virus fibricus. It is a RNA virus. It belongs to Arbovirus Castle's group B and family

togaviridae. It is a filterable virus and ultra microscopic, 15 to 20 mμ in size. It has both viscerotrophic and neurotrophic properties, mainly viscerotrophic. It is readily destroyed by heat and chemicals. It resists freezing. So it may be preserved even at –70°F for years together. Lesser the temperature, longer is its duration of life.

Reservoir of Infection

Epidemiologically there are 2 types of reservoirs:

- *Sylvan form (Jungle form):* Wild monkeys are the reservoirs and in
- Urban/rural form, human beings are the reservoirs.

Period of Communicability

The person suffering from yellow fever, is communicable (to mosquitoes) during the last 1 or 2 days of incubation period and first 4 days of illness, because the viruses are circulating in the blood during that period.

Host Factors

Age incidence: People of all the age group are susceptible to yellow fever. But the incidence is maximum in the age group of 15 to 40 years.

Sex incidence: People of both the sexes are susceptible to this disease. However, incidence is more among men than among women because of the risk of mosquito-bites.

Occupation: Yellow fever is not an occupational disease. But it is high among those, in the endemic areas, who work in the forests such as wood-cutters, planters, hunters, etc.

Immunity: It is acquired and humoral. One attack confers life long immunity.

Environmental factors: Atmospheric temperature of 24°C is favorable for the viruses to multiply in the body of mosquitoes and a relative humidity of 60 percent is favorable for the mosquitoes to live longer.

Social factors are deforestation, urbanization, etc. predispose for the extension of the disease from forest to human dwellings.

Vectors: The vectors of yellow fever are hematophagous mosquitoes. In Jungle (or sylvan) form, in South American forests, the vector is *Hemogogous capricorni* and in African forests, the vector is *Aedes africanus*.

In urban (or rural) form, in S. America the vector is *Aedes aegypti* and in Africa, it is *Aedes simpsoni*.

These vectors are aggressive day biters. The urban/rural form of mosquitoes are peridomestic mosquitoes. They breed near human habitations. Their breeding places are fresh water collected in artificial containers like Coconut shell, broken pots, broken bottles, empty cans, tree holes, etc.

Mode of transmission: The disease is transmitted from monkeys to monkeys, monkeys to human beings and man to man by the bite of the infective, female, *Aedes* mosquitoes. (species are already mentioned).

Man gets the infection when he enters the forest and once he gets the disease, initiates the urban cycle.

Extrinsic incubation period: It is the period between the successful entry of the viruses into the body of the mosquito (i.e. from the time of bite) till it becomes infective (That is till the viruses multiply and reach the optimum number). That is about 10 to 14 days. This type of biological transmission is called 'Propagative type'. Once the mosquito becomes infective, it remains infective throughout its life. Whomsoever it bites, transmits the disease.

Pathology and pathogenesis: Having entered the body through the percutaneous route, the viruses circulate and later affect liver, heart and kidneys.

Liver: This is mainly affected. There will be eosinophilic, hyaline necrosis of hepatocytes, mainly in the midzone of the lobule, which are called 'Counsilman bodies', which is pathognomonic. Unconjugated bilirubin gets accumulated in the blood, resulting in hyperbilirubinemia, giving rise to yellow coloration of sclera and urine (jaundice).

Heart: Activity of the heart is suppressed resulting in bradycardia.

Kidney: There is tubular necrosis, resulting in albuminuria. There are hemorrhagic foci under the capsules of the cortex.

Incubation period: Varies from 3 to 6 days.

Clinical Features

These occur in three stages:

1. *Stage of infection:* Characterized by fever, headache, bodyache, flushing of face, photophobia, relative bradycardia (Faget's sign) and pain in the loin. This stage lasts for 3 to 4 days.
2. *Stage of remission:* In this stage, the patient is symptom-free. This stage lasts for few hours to one day.
3. *Stage of intoxication:* This stage starts from 4th to 5th day. Jaundice gradually develops. Albuminuria and hemorrhagic manifestations are evident. There will be epistaxis, bleeding from the gums, petechial hemorrhages, later hematemesis and malena. Bradycardia progresses to less than 50 per minute. 'Black-vomit' is one of the striking features and is always a grave sign. Another grave sign is increase in pulse with fall of temperature. Later hiccups occur. Patient passes on to the stage of delirium, becomes stuporous, develops coma and death supervenes within 6 to 9 days.

Investigations

- Leukocytosis is followed by progressive leukopenia

- Albuminuria, hyperbilirubinemia
- Liver biopsy is contraindicated because it may result in hemorrhage. If done, shows 'Counsilman bodies.'

Management

Hospitalization, symptomatic treatment, blood transfusion, prophylactic antibiotics, maintenance of fluids and electrolytes.

Prevention and Control

- Elimination of reservoirs
- Breaking the channel of transmission
- Protection of susceptibles.

Elimination of Reservoirs

Since it is neither possible to eliminate animal reservoirs such as wild monkeys, nor there is treatment for yellow fever, nor it is possible to control the vectors (mosquitoes) in the forests, control of *jungle* form of yellow fever continues to be an uncontrollable disease. Therefore control of yellow fever for all practical purposes, means control of urban yellow fever, which consists of control of vectors, vaccination of susceptibles and surveillance program.

Breaking the Channel of Transmission

This consists of control of vectors—antilarval and antiadult measures. Control of vectors reduces transmission.

Antilarval measures: The most important and effective measure is by elimination of breeding places. This is known as 'source reduction' method. This consists of making the water holding containers (such as broken pots, coconut shell, broken bottles, tins, etc.) topsy turvy or such things are removed from the human dwellings.

Antiadult measures: Consists of using organophosphorous compounds such as malathion in the form of ULV-fogging; by using special machines.

Protection of Susceptibles

By personal protection and vaccination measures.

Personal Protection

This consists of using mosquito repellants, mosquito nets, mosquito coils and fumigation mats. But they are not very effective against bites of *Aedes* mosquitoes, because these mosquitoes are day biters.

So the only very effective measures is by immunization.

Immunization: The internationally approved vaccine is 17-D vaccine. It is a live vaccine, freeze-dried and the diluent is sterile normal saline. It contains live attenuated avirulent 17-D strain of the virus, grown in chick-embryo, to be used within half an hour of reconstitution. Dose is 0.5mL, given subcutaneously, near the deltoid region, irrespective of age and sex. Immunity develops within 1 week and lasts for more than 10 years, probably life-long. However, WHO recommends re-vaccination once in 10 years for international travelers.

Reactions following vaccination are minimal. But may occur among those who are sensitive to egg protein.

Storage temperature is preferably sub-zero degree centigrade (–20°C).

Surveillance Program

WHO has recommended an index for the surveillance of the aedes mosquitoes, called '*Aedes aegypti* index,' also known as 'House-index,' which is defined as percentage of the houses, in a defined area, showing actual breeding of the larvae of these mosquitoes.

$$\textit{Aedes aegypti}\ \text{index} = \frac{\text{No. of houses showing actual breeding of larvae}}{\text{Total no. of houses in the defined area}} \times 100$$

This index should not be more than 1, to ensure freedom from yellow fever, in the endemic areas. Thus, this index is also used to evaluate the antilarval control measures. If this index becomes more than 1, there is a fear of outbreak.

International Certificate of Vaccination against Yellow Fever

This is necessary for those who are traveling from endemic areas of yellow fever to yellow fever receptive area. Yellow fever receptive area is one where yellow fever does not exist but conditions would permit its development, if introduced. The validity of the certificate begins 10 days after the vaccination and lasts for 10 years. If revaccination is performed before the expiry of the validity, renders the certificate valid for a further period of 10 years, from the date of re-vaccination. On the other hand travelers coming to endemic areas also should receive vaccination for their self-protection.

Prevention of Yellow Fever in India

India is an yellow fever receptive area because:

- People are all unvaccinated and are susceptible
- Monkeys (*Macacus rhesus* and *M. sinicus*) are also susceptible
- Vectors (*Aedes aegypti*) are in abundance
- Climatic conditions are favorable.

But still the disease does not exist because the causative agent virus, is not present. Virus can gain entry at any time. Therefore, special precautions have been taken by the Ministry of Health, Government of India, through stringent

International Health Regulations. The virus can enter India through travelers and mosquitoes, through aircrafts and ships.

So the aerial and maritime traffic regulations are:

- *For passengers:* Travelers must possess valid certificate of vaccination against yellow fever, if not such persons are placed under 'Quarantine', in a mosquito-proof ward for the incubation period of 6 days, for observation, from the date of leaving the endemic area. If the traveler possesses the certificate but arrives before the certificate becomes 'valid', he is quarantined till the certificate becomes valid.
- *For mosquitoes:* The air crafts and ships coming from endemic areas are subjected for disinsection for the control of the vectors. In the area of about 400 sq meters, near the air-port or sea-port, the '*Aedes aegypti* index' is kept below 1. The ships are also moored about 400 meters away from the shore and disinsected.

Yellow fever is an epidemiological mystery. Inspite of these stringent regulations, now it is thought that viruses could have entered in India, at least off and on. But still the disease has not been reported based on the following explanations:

- Indian *Aedes* mosquitoes may be less efficient vectors than those of Africa and South America.
- Indians might have developed cross immunity by suffering from other arboviral diseases such as Dengue fever, KFD and JE, which has provided an 'Ecological barrier'.
- Indians might have developed antimosquito antibodies, following bites by *Aedes* mosquitoes.

DENGUE FEVER

It is an acute, infectious, commonest arboviral disease, caused by dengue viruses, transmitted from person to person, by the bite of infective, female, *Aedes* mosquito. Clinically it is characterized by high fever, headache, body ache, severe joint and muscular pains. Usually it is not fatal, but under certain circumstances it can cause severe hemorrhage and profound shock, which may become fatal. It is a self-limiting disease. Next to malaria, dengue is now the most common cause of fever in India.

Magnitude of the Problem

This disease has been known for more than a century in all the tropical and subtropical regions. It is endemic in more than 100 countries in this region, often giving rise to epidemic and even pandemic. In 1998 pandemic WHO reported 1.2 million cases with about 15,000 deaths. Every year it is increasing, so much so, it is estimated that each year 50 million infections occur, with 5,00,000 cases and 12,000 deaths. Prevalence of dengue fever is mainly due to industrialization, urbanization, eruption of slums, lack of sanitation in and around the houses.

In India, first epidemic occured in Vellore District of Tamil Nadu in 1956. Another epidemic occurred in 1996 in Delhi. About 10,000 cases and 400 deaths were reported. During 1997, another epidemic occurred in Maharashtra. During 2003, there were about 12750 cases with 217 deaths in the country. Thus, dengue fever is an emerging public health problem in India, with cyclical epidemics.

Agent Factors

Causative agent: The dengue virus, a member of *Flavi-virus* group, belongs to Castle's group B and family Togaviridae. It is RNA virus, spherical, 17 to 25 mμ in diameter. Serologically there are 4 types, DEN-1, DEN-2, DEN-3 and DEN-4. Eventhough they are similar antigenically, they provide only partial cross-immunity. The virus is easily destroyed by heat and chemicals. But it survives for several years at – 70°C. All four serotypes have been isolated in India.

Period of communicability: It is first 4 to 5 days of illness.

Reservoir: Only case is the chief reservoir. (However, monkeys are the reservoirs in Malaysian forests). No carrier state exists.

Age incidence: Dengue fever is common among young children and adults. However, children have a milder disease than adults.

Sex incidence: It is more among men than among women may be because men are more exposed and women are better clothed.

Immunity: One attack confers type specific immunity for about 9 months against a particular sero type of virus and partial cross immunity against the other types. However, several attacks with the same sero type confers lifelong immunity.

Mode of transmission: It is by the bite of infective, female, aedes mosquito.

Vectors: The most efficient vector is *Aedes aegypti* mosquito. It is most efficient because of its peri-domestic habit, i.e. it breeds near human habitations, in the water, collected in artificial containers like coconut shell, broken pot, flower-vase, broken bottle, air coolers, etc. Air coolers turned out to become killers in Delhi epidemic. It is a black mosquito with white bands. So it is called 'Tiger mosquito'. It is an aggressive day biter, i.e. it bites during morning hours and late afternoon. It is anthrophilic (feeds on human blood).

After the blood meal, the viruses multiply in the body of the mosquito and reaches an optimum number, when the mosquito is said to have become infective. Thus the virus undergoes propagative type of biological transmission. The extrinsic incubation period is 8 to 10 days. Once the mosquito becomes infective, it remains infective.

The other less efficient vectors are *Aedes albopictus, Aedes polynsiensis* and *Aedes scutellaris* complex. They have their own peculiar geographical distribution.

Environmental factors: The risk of dengue has shown an increase in recent years due to rapid, urbanization, life style changes of using air coolers and deficient water management including improper water storage practices in urban, periurban and rural areas, making the environment aedes friendly.

Incubation period: Varies from 5 to 10 days.

Clinical spectrum: Following is the spectrum of dengue viral infection:

- Asymptomatic dengue viral infection
- Undifferentiated viral fever syndrome
- Classical dengue fever
- Dengue fever with unusual hemorrhage
- Dengue hemorrhagic fever (without shock)
- Dengue hemorrhagic fever with shock (Dengue shock syndrome).
- *Asymptomatic dengue viral infection:* In this type, there is infection with the virus, but not associated with symptoms, probably because of subclinical infection.
- *Undifferentiated viral fever syndrome:* In this type, the patient will have mild fever with mild prodromal symptoms, characterized by mild fever, mild headache, mild bodyache, and loss of appetite. Maculopapular rashes may appear. This type is among infants and young children. The features last for a few days followed by complete recovery. Since there are no classical features, it is symptomatic type but undifferentiated viral fever.
- *Classical dengue fever:* In this type, there is sudden onset of high fever, up to 104°F, associated with severe prodromal symptoms like severe headache and body – ache. There is associated severe muscular pain (myalagia) and joint pains (arthralgia) so much so, that the patient feels as if his bones are broken. Hence this condition is also called 'Break bone fever' (or Dandy fever). Other characteristic features are retrobulbar pain and periorbital pain, particularly on movements of eye and photophobia also develops. Myalgia and arthralgia restrict the body movements. Fever is 'biphasic' (Saddle–back form of temperature curve). Sudden rise of temperature declines gradually from 2nd day and rises again on 4th or 5th day and then declines again. Rashes appear in about 80 percent of the cases during second febrile phase. They are macular or morbilliform, first appear on trunk, may spread to the extremities and rarely to the face, accompanied by itching, hyperesthesia, and generalized lymphadenopathy. Rashes last for 1 or 2 days. During the latter part of second febrile phase, rashes disappear.

  Classical dengue fever is a short lived infection lasting for about 8 to 10 days, with complete recovery. It is not fatal. There is profound leukopenia. Case fatality rate is very low.
- *Dengue fever with unusual hemorrhage:* In this type the patient will have features of classical dengue fever with unusual hemorrhagic manifestations such as petechial (cutaneous) hemorrhages. The tourniquet test is positive. That means there is an increased capillary fragility (i.e. Using a standard blood pressure cuff, pressure is raised between systolic and diastolic pressure. The test is considered as positive, if more than 20 petechiae are seen per square inch). There may be epistaxis, gingival bleeding, bleeding in the gut, hematuria and hypermenorrhea as a complication resulting in death.
- *Dengue hemorrhagic fever (DHF) without shock:* It is a severe form of dengue fever, proposed to be the result of two sequential infections with different dengue serotypes, the first infection with type I or II sensitizing the patient to the second infection with type III or IV, resulting in immunological catastrophe. A critical period of about 6 months between the two infections has been thought to be necessary.

Pathophysiology

There is increased capillary permeability due to activation of the complement by dengue antigen, leading to leakage of plasma, fluid and erythrocytes not only in the interstitial spaces but also in serous cavities like pleura and peritoneum, ultimately resulting in hypovolemia, hemoconcentration, acidosis and even shock. Liver is enlarged and shows midzonal necrosis plasma leakage constitutes the critical phase.

Age incidence: DHF is common among young children. Adults develop classical dengue fever but escape hemorrhages.

Clinical Features

There are four major clinical manifestation.

1. *High fever:* Sudden in onset, high, continuous, associated with severe prodromal symptoms, lasts for about 1 week.
2. *Hemorrhagic phenomenon:* Usually spontaneous. Common phenomenon is a positive tourniquet test. Any of the following hemorrhagic manifestations may be present such as fine petechiae on the extremities, axillae, face during the early febrile phase, epistaxis, gingival bleeding, hematemesis and/or malena.
3. *Hepatomegaly:* But not associated with jaundice.
4. *Circulatory failure:* Characterized by profound sweating, hypothermia, low blood pressure, narrowing of pulse–pressure, increased pulse rate, rapid and weak pulse, cold clammy skin and restlessness.

Grading of DHF: Depending upon the severity, DHF has been graded as follows:

Grade I: Fever with prodromal symptoms. The only hemorrhagic manifestation is a positive tourniquet test.

Grade II: Features of Grade I + spontaneous hemorrhage.

Grade III: Features of Grade I and II + features of circulatory failure.

Grade IV: Features of Grade I, II and III + profound shock.

With Grade III and IV, the CFR is 40 to 50 percent.

Convalescent (Reabsorption) phase: This phase begins when the critical period of 24 to 48 hours ends. This is characterized by

stoppage of plasma leakage, reabsorption of plasma and fluids into the intravascular compartment, stabilization of vital signs (improvement in the pulse) improved well being, increased urine output and appearance of characteristic Convalescence Rash of Dengue (confluent often pruritic, petechial).

Except for the complications of fluid overload or mechanical ventilation nearly all patients with DHF recover rapidly with timely initiation of judicious fluid management and careful monitoring. Recovery is due to the fact that the period of increased vascular permeability is time limited (lasting 24–48 hours) and functional change in the vascular endothelium appears to be entirely reversible with no known permanent structural defect. Often the patients recover fully without sequelae, if managed properly.

Investigations

- Platelet count is < 1,00,000 cells/mm^3 (Normal = 2 to 5 lakhs cells/mm^3).
- Hematocrit value is increased by 20 percent or more (due to hemoconcentration).

  The clinical criteria like high fever, spontaneous hemorrhagic manifestation associated with thrombocytopenia and rise in hematocrit value are sufficient to establish the diagnosis of DHF. Hypoproteinemia, pleural effusion and ascites constitute the supporting evidence of plasma leakage.
- *Real time polymerase chain reaction (RT-PCR):* This is done to detect viral gename in serum. It is a primary tool to detect virus early in the course of illness. It is a definite proof of current infection. But this test is not available.
- *NS1 ELISA:* Detection of nonstructural protein (NS1-Antigen) in the serum of dengue fever patients is an useful tool for the diagnosis of acute dengue infections. This is commercially available.
- IgM detection is not useful.
- *Dengue hemorrhagic fever with shock (dengue shock syndrome):* It is a very severe form of DHF associated with profound shock. It occurs in 30 percent of cases of DHF. The patient will have high fever with hemorrhagic manifestations. On second or fifth day of illness, the patient deteriorates suddenly and rapidly. The skin is cold, clammy, blotchy with circumoral cyanosis with hypotension and a narrow pulse-pressure. Patient is restless and may die within 12 to 24 hours. With intracranial hemorrhage, the patient may go into coma. Acute abdominal pain frequently occurs before the onset of shock.
- *IgG ELSIA:* Samples with negative IgG in acute and a positive IgG in convalescent phase of the infection are primary dengue infections. Samples with a positive IgG in the acute phase and a four fold rise in IgG titre in the convalescent phase, is a secondary dengue infection.
- The most specific serological tool for the determination of dengue antibodies is plaque reduction and neutralization test (PRNT) assay. This determines the level of antibodies.

Management

Since there is no treatment, management is only symptomatically and by supportive therapy such as antipyretics, prophylactic antibiotics, blood transfusion and fluids and electrolyte balance. Some points which deserve special mention are:

- Isolation of the patient in a mosquito-net or mosquito-proof room, because the viruses are circulating in the blood during first 3 to 5 days of illness and the aedes mosquitoes are the day biters. The mosquitoes are capable of transmitting the infection soon after blood meal. Using mosquito curtain prevents further transmission from the patients.
- Salicylates must be avoided, because they may cause bleeding.
- Avoid IV fluids till the evidence of hemorrhage.
- Avoid boold transfusion till hematocrit falls.
- Antibiotics and steroids not necessary.

Prevention and Control

- *Elimination of reservoir:* Since there is no specific treatment, further transmission from the cases can be prevented by nursing them under mosquito nets, so that they are not bitten by *Aedes* mosquitoes. Thus elimination of reservoir has a limited role in control of dengue fever.
- *Breaking the channel of transmission:* This consists of anti-larval and anti-adult measures, which are already explained under yellow-fever. One important point is that the flower-vase and air coolers must be periodically emptied and kept dry at least for a day before they are refilled, a measure not adopted and predisposed for Delhi epidemic. Antiadult measures are explained under epidemiology of Japanese encephalitis.
- *Protection of susceptibles*
- *Immunization:* Research is being carried out to develop a live tetravalent cell culture vaccine against 4 serotypes of dengue viruses. This has been developed by Mahidol University in Thailand and trials are going on. This is the first time, a developing country has carried out the development of a vaccine for human use.

The area is declared free of the epidemic when *Aedes aegypti* index is zero or twice the incubation period has lapsed from the date of detection of last case of dengue fever.

JAPANESE ENCEPHALITIS

It is so called because for the first time severe epidemic of encephalitis occurred in Japan during 1924 and then epidemics occurred almost annually thereafter till 1970. Since then it has been declining in Japan but started in almost all S-E Asian countries. Unless otherwise specified, it always means Japanese B encephalitis, which is so named

to differentiate from type A called 'Encephalitis Lethargica' i.e. Van Economo's disease. This type of epidemic occurred during the same period (1920 s) and much before the virus was isolated and the natural history was studied, the type-A virus disappeared from the nature. Therefore now the alphabet 'B' has been deleted from the term Japanese B encephalitis and is called Japanese encephalitis (JE).

JE is an acute, inflammatory disease of the brain, caused by an arbovirus called JE virus. Basically it is a zoonotic disease, the reservoir being pigs and cattle, transmitted accidentally to human beings, specially young children by the bite of infective, female, culex mosquito. Clinically it is characterized by sudden onset of high fever, neck rigidity and convulsions. Later delirium, coma and death supervenes with a case fatality rate, varying from 20 to 40 percent, which during epidemic may increase up to 80 percent. Those who recover may or may not have neurological deficits.

The public health importance of this disease is that it has an epidemic potential, high CFR, permanent sequelae, no treatment and it is preventable.

JE is common in SE Asian countries and rare in other parts of the world. Globally about 43,000 cases of JE occur each year with 11,000 deaths and 9000 disabled.

In India, first epidemic was reported during 1955 in North Arcot District of Tamil Nadu and Nagpur and Maharashtra, during 1958 in Agra and then in West Bengal (1973) and in Bihar, Assam and Uttar Pradesh during 1980. Extensive epidemic occurred in South Arcot in 1981 and since then, it has remained endemic with periodical epidemics. Meanwhile during 1981, contagious districts of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh and Puducherry were affected. Surveys carried out by National Institute of Virology, Pune have indicated that majority of the population in South – India have neutralizing antibodies to this virus, indicating subclinical infection and immunity.

In India, the incidence of the disease is very small compared to the population exposed to mosquito bite. That means not all the persons bitten by the infective mosquito will get the disease, but only 1 in 300 to 1000 bitten persons will get the disease. That means for every case of JE there are about 300 to 1000 persons subclinically infected. Thus, a case of JE constitutes the tip of the iceberg.

It is mainly a rural problem because these mosquitoes are found in agricultural areas.

During 2011, 6297 cases of JE were reported with 861 deaths from 135 districts of 17 states of India. About 75 percent of them were from Uttar Pradesh. Uttar Pradesh has claimed more than 3500 lives over the last five years alone.

Agent Factors

Agent: The causative agent is an arbovirus, called JE virus belonging to Castle's group B, family Togaviridae and genus *Flavovirus* (Flavi-virus). It is a RNA, filterable, ultramicroscopic virus, of about 25 to 40 mμ in diameter, enveloped by a lipid layer, showing varied type of morphology. It is easily destroyed by heat and chemicals. It is a neurotrophic virus.

Reservoir of infection: The chief reservoirs are animals and water birds. Among the animals pigs are the natural hosts. They have tremendous circulating viruses (viremia) but do not manifest any signs and symptoms of the disease. That means they never suffer from the disease but they can infect the mosquitoes. They only help in the multiplication of the viruses and help to continue the natural history of the disease. Thus pigs are called the 'Amplifier hosts.' However, pregnant pigs, when get infected with JE virus, may end up in abortion.

Cattle are also the reservoirs of infection. Neither they suffer nor they act as amplifier hosts. They are only the next attractants. That means when the pigs are not available for blood meal to the mosquitoes, the mosquitoes feed on cattle. Thus cattle prevent the mosquitoes from biting human beings. Thus the role of cattle in the transmission of disease is limited.

Horses are the only animals, which develop manifestations of encephalitis, but viremia is rarely present in high titer. Horses are unlikely sources of mosquito infection.

Among the birds, the ardeid birds, pond-herons, poultry ducks and cattle-egrets constitute the reservoirs. They also do not suffer but act as a source of infection.

Thus JE virus is maintained in the nature by a complex cycle that involves pigs as the natural and amplifying hosts, cattle as the next attractants (blocking agents), birds as the other reservoirs and culex mosquitoes as vectors, as shown in the **Figure 20.50**. Infection in man appears to be correlated with living in close proximity with animal reservoirs, especially pigs.

Among the human reservoirs, there are only active clinical cases and subclinical cases. For every case of JE,

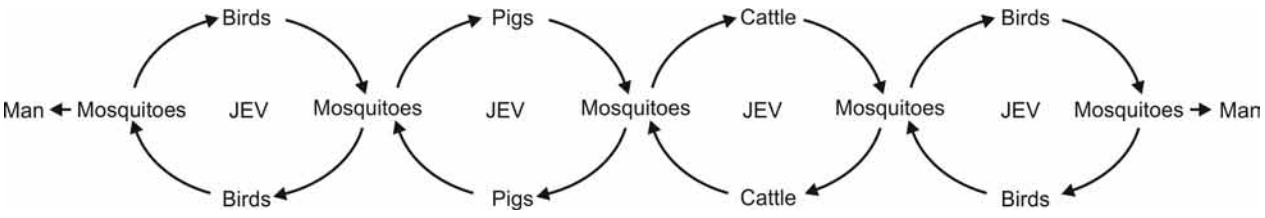


Fig. 20.50 Natural history of JE virus

there are about 300 to 1000 subclinical cases. Thus cases of JE constitute 'Iceberg disease'. There is no carrier state. Even the cases do not act as a source of infection, because of short period of viremia and low level of circulating viruses and thus there is nonavailability of the viruses to the mosquitoes from the peripheral blood. Thus eventhough infected human beings are the reservoirs, they are not the source of infection and only animals are the sources of infection.

Age incidence: Incidence of JE is high among children below 5 years. However, it can occur in any age group. Adults and elderly persons are immune because of repeated subclinical infection and development of immunity.

Sex incidence: Incidence of JE is minimally more among boys than among girls because of the outdoor movements and mosquito exposure. However, subclinical infections are equal in both the sexes.

Environment factors: Atmospheric temperature of about 20°C favors the virus and relative humidity of about 70 percent are favorable for the mosquitoes to survive longer.

Vectors: The chief vectors are culex group of mosquitoes. Important species being *Culex tritaeniorhyncus*, *Culex vishnui*, *Culex pseudovishnui*, *Culex gelidus* (Malaya) and *Culex pipiens pallens* (China). The first two are the chief vectors in India.

Some of the anopheline species have also been incriminated as vectors, the important species being *An. hyrcanus*, *An. barbirostis*, *An. tesselatus* and *An. subpictus*.

Biting habits: These vectors are mainly zoophilic and not anthrophilic (i.e. they feed mainly on blood of animals and not human beings). They feed mainly on pigs, cattle are only the next attractants. It is only accidentally, they feed on human beings and young children become the victims. These mosquitoes bite during night times and blood meal is a must for breeding.

Breeding places: Usually, the culex group of mosquitoes breed well in organically contaminated water like sewage. Whereas the culex mosquitoes of JE breed well in water collections with acquatic plants like water hyacinth, elephant-grass, pista plants, etc. Such waters are favorable for the mosquitoes to breed throughout the year. During monsoon months, the paddy fields constitute the best breeding place, because of submerged grasses. Water collections without acquatic vegetations are not suitable for larval development.

Extrinsic incubation period: It is 10 to 12 days. It is the period required for the viruses to multiply in the body of culex mosquito to reach an optimum number, when the vector is said to have become infective. Thus, there is propagative type of biological transmission. Once the mosquito becomes infective, it remains infective throughout its life. Whomsoever it bites, transmits the infection. The average lifespan of the mosquito is about 20 days. It can fly for 1 to 3 km. The course of events following the blood meal by the mosquitos is shown in **Figure 20.51**.

Mode of transmission: The disease is transmitted from animal to animal and birds and animal to man by the bite of female, infective, culex mosquito. Infection in man is because of close proximity with animal reservoirs, especially pigs. But the disease is not transmitted from person to person because of short period of viremia and low level of circulating viruses in the blood and also preference of vector mosquitoes for animal blood. Therefore, JE in man is a 'Dead end' infection (Blind end transmission).

Risk factors of JE outbreak: High density of culex mosquitoes; presence of amplifying hosts (pigs); paddy cultivation.

Pathogenesis: Having entered the body through the percutaneous route the viruses circulate in the blood for a short period. Since they are neurotrophic, they lodge in the brain resulting in encephalitis.

Incubation period: It is 5 to 15 days (1–2 weeks).

Clinical features: They are of meningoencephalitis. They occur in the following stages as follows:

- *Prodromal stage:* This is characterized by sudden onset of fever with severe headache, vomiting, bodyache, anorexia and malaise. This stage lasts for 1 or 2 days.
- *Acute encephalitic stage:* Fever becomes still higher, 103 to 104°F, associated with neck rigidity, vomiting, Kernick's sign positive, convulsions, altered sensorium, disorientation, state of confusion, become stuporous, develops coma and death supervenes. The child may die within about 8 to 10 days. The case fatality rate is about 40 percent, which becomes 80 percent during epidemics. Among those who recover, will develop sequelae, in the late stage.

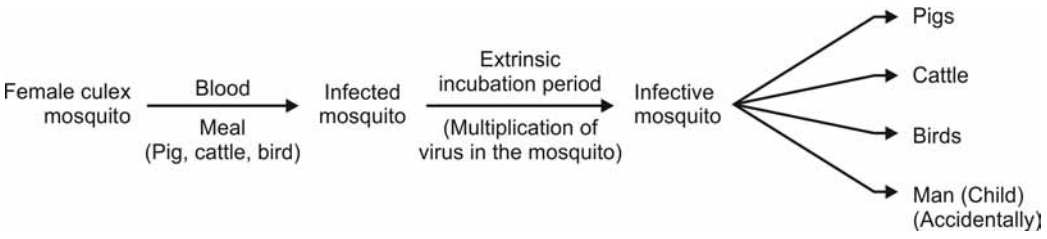


Fig. 20.51 Course of events in the mosquito following flood meal

- *Late stage and sequelae:* This occurs among those who recover. More than 50 percent of them develop neurological and psychological deficits. There will be amnesia, abnormal movements, ataxia, personality changes, emotional instability, abnormal emotional behavior, paralysis, etc.
  Laboratory findings: Polymorph leukocytosis in blood; CSF shows more of lymphocyte count, slight rise of protein and slight rise of sugar. A four fold rise in IgG antibody in the paired sera.

Management

There is no treatment. Only symptomatic and supportive treatment.

- Isolation in the hospital preferably in dark room, because the patient is sensitive to sensory stimuli.
- Expert nursing care is of supreme importance.
- Control of hyperpyrexia with cold sponge bath and antipyretics.
- Control of convulsions with anticonvulsants like diazepam.
- Reduction of cerebral edema with steroids and mannitol.
- Prophylactic broadspectrum antibiotics and maintenance of fluids and electrolyte balance.
- Follow-up of the patients by physiotherapy to prevent sequelae.

Prevention and Control

- *Elimination of reservoir:* This refers to only animal reservoirs and not human reservoirs because human beings do not act as a source of infection. The pigs and cattle are eliminated by construction of pigsties and cattle-sheds, at least 3 km (beyond the flight range of mosquitoes) away from the human habitations. This may help to some extent.
- *Breaking the channel of transmission:* This consists of control of vectors.

Antilarval measures

- *Physical method* is by improvement of sanitation (Source reduction) by means of deweeding of ponds, removal of submerged grasses, using herbicides (Shell weed Killer-D).
- *Chemical method* is by spraying larvicides such as abate, temephos in the concentration of 1 ppm in the breeding places.
- *Biological method* is by using larvivorous fish such as gambusia fish.
- *Biocide method* is by using *Bacillus sphaericus* and *Bacillus thuringensis*, which infect larvae and kill them.

Antiadult measures: Since the vectors are widely scattered, these measures consists of indoor and outdoor spraying with insecticides such as 5 percent malathion or fenitrothion. All the infected villages and uninfected villages within the radius of 3 km are covered.

- *Indoor spray:* Malathion is sprayed in the pigsties, cattle-shed and inside the houses, once in a fortnight for three fortnights.
- *Outdoor spray:* This consists of a technique called ULV-fogging (Ultra low volume), wherein the insecticide malathion is heated to vapor at high temperature in a special machine. The vapor after coming out of the machine, comes in contact with the moisture of cooler air and forms a fine fog or cloud of insecticide, which when comes in contact with the mosquitoes, destroys them. It is called 'Dry fogging' (If the droplets of the insecticide vapor are large, they fall on the ground, it is called 'Wet fogging,' which is not effective).

  There are two methods of outdoor spraying, namely Ground level thermal fogging (Ground level application technique) and aerial application technique.
- *Ground level application technique:* The special machine employed is called TIFA machine. It is fitted to the open jeep vehicle. When malathion is heated and vapors start coming out, the vehicle carrying the machine is driven slowly at a speed of 5 to 6 km per hour on the roads of the villages. The favorable time for fogging is early morning or late evening, because the air is cool and forms fine fog. The ideal atmospheric temperature is about 20°C. The output of the vehicle is about 130 liters of malathion per hour **(Fig. 20.52)**.

Safety Precautions

- The vehicle should carry one fire extinguisher.
- Gloves and masks should be used while handling the insecticide.
- Children should not be allowed to run behind the vehicle.
- *Aerial application technique:* This is done by using a special single engine, single seated monoplane air craft

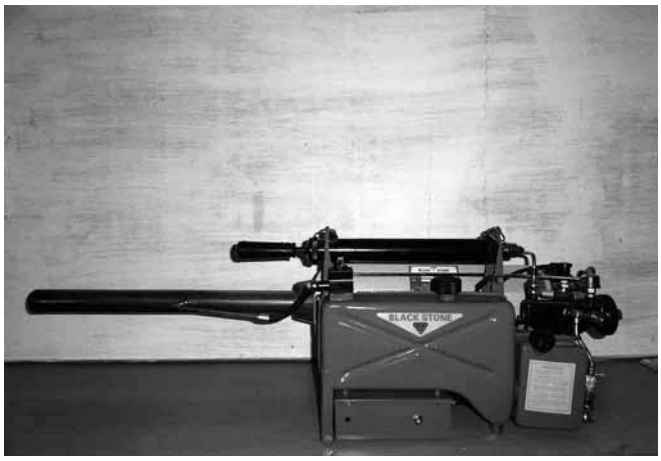


Fig. 20.52 TIFA machine

called 'Basant Agriculture Air Craft,' which is used for ULV-fogging over the paddy fields. It flies about 40 meters above the ground level, at a stretch for about 1½ hours without refueling. Three such applications, on 1st, 3rd and 12th day respectively, are necessary for satisfactory control of mosquitoes.

Instructions to the People

- People are informed about the purpose and timing of the aircraft treatment.
- They should keep all the doors and windows open so that the cloud of insecticide can reach mosquitoes resting inside the houses.
- They should cover the food and drinks as soon as they hear the sound of the air craft and for at least one hour after the application is completed.

The different machines available for ULV-fogging are:

- Fontan's (motorized Knapsack sprayer)
- LECO (Cold aerosol generator)
- TIFA–E 100
- ULV–aerial spray (Micronair Atomiser Equipment).

Protection of susceptibles: This is done by immunization. There is only active immunization and no passive immunization. There are two types of JE vaccines currently available, namely live attenuated, cell culture, freeze dried vaccine and mouse brain derived killed vaccine **(Table 20.21)**.

Other JE vaccines in advanced stages of development include:

- Chimeri Vax JE vaccine, a live, recombinant vaccine containing yellow fever 17D vaccine as backbone.
- IC 51 JE vaccine, an inactivated vaccine, derived from attenuated SA 14-14-2 JE virus strain grown on vero cells.
- Inactivated vero cell derived vaccine, derived from Beijing JE virus strain grown on vero cells.

Precautions to be taken before using live, SA 14-14-2 JE vaccine

- Past history of anaphylactic reaction to any vaccine.
- Auto-disable (AD) syringe only to be used.
- Not to use spirit for cleaning the skin before injecting.
- But to use only clean, hot water, cotton swab.
- Not to give the vaccine intramuscularly but only subcutaneously.

Note: Live, attenuated, lyophillised SA 14-14-2 JE vaccines are supplied with vaccine vial monitor (VVM), stucked up on the top of the cap of the vial. Once the cap is opened for reconstitution, the role of VVM ceases to exist. So before reconstituting the vaccine, it must be ensured that VVM is in an usable stage (i.e., the inner square should be lighter than the outer circle). If the inner square is matching or darker than the outer circle, it is not usable. VVM is same as in oral polio vaccine.

Once the cap is opened VVM becomes ineffective. So it is better to ensure that the vaccine is in the usable stage. If it is in the unusable stage as per VVM and if the date of expiry is over, then the vial should not be used.

Table 20.21 Differences between live JE vaccine and killed JE vaccine

	Live JE vaccine	Killed JE vaccine
Nature	Lyophillized using SA 14-14-2 strain of JE virus grown on vero cells (or primary Hamster Kidney Cells)	Lyophillized or liquid vaccine prepared from Nakayama strain (mouse brain inactivated vaccine)
Presentation	Single or five dose vial supplied with diluents	Single or ten dose vaccine
Primary course	Single dose 0.5 mL	Two doses of 1.0 mL (0.5 mL for < 5yrs) with 1–4 weeks interval
Route	Subcutaneously in (L) upper arm	Subcutaneously or intramuscularly
Booster dose	Not necessary	First booster dose after one year. Repeated booster doses are required
Schedule	Ideal at 9th month along with measles vaccine	Commence at 12th month of age
Manufacture	In China Used in India	In Korea, Taiwan, Thailand and Vietnam. Stopped in Kasauli (HP) India and in Japan
Use	To be used within one hour of reconstitution	To be used within 6 hours of reconstitution
Safety and efficacy	Safe and effective 1–3% develop pain 5–10% develop transient fever 95% effective	Less safe and effective 20% develop local reaction 1 in 1000 develop allergic reaction 80% effective
Storage temperature	2 to 8°C	2 to 8°C

Epidemiological Points

- JE is basically a zoonotic disease, but animals do not suffer.
- Usually rural, under-five children are at risk.
- Vaccine should be given preferably for under-five children (Infants need not be given.)
- It should be given during interepidemic period.
- It protects only those who are immunized.
- Efficacy of the killed vaccine is hardly 50 percent.
- Revaccination is recommended every 3 years.
- For immunization to be effective, coverage should be 80 to 90 percent.
- Vaccine is expensive and supply is limited.
- Most of the population are subclinically infected and protected.
- The cost effectiveness and feasibility are not in favor of immunization.
- Anti-mosquito measure is the only step for the control of the disease.

Case Definition

- **Suspect case**
  - High grade fever of acute onset with at least two of the following
  - Decrease in level of consciousness independent of convulsions
  - Significant change in mental status either in behavior or personality
  - Convulsions
  - Asymmetrical.
- **Probable case**
  - Suspected case of JE
  - Additional case/cases in the same village
  - With or without signs of meningeal irritation and varying degree of neurological deficits
  - Asymmetrical
- **Confirmed case**
  - High IgM antibody titer
  - Fourfold rise of IgG antibodies in paired serum samples.

CHIKUNGUNYA FEVER (EPIDEMIC POLYARTHRITIS)

It is an acute infectious disease, caused by chikungunya virus, transmitted by the bite of infective, female, *Aedes* mosquito. Clinically characterized by sudden onset of fever associated with chills, severe myalgia, malaise, polyarthralgia and often associated with rashes with or without mild itching. Case fatality is almost nil.

It is an urban disease resembling dengue, seen mainly in Africa, Pakistan, Indian sub-continent, South-East Asia and Philippines. Chikungunya fever was first described in an epidemic form in East Africa in 1952-1953.

In India, epidemic has occurred in Karnataka, Maharashtra, Tamil Nadu and Andhra Pradesh during March 2006 to August 2006.

The code according to ICD is A 92.0 (ICD = International Classification of Diseases).

Causative Agent

The organism is Chikungunya virus (Buggy Creek Virus). It belongs to Group A arboviruses, family Togaviridae, genus *Alpha-virus*. It is spherical, enveloped, virion of 60 nm in diameter, single stranded, RNA-genome. It is killed by common disinfectants, moist heat and drying.

Reservoir

It is a disease of human beings only. There is no animal reservoir. There is no carrier state also.

Mode of transmission: The disease is transmitted from person to person, by the bite of infective, female, *Aedes* mosquito. There is no evidence of direct transmission from person to person. Epidemics are sustained by human–mosquito–human transmission, similar to that of dengue and urban yellow-fever.

Vector

Chief vector is *Aedes aegypti* (Culicine group).

Breeding place: *Aedes aegypti* breeds in water collected in containers like tumbler, coconut-shell, bottles, broken tins and cans, tree holes, air-coolers and such others in and around the houses.

Biting time: They bite (female *Aedes*) during early hours of the morning 6 am to 9 am and in the evening 3 pm to 6 pm. They are aggressive day biters.

They hide underneath the cots, tables and other furnitures.

Extrinsic Incubation Period

It is the time required for the viruses to undergo multiplication and reach an optimum number, when the infected mosquito is said to have become infective. Extrinsic incubation period is 10 to 12 days. Since the virus undergoes only multiplication, and no cyclical development, it is a propagative type of biological transmission. Once the mosquito becomes infective, it remains infective throughout its life, whomsoever it bites, transmits the disease. This is how several members of the same family are simultaneously affected.

The lifespan of the mosquito is about 3 weeks.

Clinical Features

Incubation period is 1 to 2 weeks (Av = 4–7 days).

Clinically characterized by sudden onset of chills and fever (103–104°F) headache, nausea, vomiting and severe muscular and joint pains (significant myalgia and polyarthritis). The joints of the extremities in particular become swollen and painful to touch. The person becomes disabled. Fever is followed by maculopapular rash and often buccal and palatal enanthema. Hemorrhage is rare. Mortality is rare.

It is a self-limiting viral disease. All but few recover within 5 to 7 days. Some will have persistent myalgia and arthralgia for several weeks to several months.

Children may display neurological symptoms.

The name 'Chikungunya' comes from the word 'Swahili' meaning 'that which bends up,' referring to the stooped posture the victims adopt to relieve the joint pains of this disease.

Immunity is long lasting.

Management is by symptomatic treatment with analgesics, antipyretics, antihistaminics and bed-rest.

Prevention and Control

This is done mainly by the control of *Aedes* mosquitoes. (explained under entomology) and health education of the people about the following points:

- To maintain the sanitation in and around the house
- To remove the water containers if any
- To keep the air cooler clean and dry once a week and to remove the water if not used
- To use mosquito curtain, if habituated to sleep in the afternoon or apply mosquito repellants.
- To observe 'Dry day' once a week. This breaks the life cycle of the mosquito (the vessels containing water should be emptied on every 5th day).

KYASANUR FOREST DISEASE

Kyasanur forest disease (KFD) is an acute, communicable disease, caused by an arbovirus, basically a zoonotic disease, mainly that of monkeys, transmitted to human beings accidentally by the bite of infected hard ticks. Clinically it is characterized by fever, extreme prostration, red shot eye followed by hemorrhages. Case fatality is about 5 to 10 percent.

History

This disease was first recognized during 1956 to 1957, when there was a report of abnormal death of monkeys in Kyasanur forest area, of about 800 sq miles, of Sagar-Sorab taluks of Shimoga District of Karnataka state, followed by epidemic of this disease among the people living in the villages surrounding the Kyasanur forest, resulting in about 500 cases with a case fatality of 10 percent. The virus was isolated in 1957. Largest epidemic occurred in 1983, with 2167 cases and 69 deaths.

Another epidemic occurred on 19th Feb 2001 and about 50 people of the villages under Narasimharajapura and Koppa taluks of Chickamagalur district had been affected, proving the extension of the disease to adjacent district.

During 1956, it was thought to be yellow fever. Very soon it was excluded because of the absence of jaundice. After isolation of the virus, it was named after the forest as KFD virus and the disease as KFD. How the disease was originated in that area is not known. But since then it has remained confined to the forest areas only.

There are five tick borne viruses namely KFD-virus of Karnataka, Langat virus of Malaysia, Louping ill virus of British isles, OMSK hemorrhagic fever virus of USSR and Powassan virus of Canada. All these viruses belong to the same group under Flavi-virus group of Togaviridae family.

There is no evidence that KFD virus occurs in other countries. Similarly the other related viruses, reported in other countries are not reported from India.

Recently cases of KFD have been reported from Thirthahally of Shimoga district and Belthangadi of South Canara. Thus the disease is now restricted to Shimoga, North Canara, South–Canara and Chickamagalur districts. The disease continues to be a silent enzootic in these areas, with periodical epidemic because of deforestation.

Agent Factors

Agent: KFD virus belongs to Castle's Group B arbovirus, family togaviridae and genus *Flavivirus*. It is a RNA virus, 25 to 40 mμ in diameter, closely related to other arboviruses. It is easily destroyed by heat and chemicals like ethyl ether and sodium desoxycholate. It stimulates the production of neutralizing (N), hemagglutination inhibition (HI) and complement fixing (CF) antibodies. N and HI antibodies circulate for longer period (2 years) than CF antibodies. N antibodies are more specific in diagnosis.

Reservoir of infection: There are both human and animal reservoirs.

Animal reservoirs: The natural hosts are the small mammals of the forest such as rats, squirrels and shrews. They are the main reservoirs. The practice of cattle being taken to the forest for grazing, provides ample opportunity to the ticks to feed upon the cattle, resulting in population explosion of ticks in the forest, which in turn began spreading the disease over a large area of Kyasanur forest and its adjoining villages. An increase in tick population resulted in the proportionate increase in the viral population. Thus cattle play an important

role in the natural history of the disease, by maintaining the tick population.

Birds and bats are less important hosts. The wild monkeys are recognized as amplifying hosts for the virus, but they are not effective in maintaining the host status because they die from the infection. Two species of the monkeys, which inhabit these forests are bonnet monkey (white faced, *Macacca radiata*) and langur monkey (black faced, *Presbytic entellus*); Mortality is higher among langur monkeys.

1. Small mammals are the natural hosts and main reserviors.
2. Cattle help in increase of the tick population, thereby facilitates increase of viral population.
3. Monkeys act as amplifiers hosts but they don't maintain host status because they die.
4. Human reservior are only accidental hosts. But they do not act as a source of infection because of short period of viremia.

Human reservoir: Man is only an accidental host. Since the human reservoirs have a very short period of viremia, affected persons do not act as a source of infection. Thus, human reservoirs play no part in virus transmission.

Host Factors

Age incidence: Incidence is high in the age group of 15 to 40 years, because of the increased risk of exposure.

Sex incidence: Incidence is more among men than among women, because of the increased risk of exposure.

Occupation: Eventhough KFD is not an occupational disease, the incidence is high among those, who have been entering the forest because of wood cutting, for grazing the cattle or cultivating the lands, hunting, etc.

Season: January to June. This period coincides with the activity of the nymphs of the hard ticks and the human activities in the forests.

Predisposing factors: They are deforestation activities, allowing free roaming of cattle for grazing, expansion of rice cultivation, hunting in those forests, etc. In this interface, between the forest and the human dwellings, is colonized by a kind of dense bush, called, lantana thicket, which is a good resting place for the vectors.

Vectors: The vectors of KFD are hard ticks, belonging to the Family—Ixodidae, Class-Arachnida, Phylum–Arthopoda. The important species are *Haemaphysalis spinigera*, *H. turturis, H. papuana, H. Karbnuriensis, H. kinneri, H. minuta, H. wellington* and *H. bispinosa*, the first two being the chief vectors.

Recently, viruses have been isolated from the soft ticks also (?).

Habitat: It is the bushes of lantana–thicket and is zoophilic. They always live in these cool atmosphere and shady areas. Eggs are laid on the ground, one by one in groups. They hatch after 30 days. The larva which resembles the adult has only three pairs of legs. It is called 'seed tick'. This stage lasts for 6 weeks to 2 years. The next stage is 'Nymph,' which has four pairs of legs and lasts for about six weeks. Then develops into adult. Life cycle is 'incomplete metamorphosis'. There is propagative type of biological transmission.

Life Cycle

The special feature is that the vector has different hosts in different stages of life cycle, for its blood meal, such as:
M—Monkeys and small mammals (rats, squirrels, etc.)—during larval stage.
H— Human beings—during nymphal stage,
M—Monkeys, human beings, cattle—during adult stage **(Fig. 20.53)**.

Extrinsic incubation period: It is 10 to 14 days.

Mode of transmission: The disease is transmitted from monkeys to monkeys by the bite of infective adult, hard ticks and from monkeys to man by the bite of nymphs. After getting infection, that infected person does not initiate the urban cycle because these nymphs cannot tolerate and survive in higher temperatures of human dwellings. They live only in cool and shady areas of the forests to grow into adult stage. Thus the disease is not transmitted from person to person. Therefore, KFD is a dead end infection.

Incubation Period

It is about 1 week.

Clinical Features

There is sudden onset of fever, headache, and severe myalgia, followed by severe prostration (i.e. marked loss of strength, exhaustion). The acute phase lasts for about 2 weeks. In severe case, there is vomiting, diarrhea, followed by hemorrhages such as conjunctival congestion, ('blood-shot' eyes), epistaxis, gingival bleeding, hematemesis, malena and uterine bleeding among women.

Some cases show biphasic course of illness. During the second phase of illness, after afebrile period of 1 to 3 weeks, some patients exhibit symptoms of meningoencephalitis, characterized by high fever, severe headache, vomiting, neck-rigidity, tremors, abnormal reflexes and mental disturbances. There are associated hemorrhagic manifestations also. Case fatality rate is 5 to 10 percent.

Recovery is almost complete in 90 percent of the cases, but the patient remains asthenic for quite a long time. Convalescence is slow.

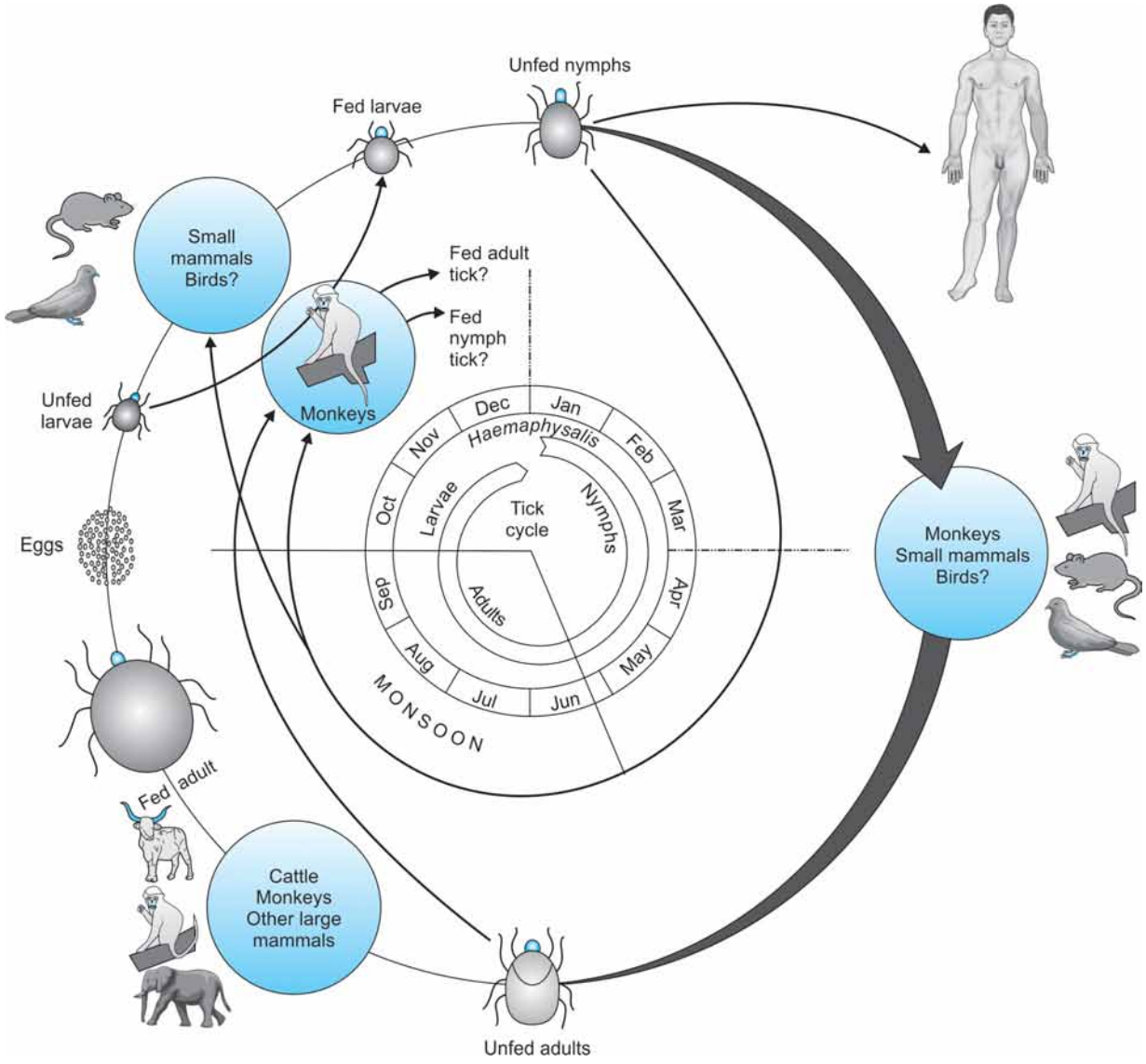


Fig. 20.53 Natural cycle of Kyasanur forest disease

Investigations

- Blood for culture of the virus
- Serological tests
- Thrombocytopenia
- Leukopenia
- Urine is positive for albumin.

Management

- Good supportive treatment
- Blood transfusion if necessary
- Prophylactic antibiotics.

Prevention and Control

- **Elimination of reservoirs:** Since there is no specific treatment, human reservoir state cannot be eliminated and elimination of wild monkeys is not possible. Thus, it is not possible to control KFD by elimination of reservoir.
- **Breaking the channel of transmission:** This measure consists of control of ticks. This is done by two ways:
  1. By using insecticides such as carbaryl, fenthion or propoxur. Application can be made by power equipment or aircraft mounted equipment. Spraying is done in 'hot-spots' (i.e. areas where monkey deaths are reported).

2. By restriction of entry of cattle into the forest will also control tick population.

- **Protection of susceptibles**
- **Use of repellants:** The people at risk are educated to protect themselves from tick bites by adequate clothing, and also application of repellents such as Dimethyl phthalate, DEET, Replex ointment, etc.
- **Immunization:** A killed KFD vaccine is being prepared at Virus Research Center, Pune. It is a formalin inactivated, tissue culture vaccine, prepared from chick embryo fibroblasts. 2 doses, each of 1 mL is recommended with an interval of 4 weeks for adults and 0.5 mL for children, I.M^{ly}. It is given for those people in that area who are at risk. Immunity lasts for 1 year. Booster doses are given every year. It is 50 percent effective, being a killed vaccine. Storage temp is 2 to 8°C.

RICKETTSIAL DISEASES

These are febrile exanthematous diseases, caused by the microorganisms of the family *Rickettsiaceae*. They are small, gram negative, intracellular, parasites of arthopods, exhibit pleomorphic appearance either as cocci or bacilli, seen in singles, pairs, short chains or in filaments.

Basically all the rickettsial diseases are zoonotic diseases (except Q-fever), transmitted through vectors, to the human beings. Human infections result from either by bite or contamination with its feces.

In the arthopods the rickettsiae grow in the gut lining and in the humans, they grow in the endothelial cells of small blood vessels, producing vasculitis, cell necrosis, thrombosis of vessels, rashes and organ dysfunction.

The different rickettsial diseases, the causative agents, the vectors and the reservoirs are shown in the **Table 20.22**.

EPIDEMIC TYPHUS

It is also called Louse-borne typhus. It is caused by *Rickettsia prowazekii*, a parasite of the body louse. The parasite is ingested by the louse when feeding on an infected person, multiplies in the gut and passes out in the feces after 5th day. The organisms are capable of living in the dry feces of the louse also.

Man gets the infection by three ways:

- Contamination of the wound or abrasion of the skin (due to itching) by the feces containing the organisms or by the body fluid after crushing the louse.
- Contact of the conjunctiva of the eye by the dried infected feces of the louse.
- Inhalation of the dried, infected, feces of the louse.

These organisms can remain viable in the dry feces for about four months.

The disease transmission is more during famine, wars, overcrowding conditions, etc. The infected louse also suffers and dies on the tenth day.

Incubation period is about 12 days.

Clinically it is characterized by sudden onset of fever associated with headache, malaise and prostration. Macular rashes appear on 5th day, on trunk and axilla, spreads to the rest of the body sparing face, palms and soles. Circulatory disturbances like hypotension, cyanosis can occur.

Diagnosis is confirmed by complement fixation test, Weil Felix reaction and Indirect Fluoroscent Antibody (IFA) test. Treatment is by tetracycline. If not diagnosed early and not treated, fatality rate is as high as 50 percent.

Table 20.22 The rickettsial diseases, their causative agents, their vectors and their reservoirs

Diseases	Rickettsial agent	Vector	Reservoir
• Typhus group			
– Epidemic typhus	*Rickettsia prowazekii*	Louse	Humans
– Endemic typhus	*R. typhi*	Rat flea	Rodents
– Scrub typhus	*R. tsutsugamushi*	Mite*	Rodents.
• Spotted fever group			
– Indian tick typhus	*R. conorii*	Tick*	Rodents, dogs.
– Rocky mountain spotted fever	*R. rickettsii*	Tick*	Rodents, dogs
– Rickettsial pox	*R. akari*	Mite*	Mice
• Others			
– Trench fever	*R. quintana*	Louse	Humans
– Q-fever	*Coxiella burnetii*	Nil	Cattle, sheep, goats

* These vectors also serve as arthropod reservoir, by maintaining the rickettsiae through ovarian transmission.

Recrudescence of the disease several years after the primary attack, it is called 'Brill Zinsser' disease.

Prevention and Control

- Delousing the infested person with application of 10 percent DDT as dusting powder, to be repeated, weekly for 3 to 4 weeks.
- Steam disinfestations of all the clothes.
- High standard of personal hygiene to be maintained by daily bath.

ENDEMIC TYPHUS

It is also known as 'Murine typhus'. It is a disease of rats. It is an acute febrile disease, caused by *Rickettsia mooseri*, transmitted from rat to rat and rat to human beings by the bite of infective rat-flea, *Xenopsylla cheopis*. It is mainly transmitted through the contamination of the wounds or abrasions by infected feces of fleas. Infection may also take place through inhalation of dry infected feces.

The infection in the rats is inapparent, long lasting and nonfatal.

Incubation period is about 1 to 2 weeks.

There is gradual onset of fever with mild prodromal symptoms, such as headache, bodyache, nausea and vomiting. Rashes appear on 3rd or 4th day on the trunk and fade rapidly. Clinical features resemble those of epidemic typhus but less severe. Usual course of the illness lasts for about 10 to 12 days. Rarely, it becomes severe.

Weil Felix reaction with proteus OX-19 becomes positive during second week.

Tetracycline is the drug of choice. Dose is 500 mg three times a day for 1 week.

Vaccine is not available.

Control of the disease is by control of rat-fleas, by using insecticides (BHC, Malathion) and cyanogas fumigation of the rat-burrows.

SCRUB TYPHUS

This is the most widespread disease of all the rickettsial disease in India. Basically, it is zoonotic disease, the chief reservoir being certain species of trombiculid mites such as *Leptotrombidium akamushi* and *L. deliensis*. The disease is caused by *R.orientalis*. Clinically, the features are the same as that of epidemic typhus. Generalized lymphadenopathy and lymphocytosis are common. Characteristic feature is a punched out ulcer (eschar) covered with a black scab at the site of bite. The Weil Felix reaction is strongly positive.

The infection is maintained in the nature transovarially from one generation of mite to the next generation. The larva of this mite bites only once during its life time. Rat gets infected with *R. orientalis*. When the infected rat is bitten by the larva, the infection is passed through the nymph, imago and adult stages. The *R. orientalis* enters the eggs even before they are laid and then goes to the larva of next generation, which transmits the disease. This method of transmission is called 'Transovarian transmission'. Man gets the infection accidentally when bitten by the infected larva. Thus the infection contracted in the larval stage can only be transmitted in the next larval stage. The larva is also called 'Chigger'. Thus the larval stage serves both as a reservoir and as a vector for infecting humans and rodents.

The disease is not directly transmitted from person to person.

Incubation period is about 1 to 3 weeks.

Tetracycline is the drug of choice. Dose 500 mg three times a day for 1 week.

Control of vectors is by clearing the vegetation (grass) around the human dwellings and out-door application of 10 percent DDT or BHC dusting powder on grasslands, will control larva, nymph and adult stages of this mite.

Personal prophylaxis is by application of repellents like DEET, DET to the skin and impregnation of cloths and blankets with miticidal chemicals like benzyl benzoate.

Presently no vaccine is available.

INDIAN TICK TYPHUS

It is an acute, febrile, exanthematous disease, caused by *Rickettsia conori*. The chief reservoir is the tick. The organisms are maintained in the nature among rodents, dogs and other animals. Man is only an accidental hosts. The disease is transmitted by the bite of infected hard tick. Not only it is a chief reservoir but also a chief vector in transmitting the disease. It is infective in all stages of its life cycle and remains infective for life (about 18 months). Various species of ticks have been incriminated as vectors, such as *Rhipicephalus, Ixodes, Boophilus, Haemaphysalis,* etc.) The pathogens are also transmitted from one stage of the life cycle to another stage (i.e. transstadial transmission) and also to next generation through ovaries (i.e. transovarian transmission).

Incubation period is about 1 week. Clinically, it is characterized by sudden onset of fever, lasting for about 2 to 3 weeks. On examination, eschar is seen at the site of bite. Maculopapular rashes appear on 3rd day, first on the extremities (ankles and wrists), spreads centripetally (unlike in other rickettsial diseases) and cover the whole body.

Tetracyline is the drug of choice for the treatment. 500 mg thrice a day for 5 days constitutes the course.

Prevention is by disinfection of pet animals to control tick population and by health education of the people about mode of transmission and personal prophylaxis.

ROCKY MOUNTAIN SPOTTED FEVER

It is also an acute febrile disease, caused by *Rickettsia rickettsiae*, reservoir being the ticks and rodents. Man is only an accidental host. Disease is transmitted by the bite of tick, all stages in its life cycle is infective. Clinical features are the same as those in Indian tick typhus fever. Control measures are the same as above.

RICKETTSIAL POX

It is also an exanthematous, febrile disease caused by *R. akari*, a disease of rats, transmitted by the bite of infective mite. Transovarian transmission occurs in the mite. Clinically, it is characterized by fever lymphadenopathy, eschar at the site of bite and rashes resembling those of chickenpox. Control of the disease is by control of rats.

TRENCH FEVER

It is also an acute, febrile, exanthematous disease, caused by *R. quintana*, reservoir being man, transmitted by the bite of infective louse. Clinically, characterized by fever, rashes and spleenomegaly.

The disease is limited to central Europe. It used to occur among those people, who were staying in the trenches for days together during war time. Hence the name trench fever.

The organisms remain viable in the dry feces of the louse for a period of about two years. Hence man gets the infection in the same ways as in epidemic typhus. The infected louse does not suffer from the infection of trench fever unlike in epidemic typhus.

Control is by delousing and personal hygiene.

Q-FEVER

It is an acute, febrile disease, caused by *Rickettsia burnetii* (It is now called *Coxiella burnetii*). Primarily it is a zoonotic disease, disease of herbivorous animals like sheep, goat and cattle, transmitted through the feces, milk and meat. Clinically it is characterized by fever with chills, associated prodromal symptoms. The infection may result in pneumonia, hepatitis, encephalitis and even endocarditis.

Q-fever differs from other rickettsial diseases in that there is no arthropod involved in the transmission of the disease, there are no rashes on the body during illness and Weil Felix reaction is negative.

Man gets the infection from infected herbivorous animals. The animals shed the disease agent in the urine, feces, and milk. Placenta also contains pathogen, which create infectious aerosols during parturition. Meat also contains pathogen. Thus transmission occurs in three ways:

1. From inhalation of infected dust from the soil contaminated by the urine or feces of the infected animal.
2. Through ingestion of contaminated milk or meat.
3. Percutaneously through the abrasions of the skin.

Tetracycline, 500 mg three times a day for 5 days cures the disease.

Prevention and Control Measures

- Pasteurization or boiling of the milk and meat hygiene.
- Sanitation of the cattleshed.
- Disinfection and disposal of the wastes of the cattle, sheep and goats.
- Inactivated coxiella vaccine is given for those who are at risk.

BIBLIOGRAPHY

1. Chatterjee KD. Parasitology in Relation to Clinical Medicine. 17th edn. 1969.
2. Directorate General of Health Services. Lymphatic Filariasis. Morbidity Management, Community Based Approach. Training for Medical Officers, NICD, New Delhi.
3. GOI. A Guide to Malaria and its Control for PHC Medical Officers of Karnataka. Regional Office for Health and Family Welfare, MOHFW, Bangalore, 1999.
4. GOI. Guidelines for the Treatment of Dengue Fever/Dengue Hemorrhagic Fever in Small Hospitals. Malaria and Filaria Division, DOHFW, New Delhi.
5. GOI. Japanese Encephalitis in India. DGHS. New Delhi.
6. GOI. National Anti-Malaria Programme. Directorate of National Anti-Malaria Programme, MOHFW, New Delhi, 2002.
7. ICMR Bulletin. Prospects of Elimination of Lymphatic Filariasis in India. New Delhi. Vol 32: No 5 & 6; May–June 2002.
8. Manson Bhar. Manson's Tropical Diseases. 18th edn.
9. NICD. Operational Manual—National Filariasis Control Programme, New Delhi, 1979.
10. Rural Medicine: Dengue an overview. IJ Rural Health Care. 2012;1(2):94–5.
11. Senior Regional Director. National Anti-Malaria Programme; Malaria Treatment Chart. Regional Office for Health and Family Welfare, Bengaluru.
12. WHO. Dengue Hemorrhagic Fevers. Diagnosis, Treatment and Control. Geneva, 1986.
13. WHO. Plague WHO Chronicle. 1970;24:373.
14. WHO. Prevention and Control of Yellow Fever in Africa. Geneva, 1986.
15. WHO. Tech Rep Ser. No. 359, 1967.
16. WHO. Tech Rep Ser. No. 553, 1974.
17. WHO. Tech Rep Ser. No. 674, 1982.
18. WHO. Tech Rep Ser. No. 682, 1982.
19. WHO. Tech Rep Ser. No. 701, 1984.
20. WHO. Tech Rep Ser. No. 702, 1984.
21. WHO. Tech Rep Ser. No. 721, 1985.
22. WHO. Tech Rep Ser. No. 721, 1985.
23. WHO. Tech Rep Ser. No. 736, 1986.
24. www.path.org/_/file_JE_vaccine_at_a_glance.
25. www.who.int/vaccine-safety/topics/japanese_encephalitis/en/index/html

SEXUALLY TRANSMITTED INFECTIONS

Sexually transmitted infections are a group of diseases transmitted usually by sexual contact and caused by a wide range of pathogens and clinically characterized by mainly three different syndromes–urethral discharge, vaginal discharge and genital ulcer. Some are curable while others can only be controlled.

Previously, the STDs were called 'Venereal Diseases' (VDs). The adjective 'Venereal' is derived from the word 'Venus,' meaning the 'Goddess of Love' in Egypt. In view of the social stigma, attached to the label VD, WHO rephrased in 1974, the nomenclature from VD to STD. The current terminology is sexually transmitted infection (STI), since 1999, as it incorporates asymptomatic infections also.

STIs constitute an important public health problem because of their health, social and economic consequences. The health consequences occur mainly among women and children such as cervical cancer, pelvic inflammatory disease with resultant infertility, ectopic pregnancy and congenital infections such as syphilis, ophthalmia neonatorum, HIV and hepatitis B and also stillbirths and prematurity. The social consequences are the stigma being attached to it and discrimination falls predominantly on women. The economic consequences are the loss of productive life years, affecting the progress and development of the country. Moreover, it is now firmly established that presence of STI can increase the risk of getting HIV 6 to 10 folds. This has added an element of urgency to the problem of STD control.

EXTENT OF THE PROBLEM

STIs are the global problem. The true incidence of STIs is difficult to estimate because of under reporting as well as due to the secrecy that surrounds them.

Under reporting is due to following reasons.

- The disease is concealed by the patient because of stigma and shame.
- The disease is often not diagnosed properly.
- Taking self and incomplete treatment by the patients.

WHO estimates that at least 333 million new cases of STD other than HIV occurred in 1997, globally. On an average, 900,000 people are believed to be infected each day. Ninety percent of them occur in developing countries.

In India, the annual incidence of STI is estimated to be about 5 percent of population (approximately 50 million infections annually) and it is on the increase, because of the changes in the lifestyle (i.e. one out of 20 sexually active Indians has STI).

Table 20.23 Classification of STI agents and diseases caused by them

Agents	Diseases
Bacteriae (including spirochetes) *Treponema pallidum, Haemophilus ducreyi, Neisseria gonorrhoeae*	Syphilis, Yaws, Pinta. Chancroid (Soft sore) Gonorrhea, Urethritis, Cervicitis, Epididymitis, Salpingitis, PID, Ophthalmia neonatorum.
Calymmatobacterium granulomatis	Donovanosis (Granuloma inguinale)
Chlamydia trachomatis (L_1, L_2, L_3)	Lymphogranuloma venereum (LGV)
Chlamydia trachomatis (D to K)	Nongonococcal Urethritis (NGU) Cervicitis
Mycoplasma hominis	NGU
Ureaplasma urealyticum	NGU
Shigella spp.	Proctocolitis (due to anal sex)
Campylobacter spp.	Proctocolitis (due to anal sex)
Bacterial vaginosis–associated organisms	Bacterial vaginosis
Group B streptococci	Vaginitis, Urethritis, Cervicitis, Balanitis, Cystitis
Viral agents Human (alpha) herpes virus 1 and 2	Herpes genitalis
Human (beta) herpes virus 5	Cervicitis, NGU
Hepatitis B virus	Serum hepatitis
Human papilloma virus	Genital warts
Molluscum contagiosum virus	Genital molluscum contagioum
Human immunodeficiency virus (HIV)	AIDS
Protozoal agents *Entamoeba histolytica*	Amoebiasis
Giardia lamblia	Giardiasis
Trichomonas vaginalis	Trichomoniasis (vaginitis)
Fungal agents *Candida albicans*	Vaginal candidiasis
Ectoparasites Pthirus pubis	Pubic pediculosis (It is not a disease but infestation)
Sarcoptes scabiei	Genital scabies

Agent Factors

Agent

There are about 25 pathogens responsible for sexual transmission of various diseases from person to person. Most of them require a break in the epithelium to enter the body

and such a trauma readily occurs during sexual contact and thus the infection is transmitted from the infected partner to healthy partner. The disease agents and the diseases caused by them are grouped as follows **(Table 20.23)**.

Host Factors

Age: The incidence of STI is found to be highest in the age group of 20 to 30 years, followed by 15 to 19 years and above 30 years.

Sex: The incidence is more among men than among women in developing countries. However, severity is more among women. But it is same in developed countries.

Marital status: It is high among unmarried (single), divorced and separated individuals than among married couples.

Socioeconomic status: People of lower-economic status are more affected.

Occupation: Incidence is high among commercial sex-workers.

Social Factors

STI is called as a social disease because of the prevalence of social factors, as follows:

Prostitution: A prostitute acts as a reservoir of infection. They are now called as commercial sex workers (CSWs).

Poverty: The extreme poverty in the family predisposes the girls to go astray and become prostitutes. The prostitution in turn becomes an occupation for easy money.

Illiteracy: Illiteracy associated with emotional immaturity predispose the girls to become easy victims of STI.

Polygamy: Polygamy (One person having many wifes) still practiced in some tribal areas, predisposes for the prevalence of STIs.

Polyandry: Polyandry (One woman having many husbands) is also responsible for the increased prevalence of STDs. Some women change their husbands.

Broken homes: In families, where there is death or divorce of the parents, the children are likely to go astray in avenues of pleasure, predisposing to STI.

Sexual disharmony: Among married persons due to strange relation, predisposes them to become victims of STI.

Social disruption: Like famine war, floods and such other disasters favor the spread of STDs.

Social stigma: Attached to STDs associated with shame, accounts for non detection of cases, not disclosing the sources of contact, taking incomplete self treatment, lead on to increased prevalence of STIs.

Co-education and co-work: Also foster casual sexual relationships.

Demographic Factors

Like industrialization, urbanization, migration of the people to urban areas for seeking an employment, eruptions of slums, isolation from the family also foster casual sexual relationships, as among long distance truck drivers.

International Travel

In these days of jet travel, there has been rapid spread of STIs internationally. HIV/AIDS is the current pandemic in the world.

Changes in the Lifestyle

Specially alcoholism increases the desire of sex and encourages prostitution, which in turn increases the sale of alcohol.

The present youths want relaxation of moral and cultural values. They want freedom from supervision and equal rights for both the sexes.

High-risk Groups

Those who spend long days away from home like seafarers, defence personnel, immigrants, refugees, labor class, tourists, professional travelers, and such others. Others who are also at risk are truck-drivers, commercial sex-workers, homosexuals, hotel staff, convicts of law and order, call-girls, etc. These high-risk groups are identified as 'core population groups', from the point of view of transmission, prevention and control of STDs **(Fig. 20.54)**. All the above mentioned socio-psycho-economic factors are identified as 'risk-factors' or 'markers' of STDs.

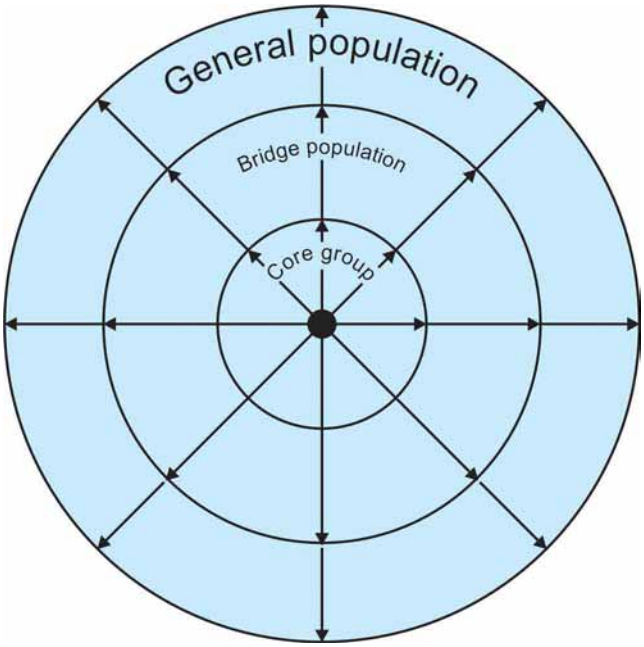
Prevention and Control

- Elimination of reservoirs.
- Breaking the channel of transmission.
- Protection of the susceptibles.

Elimination of Reservoirs

Elimination of reservoirs is by case detection, and complete treatment.

A. *Case detection*: Early case detection is of supreme importance. More number of cases can be detected by the following procedures.
   a. *Screening:* This mainly consists of high-risk (selective) screening, i.e. screening of core-population groups, because STIs constitute the iceberg phenomenon. All these high-risk population are examined



Core group includes:
CSWs (commercial sex workers), homosexuals, callgirls, drugs users, hotel staff

Bridge population includes:
Clients of CSWs, STI patients, refugees, migrants, partners of drug users

Fig. 20.54 Model of waves in spread of HIV/STI epidemics

clinically and also by relevant laboratory investigations, because they are apparently healthy individuals. Screening should also be done for other groups such as blood donors and antenatal mothers.

b. *Contact tracing:* This means tracing the sexual partners (contacts) of diagnosed STI patients by rapid means such as telephone or mobile phone or telegram to identify before completion of the incubation period preferably and persuaded to attend to STI clinic, for examination and treatment, so that they are made non-infectious. This is one of the best methods of controlling STDs. This procedure is difficult but not impossible in Indian setup. The success depends upon gaining the confidence of the patient.

c. *Cluster testing:* In this procedure the diagnosed STI patient is asked to give the names and address of other persons, of either sex, who move in the same socio-sexual environment, because 'birds of the same feather floc together.' Such persons are screened for STI. This procedure helps in detection of more number of cases, as among homosexuals, CSWs.

B. *Case holding and treatment:* This means giving the treatment correctly, completely and confidentially. This is the main stay of STI control. There is a tendency among such patients to drop-out before the treatment is complete and such persons become 'repeaters.' Therefore follow-up of such patients is essential through outreach activities of STI clinic and is an important work of medico-social worker of STI clinic. Administration of full therapeutic dose of treatment to the contacts or to the recently exposed persons, even before getting the results of investigations, is referred to as 'Epidemiological treatment' or 'Contact treatment.' It is also highly effective and is the key-stone of STD control.

Breaking the Channel of Transmission

Complete abstinence from sex is the best way to prevent STIs but this is impractical.

Protection of the Susceptibles

That is practice of 'safe-sex.'

- Having a faithful sexual partners
- Practicing monogamy
- Using condom, if the sexual partner is more than one
- Condom to be used correctly, continuously and consistently (i.e. one condom for every act of sexual inter-course).

Other Measures

- Sex education of the people
- Education to alter their sexual behavior
- At present, no vaccine is available, except for serum hepatitis.
- Establishment of STI-clinics for early diagnosis, prompt treatment (including laboratory facilities), contact tracing, cluster testing and follow-up, in all the urban areas, preferably separate clinics for men and women.
- Implementation of legislative measures to abolish prostitution and also to encourage patients to seek

early treatment and help in contact tracing and cluster testing. The current Act implemented is Immoral Traffic (Prevention) Act, 1986 [This was previously called Suppression of Immoral Traffic Act, 1956 (SITA)]. The Act covers all persons (males and females), who are exploited sexually for commercial purposes. The offences are also liable for severe punishment.

- Implementation of Social Welfare measures (Social therapy) such as:
  - Rehabilitation of CSWs
  - Provision of recreation facilities
  - Provision of decent living conditions (home discipline) (Parents should understand that their own sex behavior influences the children).
  - Marriage counseling
  - Sex education in schools and colleges
  - Prohibition on the sale of pornographic books and photographs
  - Prohibition of showing 'Blue films'.

SYNDROMIC CASE MANAGEMENT OF RTIs/STIs (SYNDROMIC APPROACH)

It is a scientific method of treating STI in health facilities that lack laboratory equipment or skills to make an etiological diagnosis.

This approach has come into vogue because the traditional approach of etiological diagnosis by microscopic examination and culture of the material is not only expensive but also time consuming in obtaining the results. Added to that facilities are not available in rural areas. A guide to syndromic case management is given as flow diagrams/charts **(Figs 20.55 to 20.62)**.

Syndromic management is based on the identification of a consistent group of symptoms and easily recognizable signs.

The provision of treatment will deal with the majority of organisms responsible for producing the syndrome.

Steps Involved in Adopting Syndromic Approach

- Classify the main causative agents by clinical syndromes they produce.
- Choose the appropriate treatment flow chart for each syndrome.
- Choose the appropriate treatment flow chart if laboratory investigations are available.
- Treat the patients for all the important causes of the syndrome as per directions on the respective flow chart, after examination of the patient.
- Ensure that the partners are treated, patients are educated and that the use of condoms promoted.

The syndromes in STI are grouped as **(Table 20.24)**.

Gathering Information for Syndromic Diagnosis of STDs

History Taking

Objectives:

- To make in accurate and efficient syndromic STD diagnosis
- To define the patient's risk of transmitting or contracting STDs
- To find out partners, who may have been infected.

History taking also helps the health care provider to:

- Assess the patient's risk of becoming infected again
- Find the sexual partners who may need to be treated
- Educate them about prevention of STIs including condom promotion.

Clinical Examination

- Ensure privacy
- Explain what they are going to do and its importance
- Never showing embarrassment
- Be gentle.

Syndromic care management is not just symptomatic treatment.

Steps in Examining the Patient for STI Syndromes

Male Patients

- Ask the patient to stand and lower his pants up to knees.
- Palpate the inguinal region for enlarged lymph nodes.
- Palpate the scrotum (testes, spermatic cord, epididymus).
- Examine the penis for rashes and sores.
- Ask the patient to retract the foreskin and look at the glans penis and urethral meatus.
- Ask the patient to milk the urethra to express any discharge.
- Examine the anal and oral region for ulcers or signs of inflammation.
- Record all the observations of ulcers, swellings, urethral discharge, its color and amount.

Female Patients

- Remove her clothes from the waist down
- Lie down on the couch in lithotomy position
- Palpate the inguinal region for enlarged lymph nodes.
- Palpate the lower abdomen for any pelvic mass/tenderness.
- Examine the oral region as well.

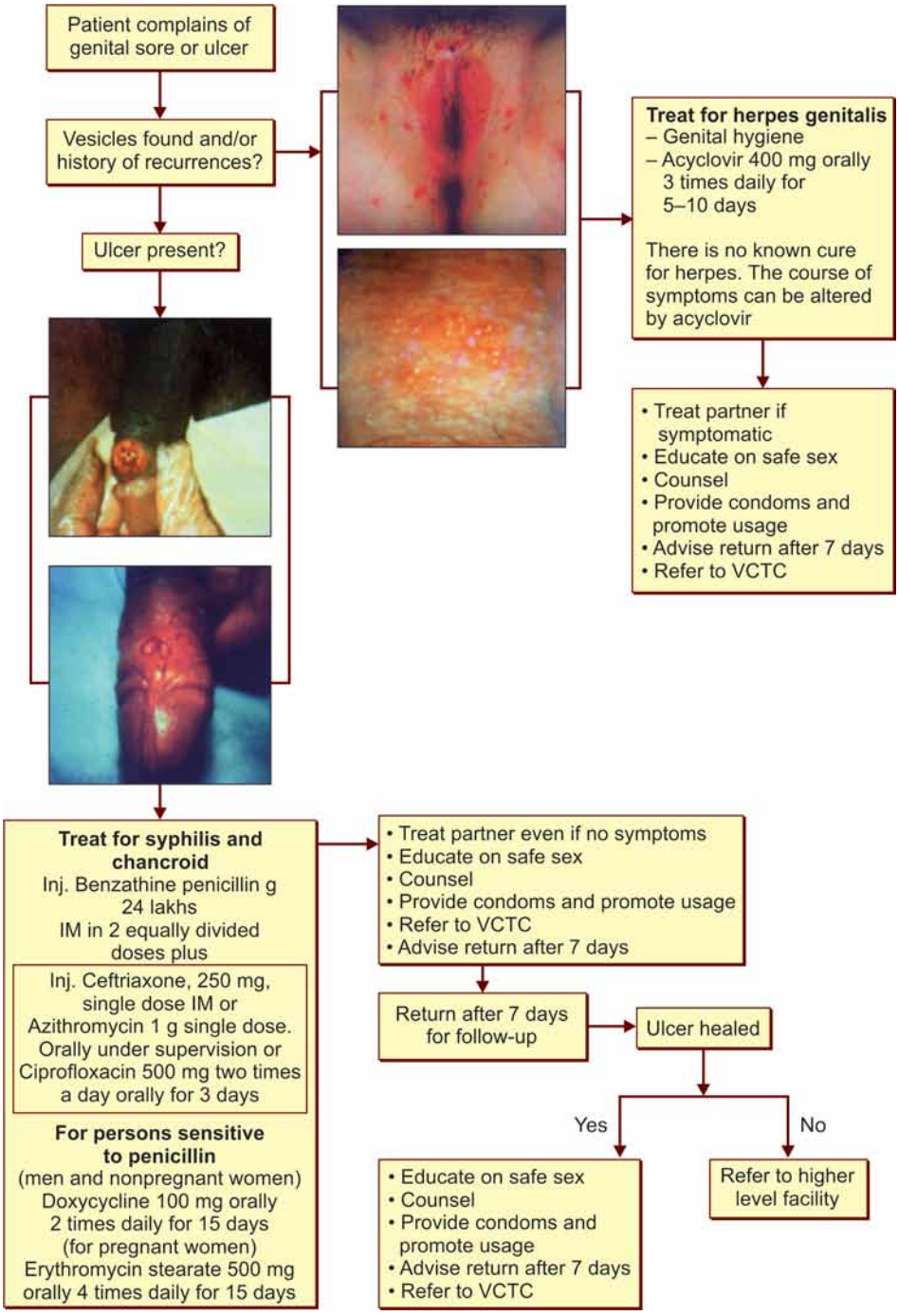


Fig. 20.55 Genital ulcers

- Record the presence or absence of ulcers, swellings, pain or tenderness of lower abdomen and vaginal/cervical discharge if any.
- Speculum examination of vagina to differentiate between cervical and vaginal discharge.
- Additional findings if any by per vaginal examination for adnexal or cervical motion tenderness.

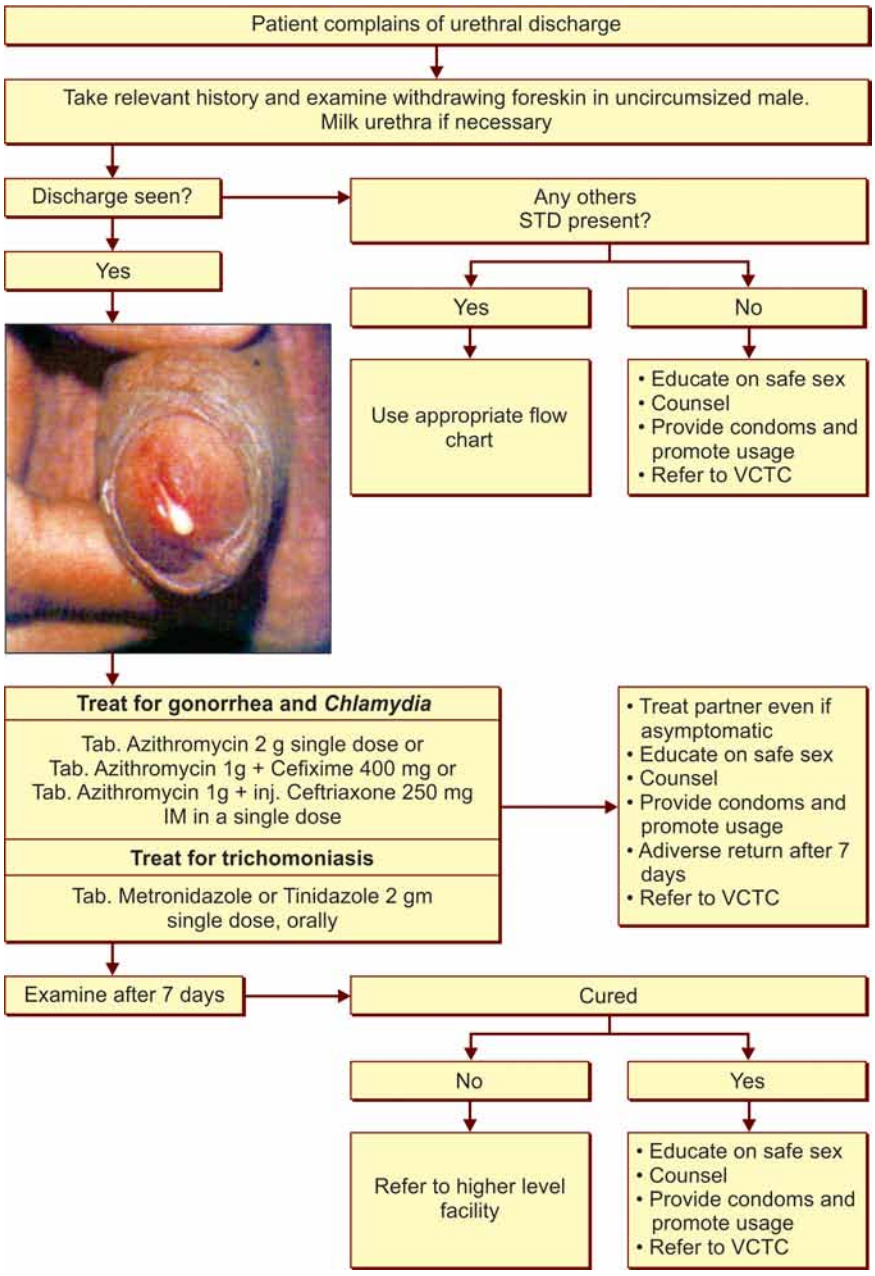


Fig. 20.56 Urethral discharge

Roles and Responsibilities of the Doctors while Caring for Patients with STI (6 Cs)

- *Compliance:* Ensure that the patient takes full course of treatment as prescribed. This means that you need to spend some time communicating with him/her on the importance of completing the treatment.
- *Contact treatment:* Treat the sexual partner (s) for the same STI condition and initiate the treatment of the partner at the same time as the patient. Partner treatment is necessary even if the partner does not have symptoms!
- *Condom promotion:* Advice, prescribe, distribute or demonstrate how condoms must be used correctly. Insist on use of condoms every time there is sexual contact.
- *Counseling:* Counsel the patient or refer him/her for counseling. Counseling includes risk reduction counseling and pre-test counseling for HIV/AIDS.

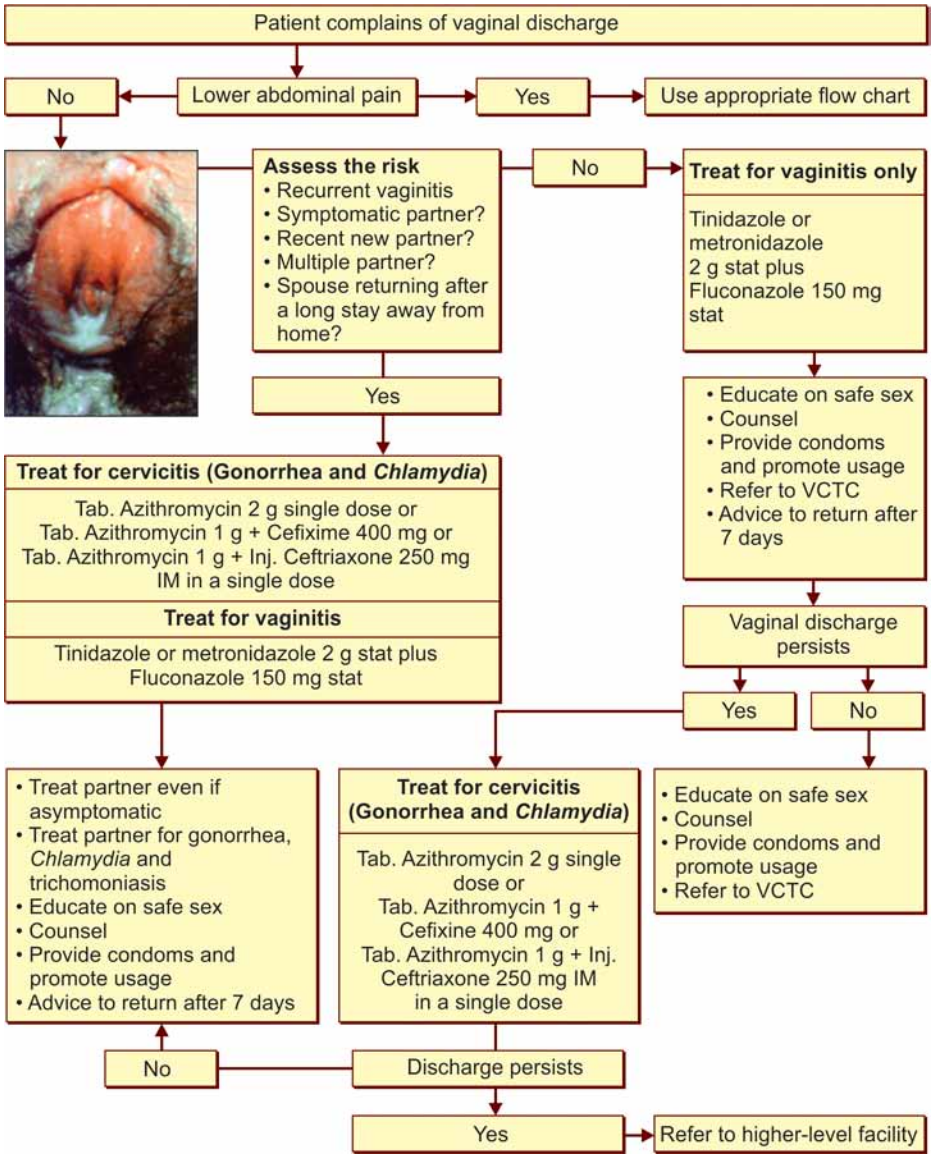


Fig. 20.57 Vaginal discharge (Without speculum examination)

- *Continued support:* Follow-up the patient to ensure that there is total cure of the condition, not only disappearance of syndromes. During follow-up once more emphasize on safer behaviors. Refer the patient to a STI specialist if there is no improvement after treatment or developing of complications such as super-added infection or sequel of the condition.
- *Collection of essential data:* Maintenance of basic records for STI patients will not only help to document follow-up but will also be useful to track social, demographic and behavioral characteristics of patients with STI.

Advantages of the Syndromic Case Management

- The treatment for each syndrome is immediate and is given at the first line health facility.
- There is wider access to treatment catering to a large needy population.
- There are ample opportunities for preventive measures and promotion of condom use.
- Syndromic case management is:
  - Scientific
  - Simple

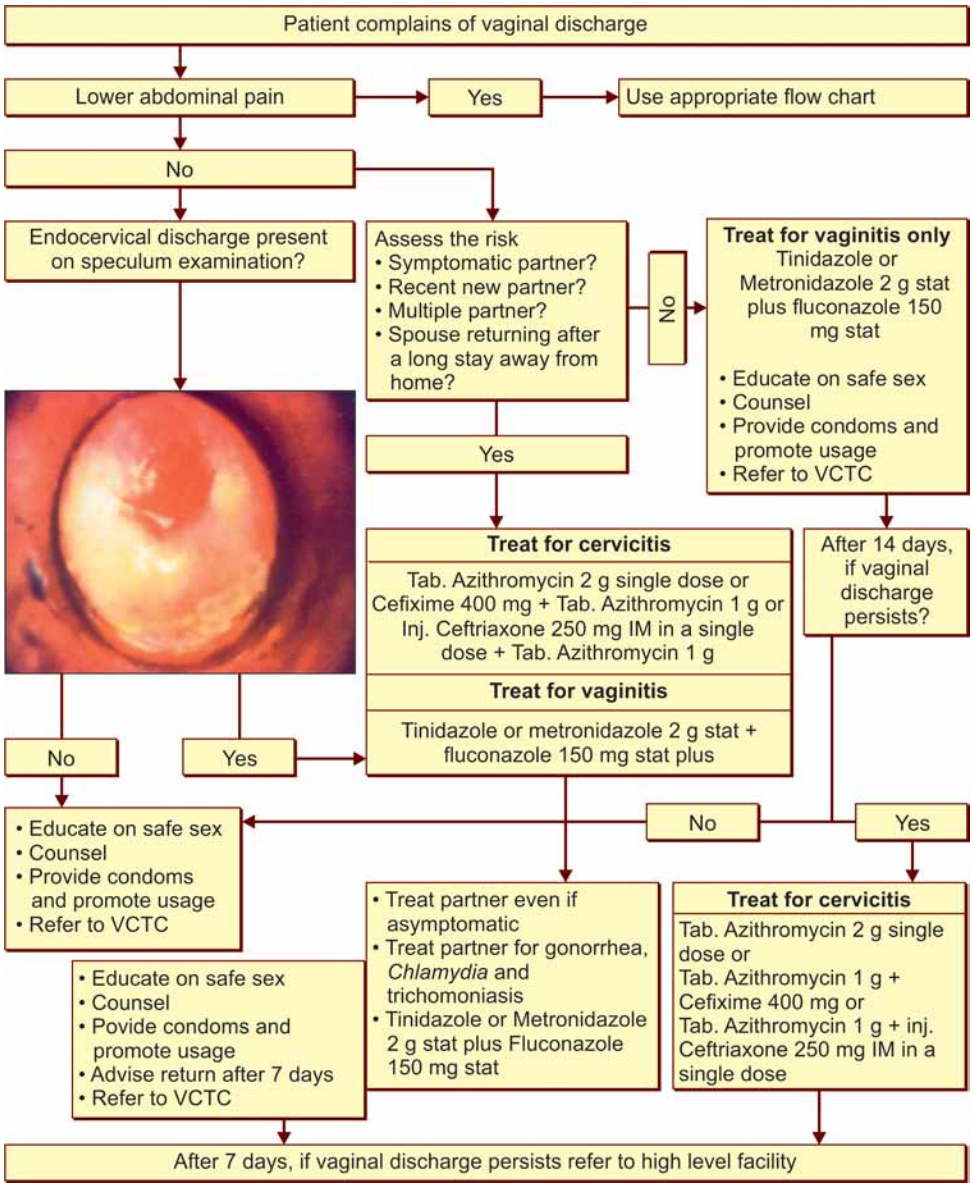


Fig. 20.58 Vaginal discharge (Speculum examination)

- Free from errors in clinical judgement
- Effective against mixed infections
- Cost-effective in the long-run as it does not require laboratory tests.

Disadvantages of the Syndromic Case Management

Asymptomatic STI conditions are not treated, except as a component of partner treatment.

Managing STI using the Syndromic Approach

	Syndrome	Treat for
Men	Urethral discharge	Gonorrhea and *Chlamydia*
Women	Lower abdominal pain Vaginal discharge	Gonorrhea, *Chlamydia* and other bacteria *Cervicitis:* Gonorrhea and *Chlamydia* *Vaginitis:* Trichomoniasis and candidiasis
Men or women	Genital ulcers	Syphilis, Chancroid and genital herpes

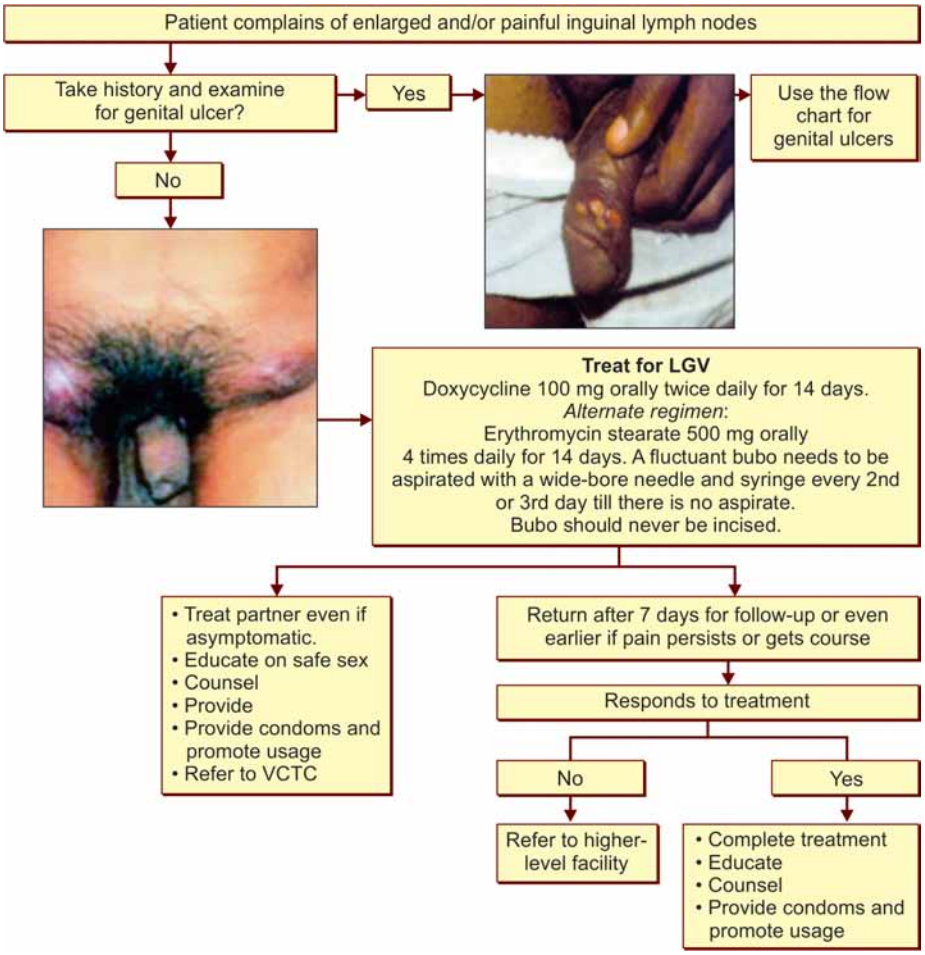


Fig. 20.59 Inguinal bubo (Swelling) (Both sexes)

Seven Pre-packed STI/RTI Kits for Syndromic Management

Kit no.	Syndrome	Color	Contents
Kit 1	UD (Urethral discharge), ARD (Anorectal discharge), Cervicitis	Gray	Tab. Azithromycin 1 g (1) and Tab. Cefixime 400 mg (1)
Kit 2	Vaginitis	Green	Tab. Secnidazole 2 g (1) and Tab. Fluconazole 150 mg (1)
Kit 3	GUD (Genital ulcer disease) Nonherpetic	White	Inj. Benzathine penicillin 2.4 MU (1) and Tab. Azithromycin 1 g (1) and Disposable syringe 10 mL with 21 gauge needle (1) and Sterile water 10 mL (1)
Kit 4	GUD (Genital ulcer disease) Nonherpetic	Blue	Tab. Doxycycline 100 mg (30) and Tab. Azithromycin 1 g (1)
Kit 5	GUD (Genital ulcer disease) Nonherpetic	Red	Tab. Acyclovir 400 mg (21)
Kit 6	LAP (Lower abdominal pain)	Yellow	Tab. Cefixime 400 mg (1) and Tab. Metronidazole 400 mg (28) and Cap. Doxycycline 100 mg (28)
Kit 7	IB (Inguinal bubo)	Black	Tab. Doxycycline 100 mg (42) and Tab. Azithromycin 1 g (1)

(For color version see Plate 8)

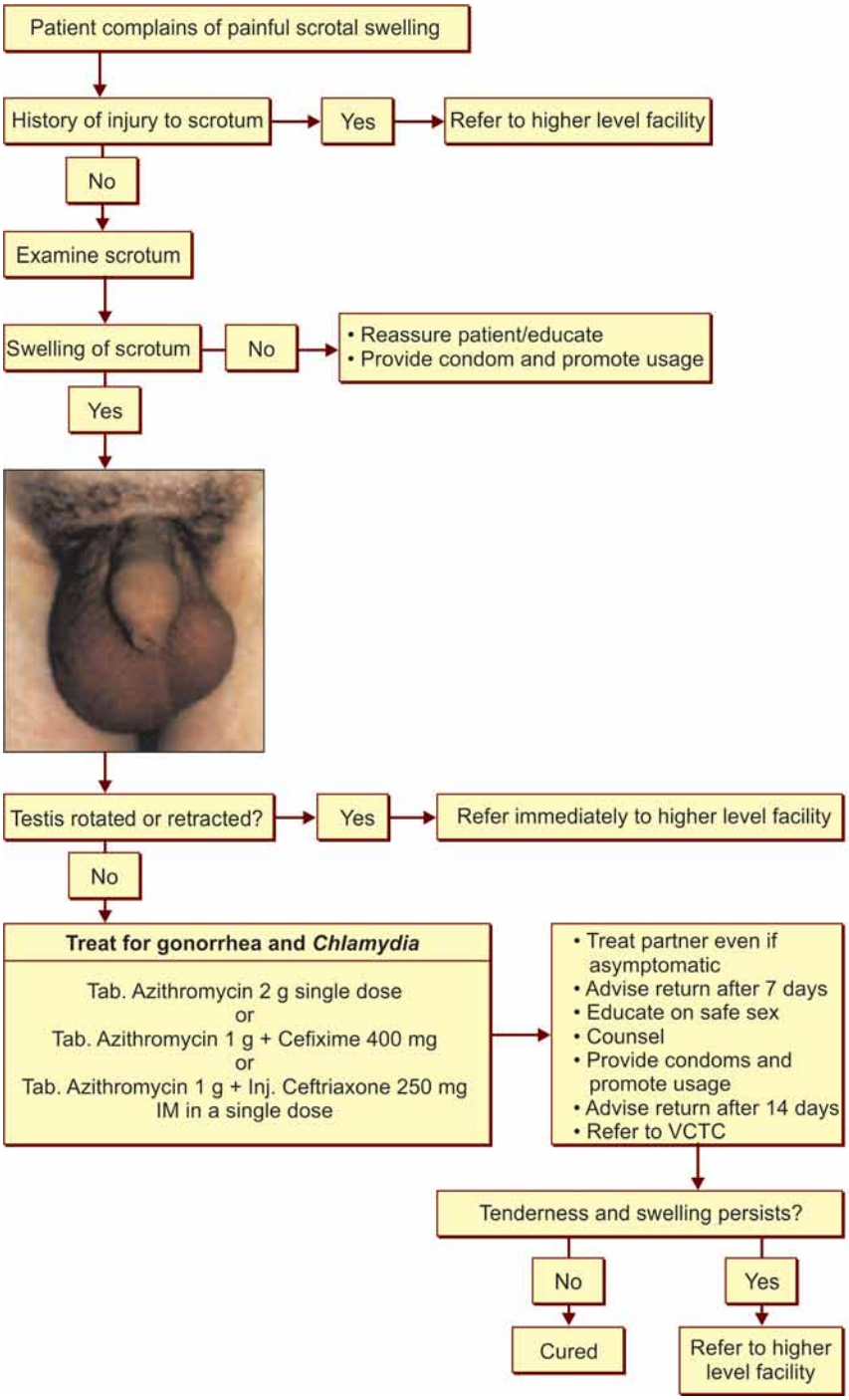


Fig. 20.60 Painful scrotal swelling

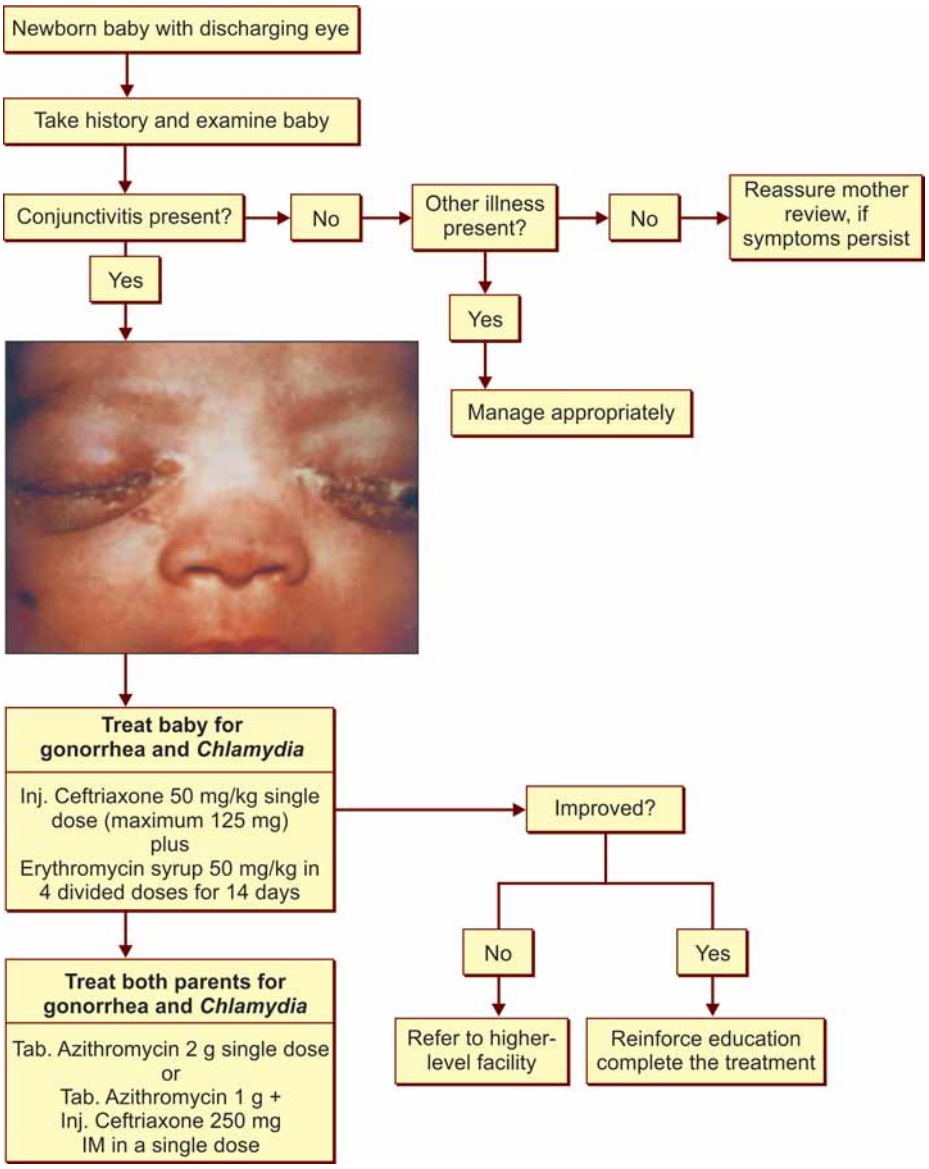


Fig. 20.61 Ophthalmia neonatorum (Neonatal conjunctivitis)

Table 20.24 The syndromes in STI

	Common clinical signs	Most common causes	Etiology
Genital ulcer in males or females	Genital ulcer on penis or scrotum in men; on labia, vagina or cervix in women	Syphilis Chanchroid Genital herpes Lymphogranuloma-venereum Donovanosis	*Treponema pallidum* *Haemophilus ducreyi* Herpes simplex virus *Chlamydia trachomatis (L1-L3)* *Calymatobacterium granulomatis*
Urethral discharge, dysuria in males	Urethral discharge on milking urethra	Gonorrhea Nongonococcal urethritis	*N. gonorrhea* *C trachomatis* or ureaplasma
Vaginal discharge	Abnormal vaginal and/or cervical discharge Vaginal inflammation Cervical friability	*Cervicitis* Gonorrhea Chlamydial infection	 *N. gonorrhea* *C trachomatis*

Contd…

Contd…

	Common clinical signs	Most common causes	Etiology
	Cervical motion tenderness	Vaginitis Trichomoniasis Bacterial vaginosis Candidiasis	*Trichomonas vaginalis* *Gardenella vaginalis, anaerobes* *Candida albicans*
Lower abdominal pain in women	Adnexal + cervical motion tenderness	Gonorrhea Chlamydial infection	*N. gonorrhea* *C. trachomatis*
Dyspareunia, irregular bleeding	Vaginal or cervical discharge Fever (sometimes)	Anaerobes	Anaerobes
Inguinal swelling or bubo in males or females	Inguinal lymphadenopathy with or without ulceration	Lymphogranuloma venereum	*C. trachomatis* (L1-L3)
Scrotal swelling or pain in males	Red + Edematous scrotum Urethral signs	Gonorrhea Nongonococcal urethritis	*N. gonorrhea* *C. trachomatis* or ureaplasma Urealyticum

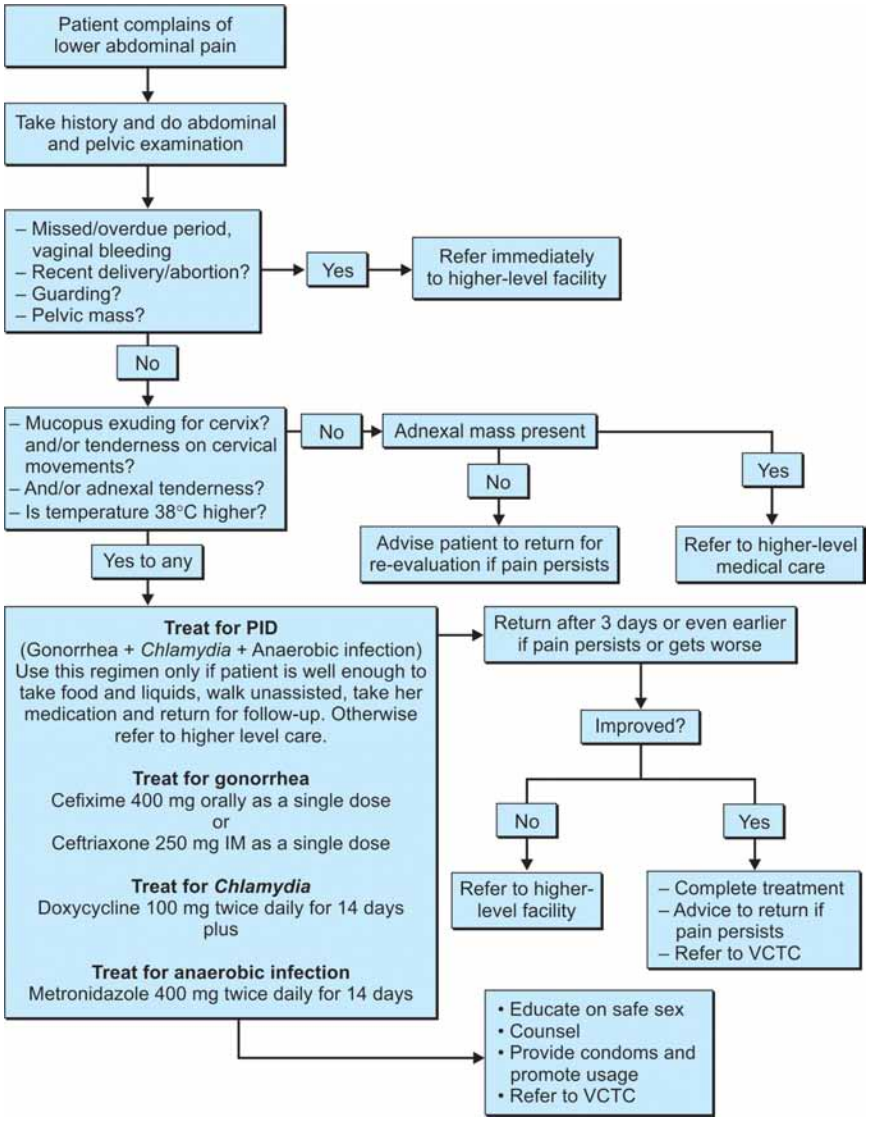


Fig. 20.62 Lower abdominal pain (in females)

Diagnosis and Treatment for Partners based on the First Patient

Syndrome of patient	Treat of partner
Urethral discharge	Treat partner for gonorrhea and *Chlamydia*
Genital ulcers	Treat partner for syphilis and chancroid
Vaginal discharge	Treat partner for gonorrhea and *Chlamydia*
Patient treated for vaginitis and cervicitis	Not necessary for the partner to be treated unless the discharge recurs
Patient treated for vaginitis only	
Pelvic inflammatory disease	Treat partner for gonorrhea and *Chlamydia*

HUMAN IMMUNODEFICIENCY VIRUS (HIV)/ACQUIRED IMMUNO-DEFICIENCY SYNDROME

Human: Because this disease agent is found only in humans and can live only in human beings or on human cells.

Immunodeficiency: Because HIV destroys the immune or defence system of the body.

Virus: Because it is a virus, a retrovirus. That means it is able to convert RNA into DNA. AIDS is the abbreviation of Acquired Immunodeficiency syndrome.

Acquired: This means that the disease is 'got' and not 'caught'. HIV cannot be caught from the air like common cold or cough. It spreads only by few specific routes.

Immunodeficiency: This means that the capacity of the immune system to respond and fight against infections is lost. HIV slowly destroys the body's defense system. It kills an important kind of blood cell, CD4 T-lymphocyte or T-cell, without which a person cannot fight off germs and cancers. Therefore, the HIV infected person gets a number of diseases.

Syndrome: This means a collection of signs and symptoms. AIDS is the last stage of HIV infection. AIDS is a disease that presents with different kinds of signs and symptoms. The infections that are caused because of the immunodeficiency, an opportunity obtained for many pathogens to infect that person, are referred to as 'Opportunistic Infections (OIs)'. When people with HIV get these OIs or when their CD4 T-cell count becomes very low, (< 200/mm^3) they have AIDS. OIs are life threatening. Normal CD4 T-cell count is 450 to 1200 cells per microliter of blood.

AIDS is an infectious disease, caused by a retrovirus, called HIV, usually transmitted by sexual intercourse, but often also transmitted percutaneously, parenterally, transplacentally and through breast-milk. Pathologically, it is characterized by slow but gradual, progressive, permanent, paralysis of the immune system of the host, leaving the victim vulnerable to life threatening infections, unusual malignancies and neurological disorders. Clinically it is characterized by prolonged incubation period, persistent diarrhea, intermittent fever, loss of weight, fatigue, malaise, lymphadenopathy, neurological disorders, unusual malignancies and features of opportunistic infections.

The important epidemiological features of this disease are:

- Once an infection with HIV, it is a permanent infection.
- AIDS is the last stage of HIV infection.
- It is cent-percent fatal (Death is the rule).
- Not all the persons who are infected with HIV, will develop AIDS. Only about 10 to 20 percent will develop the disease, about 25 percent get mild form of the disease and remaining 60 to 65 percent remain apparently healthy, do not develop the disease but act as carriers.
- It is difficult to make clinical diagnosis.
- Neither there is treatment nor there is vaccine.
- Prevention is the only intervention.
- AIDS, often called as 'slim disease', is undoubtedly the scourge of this century.
- AIDS is the modern pandemic.

HISTORY

In the middle of 20th century (during 1970s) the infection was confined to green monkeys of Africa. How it was transmitted to human beings is not known. Then it spread to Haiti, Caribbean Islands and reached USA, from where it spread to all parts of the world like a devastating fire.

In 1981, the first case of a new syndrome was recognized and reported by the Center for Disease Control (CDC), Atlanta, USA, a rare form of pneumonia caused by *Pneumocystis carinii* and Kaposi's sarcoma in an apparently healthy person, who was a homosexual man, and who died due to loss of immunity.

In 1982, the disease was named as AIDS.

In 1983, the virus was identified by French Scientists Luc-montagnier, Pasteur Institute, Paris and was named as Lymphadenopathy Associated Virus (LAV).

In 1984, it was confirmed that LAV was the causative agent of AIDS in USA.

In 1985, the virus was renamed as 'Human T-cell Lympho-trophic Virus' (HTLV).

In 1986, the International expert committee on Taxonomy called the virus by a new name 'Human Immuno-deficiency Virus' (HIV) type 1.

In 1987, a new virus of the same character has been identified in West Africa and is now called as HIV-type 2.
In 1988, WHO announced December 1st of each year as World AIDS Day.
In 1989, number of new antiretroviral drugs became available.
In 1990, estimated number of HIV positives, world-wide was 8 to 10 millions. Transmission through breast feeding became clear.
In 1991, red ribbon was launched as an international symbol of AIDS awareness.
In 1992, combination therapy of AZT + DDC became successful, for the first time.
In 1994, AZT was shown to reduce the risk of transplacental transmission by 66 percent.
In 1998, first human trial of an AIDS vaccine was performed by AIDS-vax company on 5000 volunteers.
In 1999, a single dose of another new drug Nevirapine was found to be more effective in prevention of mother to child transmission of HIV.

Recognized as an emerging disease only during early 1980s, AIDS has rapidly established itself throughout the world. It has evolved from a mysterious illness to a global pandemic, affecting millions and millions of people, within a span of 2 decades, thus forebonding a grim future for the world. People living with HIV/AIDS are living in shadow of death. Thousands of mothers have given birth to HIV infected babies, thousands of children have become orphans to the scourge of AIDS.

AIDS has been described variously as modern scourge, modern plaque, devastating disease, biological disaster, microbiological bomb, and so on. Having emerged as unprecedented pandemic, has cut across all boundaries – International, socioeconomic, age, sex, race, etc.

The virus having gained a foot-hold has divided the twentieth century into 2 eras—'Before and After AIDS'. AIDS-era is likely to be an enduring one stretching far into the century ahead. No end in sight.

MAGNITUDE OF THE PROBLEM

AIDS has produced three related epidemics and not one. HIV infection, AIDS disease and Global reaction to the first two, socially, economically, culturally and politically. Thus AIDS is not only a health problem, but also a social problem, economic problem, cultural problem and a political problem.

The first epidemic which began during 1970s, continues today as a 'Silent Pandemic', affecting about 50 million people globally to live with HIV/AIDS, including nearly 2 million children below 15 years. It is reported that as many as 16,000 people become infected with HIV every day (viz, one person for every ten seconds, 6 to 10 persons per minute, and 7 million new infections each year).

The second epidemic is that of the disease AIDS itself, which has resulted in more than 20 million deaths globally, including 5 lakhs children below 15 years, by 2003.

The third epidemic is the uprooting of social and cultural values, all over the world.

Africa is the home to two-thirds of world's people living with HIV/AIDS.

On 1st December 2003, WHO and UNAIDS announced a plan to reach the '3 by 5 target' of providing antiretroviral treatment (ART) to three million people living with HIV/AIDS in the developing countries by the end of 2005. Thus, it is a vital step towards the ultimate goal of providing universal access to treatment for HIV/AIDS to all those who need it. The '3 by 5' strategy will focus on simplified, standardized tools to deliver ART, a new service. It is estimated that approximately 5.5 billion US $ will be required for this purpose.

INDIA

In India, the first case of HIV infection was diagnosed in a sex worker, in Chennai, in 1986 and the first case of AIDS was recognized in 1987, in a commercial sex worker in Mumbai. By 1996-1997, there were about 2 million HIV infected persons and about 3500 cases of AIDS. The epidemic which was confined to core-population, (commercial sex workers, homosexual men, injecting drug users), has shifted to Bridge population (clients of sex workers, STI patients, migrant population, partners of drug users) and now to general population, including mothers and children.

By 2003, the total number of HIV cases increased to 5.1 million, including 86028 cases of AIDS, by August 2004.

Globally India is next to South Africa in terms of the overall number of people living with AIDS. Depending upon HIV prevalence rates, the states are classified into 3 groups.

Group I: High prevalence states, where HIV infection is more than 5 percent among high-risk group and more than 1 percent among antenatal women. These include Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Manipur and Nagaland.

Group II: Moderate prevalence states, where HIV infection is more than 5 percent among high-risk groups but less than 1 percent among antenatal women. These include Gujarat, Goa and Puducherry.

Group III: Low prevalence states, where HIV infection is less than 5 percent among high-risk groups and less than 1 percent among antenatal mothers. These include remaining states.

In Karnataka, HIV prevalence among antenatal mothers was 1.75 percent in 2002. It is high in north Karnataka's '*Devadasi* belt'. *Devadasis* are a group of women, who historically, have been dedicated to the service of Goddess '*Savadathi Yellamma*'. But these days, this system has evolved into sanctioned prostitution, as a result, many of such women

from this part of the country are supplied to the sex trade of big cities like Mumbai.

Since the problem of injecting drug users (IDUs) is high in North-Eastern States like Assam, Arunachal Pradesh and Manipur, the prevalence of HIV is also high (39.06% of general population). It is 70 percent among the IDU in Mizoram. Their female partners suffer the risk of HIV. The geographical nearness of Manipur to Burma and therefore to the Golden Triangle drug trail, has made it a major transit route for drug smuggling with drugs easily available.

The total burden of HIV in any area can be estimated by the following formula:

$V = (P/T) \times (R)$

where V = Total estimate of the burden of HIV
P = Number of HIV-positives
T = Number of samples tested
R = Estimated size of the population.

Agent Factors

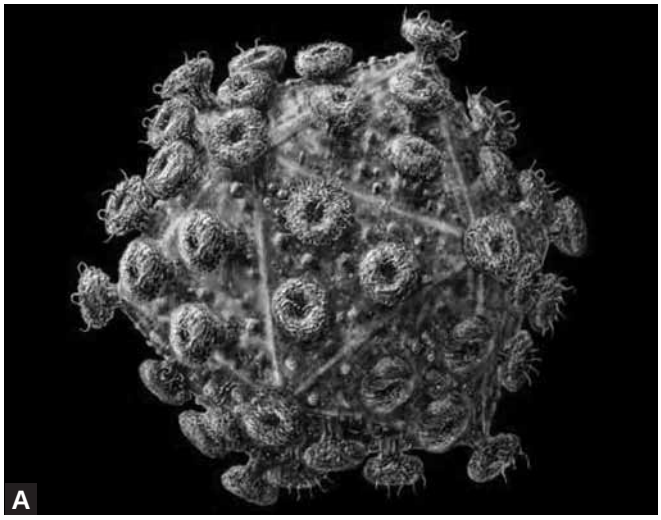
HIV is a lentivirus belonging to the family retroviridae, which derives its name from possession of an enzyme called 'reverse transcriptase', which synthesizes DNA on an RNA template (i.e. RNA dependent DNA polymerase). Virus is able to convert RNA into DNA.

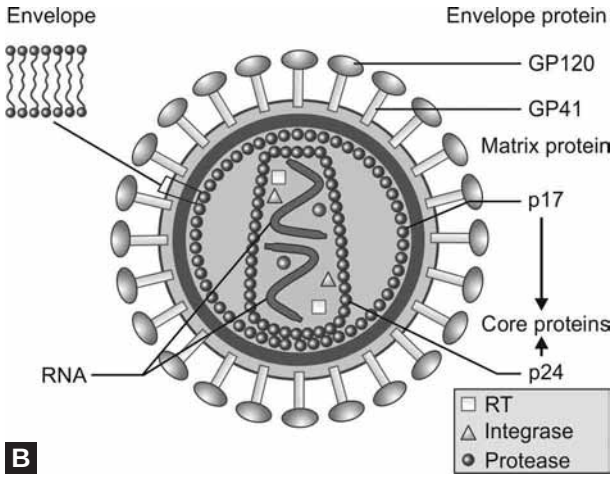
It is about 100 nm in diameter. It has a circular, bilayered outer lipid envelope marked by glycoprotein studs (GP 120 and 41) (projections) at regular intervals **(Figs 20.63A and B)**. Envelop protein (glycoprotein) has affinity for CD4 molecule on host cell membrane. It has dense core protein P17 and P24. Inside is a dense nucleocapsid, bar shaped, exhibiting, icosahedral symmetry, containing diploid RNA genome (viz. two single stranded RNA genome), each carrying an enzyme 'reverse transcriptase' (RT). The virus maturation occurs by budding through host cell membrane. The virus replicates in actively dividing T4 lymphocytes and like other retroviruses can remain in lymphoid cells in a latent state and can be activated at any time later.

The virus has a unique ability to destroy human T-4 helper cells (i.e. CD4+ T-lymphocyte) a subset of human T-lymphocytes. Thus it is mainly lymphotrophic virus. The virus is able to spread throughout the body and can pass through the placenta and the blood-brain barrier. It is neurotrophic also. It is capable of mutating rapidly coming out with new strains, a reason for the inability to prepare vaccine. When T4 cells rupture, the virus will affect the adjacent T-4 cells, thus ultimately paralyses the whole immune system.

There are two types of HIV—HIV-1 and HIV-2. HIV-1 is the most common and is more virulent **(Fig. 20.64)**. Both the types are prevalent in India.

HIV is a finiky virus, easily killed by heat and chemicals like ether, ethanol, acetone and β propriolactone. It is relatively resistant to ionizing radiation and UV rays.





Figs 20.63A and B Electron microscopic structure of human immunodeficiency virus

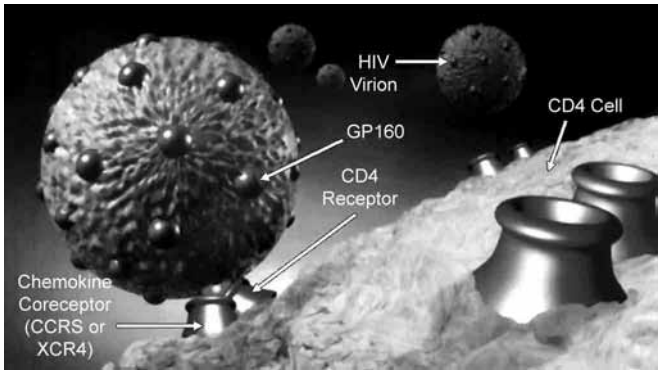


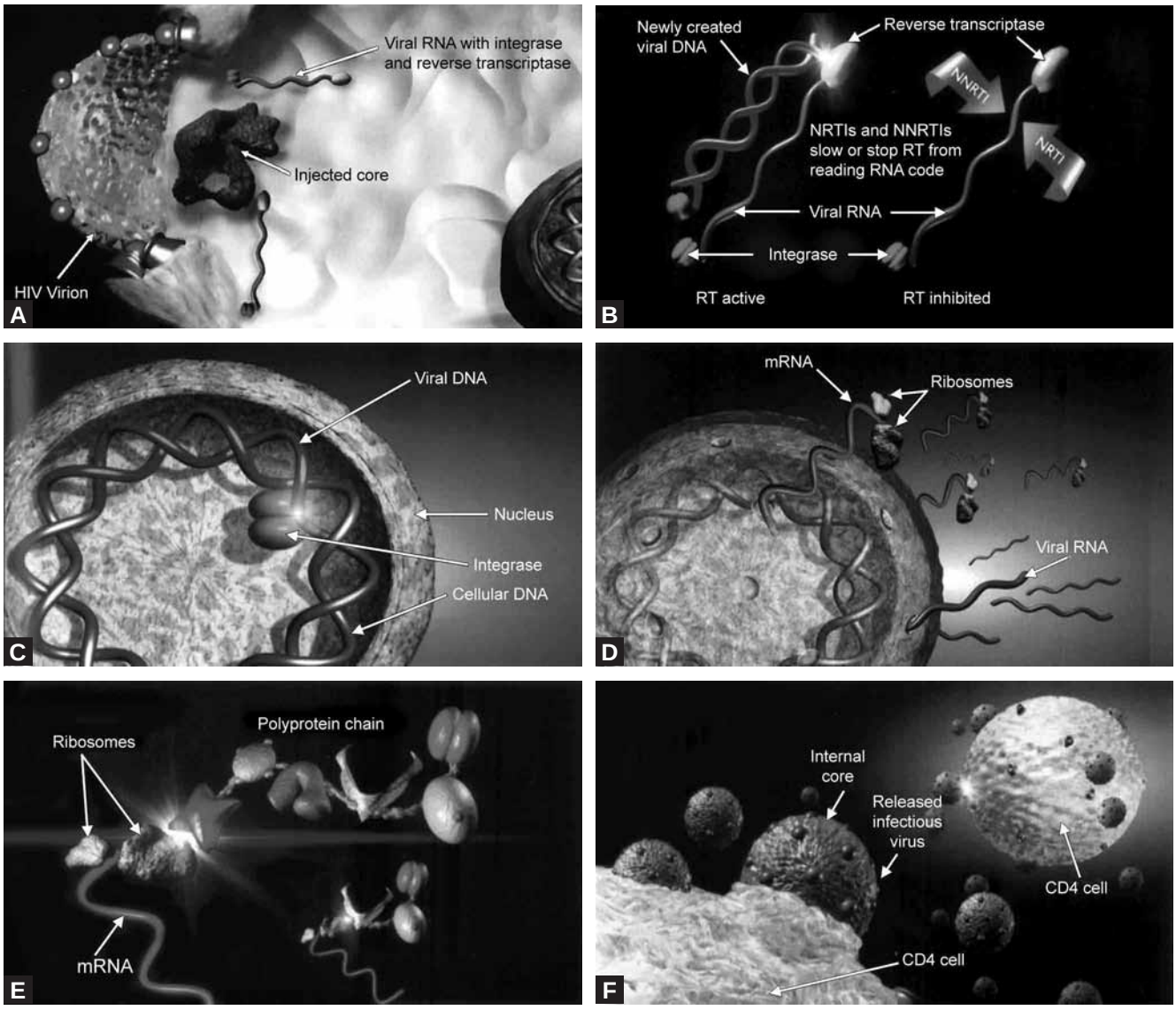
Fig. 20.64 HIV structure

Life Cycle of HIV

HIV targets the CD4 T lymphocyte cells of the body's immune system **(Figs 20.65A to F)**.

- The HIV binds to the CD4 receptors on the surface of the CD4 cell.
- The core of the virus containing it's genetic material (viral RNA) is injected into the cytoplasm of the host cell.
- The single stranded RNA of the virus is converted to double stranded DNA using the enzyme reverse transcriptase.
- The viral DNA enters the nucleus of the host cell and integrates itself with the DNA of the host nucleus, using the enzyme integrase.
- As the host cell replicates, multiple copies of the viral RNA are also produced and released into the cytoplasm of the host cell.
- The viral RNA is transcribed into polypeptides and protease. The enzyme protease cleaves the polypeptide chains into functional HIV protein units.
- The functional HIV proteins are assembled and the HIV virions bud from the cell surface.

The infected CD4 cells produce many new copies of the virus, and then die. The new copies of HIV then attack other CD4 cells, which also produce new copies of HIV and then die. As this goes on, more and more CD4 cells are destroyed, more and more new copies of HIV are made and new CD4 cells get infected.



Figs 20.65A to F Life cycle of the virus

Reservoir of infection: There is only human reservoir – cases and carriers. Once an infection with HIV, it is a permanent infection. The risk of developing AIDS increases with time. Since it requires years to manifest the disease AIDS, the infected individual acts as a symptomless carrier. The carrier state is found among 85 percent of infected persons. For every case of AIDS, there are about 8 to 10 subclinical cases, who act as carriers. Thus AIDS constitutes the 'tip of iceberg' in Iceberg phenomenon.

Carriers are highly infectious during the 'Window Period', i.e. the period between the onset of infection and the production of antibodies. This period is about 6 to 12 weeks after infection. If a HIV test is done during this period, it will be negative.

Infective Materials (Source of Infection)

Chief infective materials are only four viz. blood, semen, vaginal secretions and breast milk of the infected person. However, viruses have been found in various other body fluids such as CSF, saliva, tears, urine, and joint fluids. But they are not infective, unless they are mixed with contaminated blood. Viruses have also been isolated from certain body tissues such as brain, bone marrow, lymph-nodes and skin. However, they do not constitute the infective source.

Period of infectivity: Once a person gets HIV infection, he remains infective throughout his life.

Occupation: HIV/AIDS is not an occupational disease. But surgeons, dentists, obstetricians, commercial sex worker, blood bank and laboratory workers are at risk.

Age incidence: The incidence of HIV/AIDS is maximum among young people of sexually active and economically productive age group of 15 to 40 years. however, it can occur in age group. Less than 3 percent has been found among children.

Sex incidence: The ratio is different in different countries. In India, the sex ratio is 3:1 (M:W). Males account for 73.5 percent and females account for 26.5 percent of AIDS cases.

Susceptibility: It is universal. HIV recognizes no boundaries of age, sex, race, class, creed and community. Nobody is immune.

Modes of transmission: HIV/AIDS does not spread randomly. It is transmitted as a consequence of a specific behavioral pattern.

HIV/AIDS is transmitted from infected person to healthy person by only four routes.

1. **By direct physical sexual contact viz. by having unprotected sex (i.e. having sex without a condom!)**

   The factors which favor sexual transmission are:
   - The types of sexual act
   - Protection if any
   - Age and sex of the infected partner
   - Presence of STI
   - Stage of illness of the infected partner
   - Virulence of HIV strain
   - Period of menstruation.

   Types of sexual act: Common mode of transmission is by vaginal intercourse. Women are more vulnerable for HIV infection because of the larger surface area of vagina being exposed and semen contains higher concentration of viruses. But anal intercourse is more efficient mode of transmission because it is likely to result in the injury to the tissues of the receptive partner. However transmission can also occur through oral sex, but less efficiently. Risk increases if there are abrasions or ulcers in the mouth.

   Transmission from male to female is twice as likely as from female to male because male is an active partner, has lesser surface area of exposure and semen is rich in virus than the vaginal fluid.

   Protection if any: Use of condoms decreases the risk of transmission. However, it is not full-proof.

   Age and sex of the infected partner: Eventhough HIV is more in the sexually active age group of both the sexes, it is less among teenage girls than adult women because among teenage girls, the cervix is an efficient barrier to HIV than that of adult women.

   Presence of STI: Persons having STIs are 10 to 15 times more likely to acquire HIV infection, because of the ulceration over the genital regions. When an STI person gets HIV, the effects of HIV on STI are—disease course is accelerated, symptoms become severe, complications are frequent, STD can become chronic and serodiagnosis becomes difficult.

   Stage of illness of the infected person: HIV infected partner is more infectious during the 'window period' and also in the advanced stage than during other period.

   Virulence of the virus: Higher the virulence of the virus, greater the chances of getting the infection.

   Period of menstruation: The risk of getting HIV infection is more in a woman during menstruation period than during other part of the cycle.
2. **By blood transfusion:** By receiving a transfusion of untested blood or blood products (i.e., not tested for HIV). The efficiency or risk of transmission of HIV through blood and blood products is more than 90 percent. But still the commonest mode of transmission is through sexual route.
3. **By percutaneous route:** By sharing needles and/or syringes to inject drugs or using unsterilized needles, syringes or other surgical or dental instruments. Contact between HIV infected blood and broken skin (wounds or cuts) can also transmit HIV.

The disease is also transmitted percutaneously by various procedures of tattooing, nose or ear piercing, acupuncture, sharing of razors, etc. when contaminated needles or razors are used.

4. **By vertical transmission (Transplacental transmission):** HIV infection is also transmitted from the HIV infected mother to her child during pregnancy, during delivery or breastfeeding [Mother to: Child Transmission (MTCT): explained later].

It is important to note that HIV is not transmitted through mosquitoes or any other insect, casual social contact (such as touching the patient, shaking the hands, sharing clothes, using same toilet, swimming in the same pool) or by food or water. Even though open mouth kissing is of low risk activity, prolonged open mouth kissing can damage the mucous membrane and spread.

High-risk Groups

- Male homosexuals, bisexuals
- Having multiple sexual partners
- Prostitutes, both male and female
- Intravenous drug abusers
- STD clients, STI patients
- Newborn of infected mothers
- Transfusion recipients of blood and blood products (such as *Haemophiliacs*, patients of aplastic anemia).

Attributable Factor for HIV Transmission

- *Sex workers:* Prostitution is the major most social factor, responsible for the increasing prevalence of HIV in India. Mumbai has the country's largest brothel based sex industry, with over 50,000 sex workers.
- *Injectable drug users (IDUs):* The problem of IDUs is very high in North-Eastern states of India and also in almost all cosmopolitan cities. Since majority of them are males, their female partners are also at risk of HIV without their knowledge.
- *Migrants:* Migration of the population, by itself, is not a risk factor. But often they live in unhygienic conditions in urban slums. Long working hours and relative isolation from the family may foster casual sexual relationships making them vulnerable to STIs including HIV. Returning migrants, not knowing their HIV status, may infect their wives or other sex partners in the home community.
- *Truck drivers:* The truck drivers and helpers together constitute nearly 8 to 10 million population in India. They spend most of their time away from their families. During their journeys, they often stop at '*Dhabas*', which are the roadside hotels that usually provide food, rest, sex-workers, alcohol and drugs. They pick-up the women, use them and leave them at some other '*Dhaba*', where they are used by some other drivers and local youths. Thus, truck drivers play a crucial role in spreading STIs/ HIV throughout the country.
- *Literacy:* Poor literacy is associated with high-rate of HIV infection because of lack of awareness about risk factors.
- *Gender disparity:* Increase number of HIV postivity among antenatal mothers is an indication of gender disparity. Poverty among women makes the situation still worse. Further no woman have the status to demand condom use from their husbands, even if she knows the HIV status of her husband.
- *Heavy burden of STIs:* It is found that high prevalence of STIs and RTIs increases the chances of HIV transmission.
- *HIV and tuberculosis:* There is no risk of getting HIV in a tuberculosis patient, unless he or she practices high-risk behavior or gets infection from HIV contaminated blood transfusion. However, a person with HIV infection has 30 percent life time risk of getting tuberculosis disease. TB is the commonest opportunistic disease among AIDS patients.
- *Stigma:* The social stigma attached to STIs also hold good for HIV/AIDS, even in a much more serious manner. Such infected persons keep their status secret fearing the discrimination from their peers.
- *Lack of effective treatment:* The available drugs are costly and treatment options are still in the trial stage. Drugs are made available only in a few selected centers in the country.
- *Lack of vaccine:* Candidate vaccines are under trial, but still no effective vaccine is available (Explained elsewhere).
- *Quacks:* Quacks are taking the advantage of the situation and promising cure through so called herbal treatment providing false assurance.
- *Poor blood banks:* Unlicensed blood-banks have compounded the problem.
- *Other risk practices:* Lack of hygienic practices in hair cutting saloons, beauty parlors, etc. and also practices like tatooing, acupuncture, etc. pose a risk.
- *Lack of community involvement:* No health program will be successful without the participation of the public.
- Poor management skills and poor involvement of NGOs are other predisposing factors.

Pathogenesis (Immunology) (Life Cycle)

HIV being mainly lymphotrophic virus, it selectively affects 'helper T-cells' of lymphocytes (CD4+ T-lymphocytes), which constitute an important part of body's immune system. CD4 is the molecule on the surface of the T-helper cells, which serves as the primary cellular receptor for HIV. First the virus is adsorbed on the surface of helper T-cell and then enters. After entering the host cell, it utilizes an enzyme called

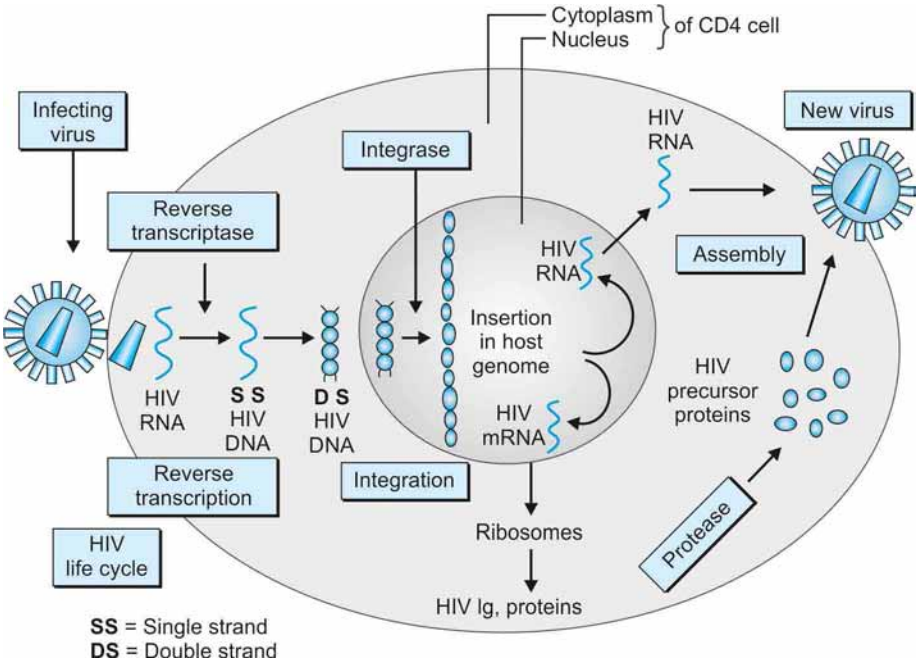


Fig. 20.66 HIV life cycle

'Reverse transcriptase' and is converted into DNA-virus. The DNA virus then penetrates the nucleus of the host cell and gets attached to cell DNA. Thus the virus hijacks the lymphocytes. Thus it integrates itself into a chromosome and takes over the machinery and then directs the host cell to produce more of HIV RNA viruses with the help of protease enzyme.

Once the RNA viruses reach the optimum number, the host cell burst open and release the new viruses, which further attack the adjacent helper T-cells, without entering the plasma or serum in the free state **(Fig. 20.66)**.

Thus, the helper T cells are affected slowly, continuously, progressively and permanently, both qualitatively and quantitatively thereby weakening or paralyzing the body's immune system, predisposing the person for a variety of infections, which are lurking in and around the body. They are called as 'Opportunistic infections'. Thus the HIV infected person cannot defend himself against such opportunistic infections. Ultimately death becomes certain and dies defenceless.

Since HIV is neurotrophic virus also, it affects CNS and damages it too.

Opportunistic Organisms

These are grouped as follows:

- **Bacteriae**—Atypical mycobacteriae,
  M. tuberculosis (Pulmonary tuberculosis)
  Legionella.
- **Viruses**—Cytomegalovirus (cause retinitis and blindness)
  Herpes virus
  Epstein-Barr virus
- **Protozoa**—*Pneumocystitis carnii* (Pneumonia)
  Toxoplasma gondii (Toxoplasmosis and encephalitis)
  Cryptosporidium (Cryptosporidiasis)
- **Fungi**—*Candida albicans* (Esophageal candidiasis)
  Cryptococcus (Meningitis)
  Coccidioides (Coccidiodomycosis)
  Histoplasma (Histoplasmosis)
- **Helminth**—*Strongyloides stercoralis* (Strongyloidiasis)
- **Unusual cancers**—Kaposi's sarcoma (of skin and mucous membrane)
  Non-Hodgkin's lymphoma.

Incubation period: Varies from 5 to 10 years.

Clinical Spectrum of HIV/AIDS

Progression from HIV to AIDS.

Stage I: Acute Retroviral Syndrome (Seroconversion)

- This stage is usually asymptomatic (No symptoms).
- It occurs within the first few weeks after getting infected (2-6 weeks up to 36 weeks).

- About 50 percent of individual experience an acute viral syndrome like viral fever. The symptoms may be mild and self-limiting and include fever, rash, joint pains, swollen lymph nodes, sore throat or diarrhea. This self-limiting condition is called acute retroviral syndrome.
- Usually HIV antibodies are not detectable during this period and hence the HIV test will be negative.
- This period is called the 'Window Period'. During this time the person has no symptoms, but has a very high viral load. His/her HIV test is negative, but he/she transmits the virus very easily through sexual or blood contact.

Stage II: Early Asymptomatic Disease (CD4 Count > 500 mm^3) (Normal CD4 Count = > 600 mm^3)

- The HIV test becomes positive during this phase.
- This is the longest period (5-7 years) when the person is asymptomatic and is therefore not detected, because he/she does not seek any medical help. However, this person transmits the virus.
- The virus continues to replicate leading to progressive damage to the immune and nervous system.
- Common signs and symptoms are seborrhoeic dermatitis/pruritus/cellulitis/herpes zoster infection/persistent generalized lymphadenopathy (PGL)/Lab reports show leukopenia and thrombocytopenia.

Stage III: Intermediate HIV Infection (CD4 Count 200–500/mm^3)

- This is the time when the person shows early symptoms of the HIV related illness.
- Signs and symptoms (called AIDS related complex - ARC) oral thrush/diarrhea/weight loss/low grade intermittent fever, night sweats/skin rashes/loss of energy/fungal infection (Tinea infection) herpes zoster infection/oropharyngeal or vaginal candidiasis/*Mycobacterium tuberculosis*.

Stage IV: Late Stage HIV Disease (CD4 Count 50–200 mm^3)

- Signs and symptoms are related to AIDS defining opportunistic infection or malignancy.
- Common opportunistic infection include:
  Pneumocystitis jiroveci Pneumonia (PJP)/cerebral toxoplasmosis/diarrheal disorders/pulmonary or disseminated tuberculosis/severe oropharyngeal candidiasis/cryptococcal meningitis.
- Opportunistic cancers include:
  Kaposi's sarcoma/undifferentiated B-cell lymphomas.

Stage V: Advanced HIV Disease (CD4 Count < 50 mm^3)

- Even with therapy the persons in this stage have a likelihood of dying in 2 years.

Other manifestations in this period include:
Neurological effects that present as motor abnormalities, cognitive impairment and behavior changes/significant weight loss/wasting of muscles/various types of malabsorption/HIV wasting syndrome.

Diagnosis of HIV

The only way is by blood test, which will show whether he/she is HIV positive or not. In order to call a person HIV positive, the blood must be tested at least three times with three different test kits, either the ELISA or rapid tests and the results of at least two tests must be positive. The three tests are performed on the same sample of blood and it is not necessary to give blood again and again. These tests are available in the Voluntary Counseling and Testing Centers (VCTCs). The person must be counseled before the test is done (pretest counseling). Post-test counseling must be given to both HIV positive and HIV negative persons. Western Blot test is the most confirmative/specific test for HIV infection.

Diagnosis of AIDS

The persons should have tested two positive tests for HIV infection. In addition the person must have any one of the following criteriae:

- Weight loss > = 10 percent of body weight (not known to be due to a condition other than HIV infection) and/or chronic diarrheas for more than one month (intermittent or constant) and/or prolonged fever for more than one month (intermittent or constant).
- *Tuberculosis:* Disseminated, miliary or extrapulmonary
- Kaposi's sarcomas.
- Neurological impairment preventing independent daily activities, not known to be due to a condition unrelated to HIV infection (e.g. trauma).
- Candidiasis of the esophagus (diagnosable with dysphagia and oral candidiasis).

Clinical Presentation of Children with AIDS

Pediatric AIDS is suspected in an infant or child presenting with at least two major signs and two minor signs in the absence of known causes of immunosuppression.

Major Signs

- Weight loss (failure to thrive)
- Chronic diarrhea for more than one month
- Prolonged fever for more than one month.

Minor Signs

- Generalized lymphadenopathy
- Oropharyngeal candidiasis
- Repeated upper respiratory infections
- Persistent cough for more than one month
- Generalized dermatitis
- Confirmed maternal HIV infection.

One of the goals of the initial evaluation of the HIV infected individual is to determine the stage of the disease. The World Health Organization (WHO) proposed a clinically based staging system **(Table 20.25)**.

Prevention and Control of AIDS

It is by three major procedures.

1. Elimination of reservoir
2. Breaking the channel of transmission
3. Protection of susceptibles.

Elimination of Reservoirs

There is treatment for HIV/AIDS but there is no definite cure. Drugs used as Anti-Retroviral Therapy (ART), have been designed to interrupt the life cycle of the virus at different stages (by inhibiting either reverse transcriptase or protease enzymes) and not by destroying the viruses, thereby decreases the viral replication (viral load) and slows down the decline of immunity, but it will not restore the immunity. This results in lesser opportunistic infections and delays the onset of AIDS. Thus ART can prolong the life and improves the quality of life.

However these drugs are expensive, strong medicines producing numerous side effects and often result in drug interactions. Once the drugs are prescribed and initiated, they must be taken life-long. Drug resistance is the rule rather than the exception. This necessitates a change in the regimen. Inappropriately prescribed ART can do more harm than good. It is more dangerous to start drugs and stop than to have never started in the first place.

Only combination of ART drugs have been able to decrease the viral load below the threshold of detectable level, as long as they are taken.

The drugs have been grouped into different groups. They are Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs), Nucleoside Reverse Transcriptase Inhibitors (NRTIs), Protease Inhibitors (PIs) and Entry Inhibitor (EI). A combination of drugs, totaling three or more drugs has demonstrated the superiority of the regimen in reducing the virus to less than detectable level in the blood. It is called Highly Active Antiretroviral Therapy (HAART). Ever since the advent of HAART in 1996 there has been a drastic reduction in opportunistic infections.

Caution

- Monotherapy or dual therapy should never be used except for prevention of mother to child transmission (PMTCT) and post exposure prophylaxis (PEP).
- Tight adherence to therapy for life.
- Side effects to be treated promptly; toxic reactions may be fatal.
- 90 to 95 percent of all ART doses must be taken for optimal viral suppression. Poor adherence results in failure to suppress virus, drug resistance, increased morbidity and mortality. (Treatment failure is usually a consequence of adherence failure).
- Regular monitoring—for immune, viral and clinical response, toxicity and adherence.

Therefore WHO's present policy does not recommend antiviral drugs but instead advocates strengthening the management of HIV associated opportunistic infections to prolong the life of the person.

It is not necessary to isolate the person with HIV but necessary to isolate the virus.

Goals of ART

- *Virological goal:* To reduce the viral load to as low as possible, preferably to undetectable levels (<50 copies/mL)
- *Immunologic goal:* To maintain the CD4 count at as high level as possible.
- *Clinical goal*
  - To decrease the incidence of opportunistic infections.
  - To improve the quality of life, physically and mentally.
  - To decrease the HIV related morbidity and mortality.
  - To prolong the life and to reduce further transmission to others.
- *Therapeutic goals is:*
  - To maintain treatment regimen to achieve clinical, immunological and viral goals
  - To reduce drug toxicity
  - To reduce pill burden
  - To increase drug adherence in the patient.

Clinical Criteria to Start ART

HIV positive test with

- Definite diagnosis of AIDS (WHO stage 4 disease), irrespective of CD4 lymphocyte count.
- All persons with a CD4 count < 200 cells/mm^3, irrespective of presence or absence of symptoms.

Table 20.25 WHO clinical staging of HIV/AIDS for adults and adolescents

		Clinical stage 1	Clinical stage 2	Clinical stage 3	Clinical stage 4
		• Asymptomatic • Persistent generalized lymphadenopathy	• Unexplained moderate weights loss « 10% of loss (>10% of presumed or measured body weight) • Recurrent URTI – Sinusitis – Tonsillitis – Pharyngitis – Otitis media • Oral lesions – Recurrent oral ulcers – Angular chelitis • Cutaneous lesions – Papular pruitic – Herpes zoster – Seborrhea – Fungal nail infections	• Unexplained severe weight loss (>10% of presumed or measured body weight) • Unexplained persistent diarrhea (>1 month) • Unexplained persistent fever (above 37.5°C intermittent or constant for longer than one month) • Oral lesions – Persistent oral candidiasis – Oral hairy leucoplakia – Acute necrotizing ulcerative gingivitis, stomatitis, or periodontitis • Severe bacterial infections – Pneumonia – Empyema – Pyomyositis – Bone and joint infectinos – Menigitis – Bacteremia • Pulmonary TB • Hematological (Unexplained) – Anemia (HB < 8 g/dL) – Neutropenia (<0.5 × 10^9/liter) – Thrombocytopenia (<50 × 10^9/liter)	• HIV wasting syndrome • Infections – Pneumocystis pneumonia (PCP) – Recurrent severe bacterial pneumonia – Recurrent septicemia (including nontyphoidal *Salmonella*) – Extrapulmonary TB (including TB lymphode) – Esophageal candidiasis (or candidiasis of trachea, bronchi or lungs) – Chronic herpes simplex ulceration (orolabial, genital or anorectal> 1 month duration or visceral at any sight) • Infections needing special diagnosis – CMV infections (retinitis or other organ infection) – Disseminated mycoses (extrapulmonary cryptococcosis- including meningitis, extrapulmonary histoplasmosis, coccidiomycosis) – Chronic cryptosporidiosis – Chronic isosporiasis – Disseminated non-TB mycobacterial inf. – Atypical disseminated leishmaniasis • Malignancy – Lymphoma (cerebral or B cell non-Hodgkin) – Invasive cervical carcinoma – Kaposis sarcoma • Symptomatic HIV cardiomyopathy • Symptomatic HIV nephropathy
Cotrimoxazole prophylaxix	CD4 not available	No need	No need	Give	Give
	CD4 available	Give if CD4 < 200	Give if CD4 < 350	Give irrespective of CD4 count	Give irrespective of CD4 count
ARV therapy	CD4 not available	Do not treat	Do not treat	Treat	Treat
	CD4 available	Treat if CD4 < 200	Treat if CD4 < 200	Treat if CD4 < 350	Treat
If patient is on ART: • The clinical stage does not have prefix T and can only worsen (1 to 2 to 3 to 4)			If patient is on ART: • Prefix to the stage indicating staging was done while on ART, e.g. clinical stage T3 • The clinical stage can either worsen or can improve (1 to 2 to 3 to 4 and vice versa) • Improving stage indicate clinical response to ART and worsening stages may indicate treatment failure (if patient received at least 6 months of ART)		

Note:

- For asymptomatic people with CD4 counts >350 cells/mm^3, treatment may be deferred with CD4 count monitoring every 3 to 6 months.
- For asymptomatic persons with CD4 counts between 201-349, the decision to start ART should be individualized. The factors that need to be considered here are : the treating physician's approach, the person's affordability, the rate of fall of CD4 count over a period of 3 to 6 months, potential drug toxicities and if necessary the viral load. The aim is to prevent the CD4 count from falling below 200/mm^3.

The principles of ART are shown in the **Flow chart 20.4**.

Anti-retroviral Drugs

Table 20.26 shows all the antiretrovirals, their doses and side effects. The ones marked with asterisk are available in our country. Tenofovir (TDF) is nucleotide reverse transcriptase inhibitor (NtRTI).

It is not necessary to isolate the person with HIV but necessary to isolate the virus.

Dosage Schedule of First Line ARV Regimens

First line regimen contains two NRTIs and one NNRTI.

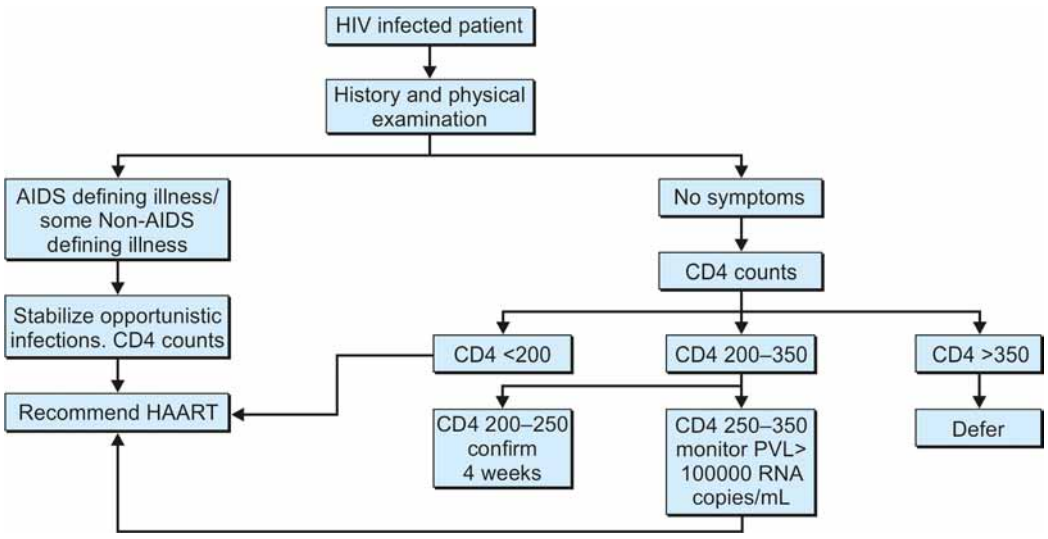
1. Zidovudine (ZDV) + Lamivudine (3TC) + Nevirapine (NVP)
2. Stavudine (d4T) + Lamivudine (3TC) + Nevirapine (NVP)
3. Stavudine (d4T) + Lamivudine (3TC) + Efavirenz (EFV)
4. Zidovudine (ZDV) + Lamivudine (3TC) + Efavirenz (EFV)

- Regimens 1 and 2 are the most commonly used because they are least expensive.
- Nevirapine is given in lower dose, 200 mg once a day, called 'lead in' dose, during first fourteen days (2 weeks), then increased to 200 mg twice daily, subsequently, called 'escalating dose'. This is to reduce the life-threatening rash.
- Missing even two doses in a month, can result in the development of resistance.
- If a dose is forgotten, double dose should not be taken.
- Nevirapine should not be used if a person is on Rifampicin based anti-tubercular treatment, as the blood levels of the former decrease by 20 to 50 percent and together there is a greater risk of hepatotoxicity.
- The recommended ART regimen during pregnancy is ZDV + 3TC + NVP. Stavudine (d4T) is not preferred because of the risk of lactic acidosis in pregnancy and Efavirenz carries the risk of teratogenicity.
- HIV +ve pregnant women, not medically eligible for ART, requires anti-retroviral prophylaxis, solely for the purpose of reducing the risk of transmission of HIV infection to the baby. The recommended prophylactic regimen is a single dose of 200 mg of Nevirapine orally to the mother at the onset of labor and a single dose of 2 mg/kg syrup of NVP to the newborn baby within 72 hours of birth.

Indications for Changing Treatment

1. Drug toxicity
2. Drug intolerance
3. Treatment failure indicated by progressively rising viral load and/or occurrence of a severe clinical episode and/or failure to raise CD4 count by at least 25 to 50 cells above the pretreatment baseline, over a period of one year.

Flow chart 20.4 Principles of antiretroviral therapy



Source: Manoj Jain, Dilip Mathai. Management of Infectious Disease, Jaypee Brothers Medical Publishers (P) Ltd. 1 edn. 2010.

Table 20.26 Antiretroviral drugs

Drug	Dose	Common side effects
Nucleoside reverse transcriptase inhibitors (NRTIs)		
Zidovudine (AZT)	600 mg orally daily in two divided doses	Anemia, neutropenia, nausea, malaise, headache, insomnia, myopathy
Didanosine (ddI)	400 mg orally daily (enteric-coated capsule) for persons 60 kg	Peripheral neuropathy, pancreatitis, dry mouth, hepatitis, diarrhea
Zalcitabine (ddC)	350 to 750 mg orally 3 times daily	Peripheral neuropathy, aphthous ulcers, hepatitis
Stavudine (d4T)	40 mg orally twice daily for persons 60 kg; 30 mg for <60 kg	Peripheral neuropathy, hepatitis, pancreatitis, lactic acidosis
Lamivudine (3TC)	150 mg orally twice daily	Headache, nausea, peripheral neuropathy
Emtricitabine (FTC)	200 mg orally once daily	Headache skin discoloration palms/soles (mild)
Abacavir (ABC)	300 mg orally twice daily	Rash, fever if occurs, rechallenge may be fatal
Tenofovir (TDF)	300 mg orally once daily	Nausea, lactic acidosis with hepatic steatosis
Nonnucleoside reverse transcriptase inhibitors (NNRTIs)		
Nevirapine (NVP)	200 mg orally daily for 2 weeks, then 200 mg orally twice daily	Rash which can be life threatening, hepatotoxicity
Delavirdine (DLV)	400 mg orally three times daily	Nausea, diarrhea, rash
Efavirenz (EFV)	600 mg orally daily	Neuropsychiatric disturbances, elevation in liver enzymes
Entry inhibitor		
Enfuvirtide (T-20)	90 mg subcutaneously twice daily	Injection site pain and allergic reaction, hypersensitivity reactions
Protease inhibitors (PIs)		
Saquinavir hard gel (SQV)	1000 mg twice daily with 100 mg ritonavir orally twice daily	Diarrhea, lipodystrophy, CAD
Saquinavir soft gel capsule (SGC)	1200 mg three times daily	Same as above
Ritonavir (r)	600 mg orally twice daily or in lower doses (e.g. 100 mg orally once or twice daily) as a booster for other PIs	Nausea, vomiting, diarrhea, hepatic failure, lipodystrophy
Indinavir (IDV)	800 mg orally TID	Kidney stones, nausea, lipodystrophy
Nelfinavir (NFV)	1250 mg orally twice daily	Diarrhea, lipodystrophy
Amprenavir (APV)	1200 mg orally twice daily	Nausea, diarrhea, rash, lipodystrophy
Fosamprenavir (F-APV)	1400 mg orally twice daily or 1400 mg orally once daily with ritonavir 200 mg orally once daily	Same as amprenavir
Lopinavir + ritonavir (LPV/r)	400 mg/100 mg orally twice daily	Diarrhea, lipodystrophy
Atazanavir (ATV)	400 mg orally once daily	Hyperbilirubinemia, diarrhea, rash, prolongation of PR interval

Second Line Regimen

This must include a protease inhibitor (PI) to the previous regimen or Triple NRTI regimen (Zidovudine + Lamivudine + Abacavir) as a last resort.

Monitoring of ART Response

The most widely used method to monitor the response to therapy is the CD4 count done every 3 to 6 months. The normal range in a noninfected HIV individual is >600 cells/mm^3. In untreated HIV infected person, the CD4 count is expected to fall by 20 to 50 cells/mm^3/year, although it is influenced by other factors like viral load, coexistent infections and individual characteristics. CD4 count is the most useful marker of when to start ART and the viral load, expressed as number of RNA copies/mL of plasma, is the most useful marker of response to ART. Viral load is the strongest predictor of the rate of disease progression. Untreated, those with viral

loads of 10,000–1,00,000 RNA copies/mL, progress to AIDS within an average of 8 to 10 years. It is often convenient to compare changes in viral load on a logarithmic scale.

A successful treatment regimen should ideally produce:

- By 6 weeks >1 log (i.e. 1 decimal point) drop in viral load.
- By 24 weeks <50 RNA copies/mL (undetectable viral load).
- A sustained rise in CD4 count.

A good virologic suppression is said to be achieved if the CD4 count shows an increase of at least 100 cells/mm^3/year. In reality however, modest increases in CD4 count with no new opportunistic infections and an overall feeling of well being can also be taken as good response. The maximum increase takes place in the first year, subsequently the count will level off by third or fourth year.

Immune Reconstitution Syndrome

(*Synonyms: Aka immune restitution syndrome; Immune restoration inflammatory syndrome*).

With the initiation of HAART, as the immune system (CD4 count) begins to recover, it is observed that within the first three months of initiation of HAART, an inflammatory response manifests to the already existing latent (asymptomatic) infections. The frequency of occurrence varies from 5 to 30 percent. Presenting characteristics maybe atypical. There is no clear management strategy. The most important thing is to continue HAART and most cases resolve over time. Steroids and other anti-inflammatory agents are yet under consideration.

Conditions Reported as IRS

Infectious

Tuberculosis	VZV
MAC	PML
Cryptococcosis	Leishmaniasis
Histoplasmosis	Toxoplasmosis
Cytomegalovirus	Non-infectious
Kaposis sarcoma	Sarcoidosis
PCP	Guillian Barre Syndrome
HBV, HCV	

Autoimmune disorders—Grave's disease, Lupus, Sweet's syndrome, Reiter's syndrome.

Breaking the Channel of Transmission

- By abstinence from sex.
- By having a faithful and uninfected sexual partner.
- By adopting safe sexual practice, as follows:
  - By avoiding sex with an unknown partner.
  - By using condom while having sex with unknown partner.
  - By using condom between married couples, if one of them has more than one sexual partner.
  - By using condoms between HIV positive couples, because each partner may be having different HIV and they may re-transmit HIV to each other. This may lead to rapid progression to AIDS.
    (However there is no guarantee that condom is full proof protective).
- By screening of donors of blood, semen, organ or tissues for HIV.
- By adopting strict sterilization practices in all hospitals and clinics.
- By discouraging practices of tattooing.
- By prompt treatment of STIs.
- By giving heat treated coagulation factors VIII and IX for all hemophiliacs.
- By using presterilized, disposable syringes and needles for giving injections.
- By avoiding sharing of razors, tooth brushes, shaving brushes, and bath brushes.
- By avoiding pregnancy among HIV positive women.

Protection of Susceptible Persons

Susceptibility is universal. There is no vaccine against HIV/AIDS. Health education is the only vaccine. All mass media channels should be involved in educating the people on modes of transmission, disease features, lack of treatment/cure and preventive measures.

Extensive education is given on the following points to protect oneself:

- By adopting safe sexual practice.
- By avoiding sharing of needles, syringes, razors, tooth-brush, bath-brush, shaving brush, etc.
- By avoiding direct contact with blood and body fluids of others.
- By adopting 'Standard (universal) Precautions' and postexposure prophylaxis among health care workers.

AIDS VACCINE

The potential HIV vaccines may be classified as:

- *Live attenuated vaccines:* These have shown high levels of protection against HIV in animals. However they are not currently being developed for use in humans because of safety concerns.
- *Subunit vaccines:* These vaccines contain a small protein or piece of the pathogen, which acts as an antigen as in AIDSVAX gp 120 vaccine. This vaccine failed to protect against HIV infection in an efficacy trial.
- *DNA vaccines:* This vaccine entails the use of copies of single or multiple genes from the live pathogen, which integrates with the human gene resulting in the formation

of a protein, which acts as an antigen and induces immune response. Eventhough it contains genes from the live pathogen, it will not cause HIV infection, because these DNA vaccines do not contain all the genes of the live pathogen.

- *Recombinant vector vaccines:* It is of the same strategy as that of DNA vaccines, but in this type, the genes are carried by a weakened bacterium or virus, called a vector. Many of the current AIDS vaccine candidates are vector vaccines. Scientists believe that the vectors are more effective in creating an immune response, rather than a DNA vaccine also. Some of these vectors include adeno-viruses, pox viruses such as Modified Vaccinia Ankara (MVA) virus and alphaviruses such as Venezuelan Equine Encephalitis (VEE) virus.

Major Challenges towards the Development of an Effective HIV/AIDS Vaccine

- Scientific challenges. These are due to the nature of the HIV virus.
  - Genetic diversity. Once the HIV virus enters the CD4 cells, it multiplies at a very rapid pace resulting in the production of copies that are genetically diverse from the parent virus. This makes development of an effective AIDS vaccine much more difficult because it will have to protect against so many different virus strains.
  - Failure in the formation of virus specific neutralizing antibodies.
  - Lack of proper animal model. The vaccine candidate is administered to macaques (monkeys) that are later infected with simian immunodeficiency virus (SIV), because HIV does not infect any other animal. As a result the animal model cannot mimic the actual HIV infection.
- Programmatic challenges.
  - HIV vaccine clinical trials are difficult, long and expensive.
  - Insufficient funding allocated to vaccine development.
  - Recruiting volunteers may be difficult in developing countries because of less education, myths and misconceptions about the vaccine.
  - Lack of political commitment.
  - Slow approval process in developing countries.

CLINICAL TRIAL ON AIDS VACCINE

World's largest HIV vaccine clinical trials phase III, was conducted in Rayong and Chon Buri provinces of Thailand, from October 2003 to June 2009 involving 16,402 noninfected adult volunteers of both sexes, aged 18 to 30 years and the results were announced in September 2009.

This trial is also known as RV 144, tested the 'Prime-Boost' combination of two vaccines namely ALVAC-HIV vaccine (the Prime) and AIDS VAX B/E vaccine (the Boost). The combination was based on HIV strains that commonly circulate in Thailand. The former consists of a diabled form of a bird virus called 'Canarypox' which cannot grow or cause disease in humans and the latter is composed of a genetically engineered glycoprotein, found on the surface of the HIV. Thus, it is neither a live nor a killed vaccine.

Half of the volunteers received vaccines and half placebo. Immunization was started in October 2003 and ended in July 2006.

A total of six doses were given in 6 months; 4 with ALVAC-HIV alone and last two with AIDS VAX B/E. They were tested for HIV every six months for 3 years. They received counseling on how to prevent being infected with HIV at the beginning of the study and every six months thereafter. Those who acquired HIV infection during the trial were given free access to HIV care including highly active antiretroviral therapy (HAART) and were offered a separate follow-up study (RV 152).

The study was sponsored by US Army and was conducted by Thailand Ministry of Public Health. Results were announced in September 2009, which showed that the vaccine regimen is safe and it is 31.2 percent effective in preventing HIV infection.

Standard (Universal) Precautions

These are a set of precautions designed to prevent transmission of HIV, Hepatitis B Virus (HBV) HCV and other blood borne pathogens while providing health care/first aid. The word 'Standard' or 'Universal' implies that these precautions must be used everytime, for every patient/procedure, considering as though he/she were HIV positive. It is not necessary to test all patients for HIV before surgery or delivery. They could be in the 'Window period'!

These precautions apply whenever there is contact or handling of blood or various other body-fluids containing visible blood (These fluids are semen, vaginal secretions, cerebrospinal, synovial, pleural, peritoneal, pericardial and amniotic fluids. Human breast-milk in milk-bank, also constitutes a suspected body fluid). However external body secretions like saliva, urine, feces, sputum, tears, nasal secretions, sweat and vomitus do not require standard precautions unless they contain visible blood.

Standard precautions are necessary:

- To prevent cross infection from infected to noninfected patient.
- To safe guard the health care personnel, who are at risk of getting infected.

- To avoid infection getting into the society through hospital–wastes.

Standard precautions involve the use of protective barriers such as gloves, aprons, gowns, masks, protective eyewear or foot coverings, by the health care worker, to protect the skin or mucous membranes to potentially infective materials and to prevent injuries caused by needles, scalpels and such other sharp instruments.

Basic essentials of standard precautions are **(Fig. 20.67)**:

- Washing hands with soap and water before and after all patient care.
- Washing hands immediately after exposure to blood and body fluids.
- Wearing gowns, gloves, eyewear, mask during procedures that are likely to generate splashes of blood or body fluids while controlling bleeding, conducting delivery, doing intubation and suctioning.
- Placing sharps such as syringes and needles, scalpel blades and such other sharp items, in puncture resistant containers for disposal.
- Do not recap the needle or recap with one hand only before disposal.
- Resuscitator bags should be used preferably to mouth to mouth breathing.
- Do not mouth–pipette; always use pipette with rubber bulb.
- Process all laboratory specimens as potentially infectious.

Disposal of Wastes (Explained under Management of Hospital Waste)

- Solid wastes are to be disinfected (with sodium hypochlorite 0.5%) and then incinerated or buried.
- Liquid wastes are disinfected and then flushed out.

Disposal of Dead Bodies of Individuals who have Died of HIV/AIDS

- It is preferable to use gloves while giving ceremonial bath.
- All orifices (nose, ears, mouth, vagina and anus) to be packed with cotton-wool.
- Contact with the fluids emanating from these orifices must be kept to a minimum.
- The body is then best disposed by cremation.
- If it has to be buried, the body is then wrapped in a plastic bag. Bleaching powder may be sprinkled below and above the body or in the coffin box.

Infection control precautions are intended to isolate the virus and the body fluids and not to isolate the patient.

Postexposure Prophylaxis

Postexposure prophylaxis (PEP) is a strategy to combat occupational exposure to HIV, which often occurs accidentally, among health care personnel, through:

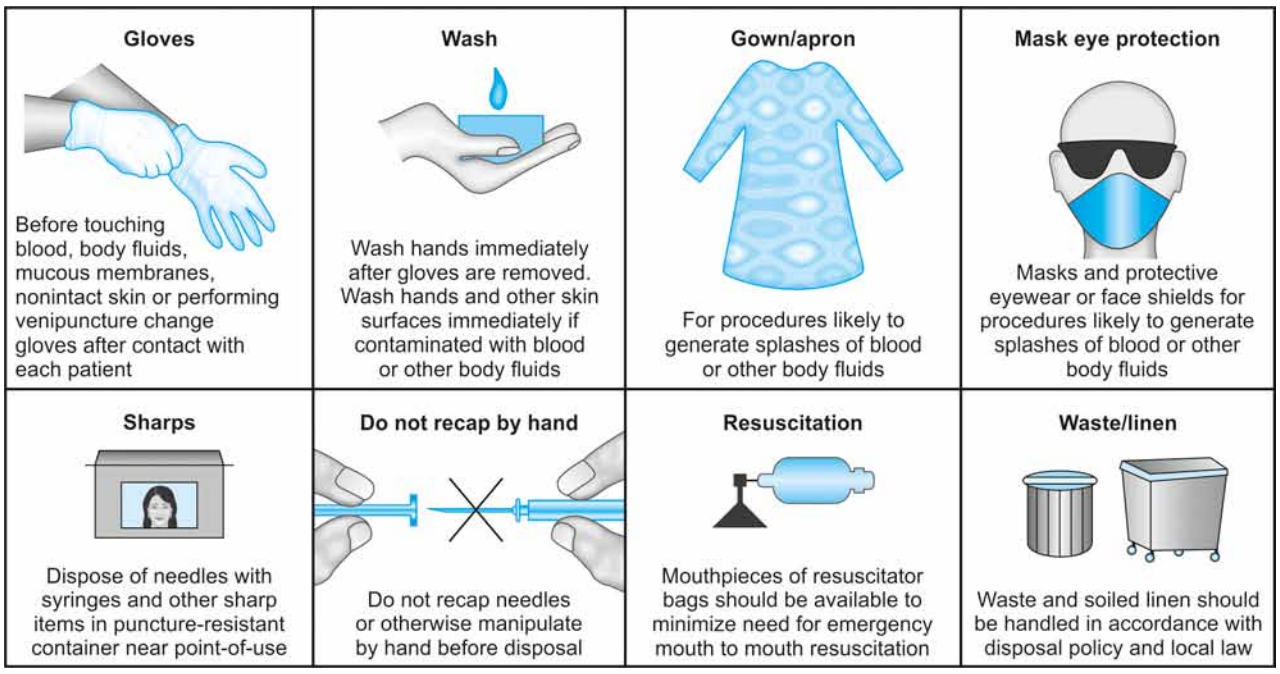


Fig. 20.67 Standard precautions against HIV
Source: Govt. of Karnataka. India Canada Collaborative HIV/AIDS Project and Karnataka State AIDS Prevention Society. Participant's Manual 2005.

- Percutaneous injuries such as needle–stick injuries or cuts with a sharp instrument.
- Contact with the mucous membranes of the eye or mouth of an infected person.
- Contact with blood or other potentially infectious body fluids such as semen, vaginal secretions, cerebrospinal fluid, synovial, pleural, peritoneal, pericardial or amniotic fluid.
- This is termed as Accidental Exposure to Blood (AEB).

The actual risk of infection depends upon:

- Type of needle (hollow or solid)
- Device visibly contaminated with blood
- Depth of injury
- Amount of blood involved in the exposure
- Viral load in the patient's blood
- Whether PEP was taken within the recommended period of 2 to 72 hours.

According to National AIDS Control Organization (NACO) PEP refers to 'Comprehensive medical management to minimize the risk of infection among Health Care Personnel (HCP) following potential exposure to blood borne pathogens (HIV, HBV, HCV). This includes counseling, risk assessment, relevant laboratory investigations, first-aid and provision of antiretroviral drugs with follow-up and support'.

Steps of PEP

Step 1: First-aid in management of exposure

- For the skin
- For the eye
- For the mouth.

For the skin

1. Immediately wash the wound with soap and water. Do not scrub.
2. Do not use antiseptics (bleach, chlorine, alcohol, betadine).
3. If there is splash of blood or body fluid on the skin, wash the area immediately and do not use antiseptics.

For the eye

1. Irrigate the exposed eye immediately with water or normal saline.
2. If there is contact lens, it is left in place while irrigating, as it forms a barrier over the eye and will help protect it. It is removed after cleaning the eye and cleaned with lens solution.
3. Do not use soap or disinfectant on the eye.

For the mouth

1. Spit fluid out immediately.
2. Rinse the mouth thoroughly, repeatedly using water or saline and spit again.
3. Do not use soap or disinfectant in the mouth.

Step 2 : Establish eligibility for PEP

- First PEP dose within 72 hours, ideally within 2 hours. PEP is not effective when given beyond 72 hours of exposure.
- Assessing the risk of transmission.

Categories of exposure

Category	Example
Mild exposure	Small caliber needle stick injury; contact with the eyes or mucous membranes
Moderate exposure	A cut or big bore needle stick injury (<18 G)
Severe exposure	Accident with a high caliber needle (>18 G); A deep wound, transmission with significant volume of blood

Note: In case of an accidental exposure to blood is with discarded sharps/needles, contaminated over 48 hours, the risk of infection with HIV is negligible. However still remains significant for HBV.

Step 3: Counseling for PEP

Every exposed person needs to be informed about the risks and benefits of PEP not only to provide informed consent but also it helps to relieve anxiety. Documentation of exposure is essential.

Step 4: Prescribe PEP regimen

There are two types of regimens.

- Basic regimen–2 drug combination
- Expanded regimen–3 drug combination.

The type of regimen depends upon the type of exposure and the HIV sero status of the source person.

Step 5: HIV chemoprophylaxis

PEP has its greatest effect if begun within two hours of exposure. The prophylaxis needs to be continued for four weeks.

ARV drugs during pregnancy

If the female Health Care Personnel (HCP) is pregnant, basic 2 drug regimen is recommended. A combination of Zidovudine (AZT) and Lamivudine (3TC) is preferred to Stavudine (d4T) and Lamivudine (3TC). Efavirenz and Indinavir are contraindicated. If third drug is needed, Nelfinavir is the drug of choice.

Step 6: Follow-up of an exposed person

Irrespective of whether the exposed person receives PEP ARV drugs or not, a follow-up is needed to monitor for possible infections and to provide psychological support.

Clinical follow-up: This is done for the features of primary HIV infection such as fever, rashes, lymphadenpathy, pharyngitis, ulcers in the mouth or genital area, which appear in 50 to 70 percent of individuals within 3 to 6 weeks after exposure. Then they are referred to ART center or for expert opinion.

Meanwhile the exposed person is advised to avoid donating blood or tissue/organ, breastfeeding, pregnancy

and unprotected sexual relation, especially during first 6 to 12 weeks following exposure.

Laboratory follow-up: HIV test should be done at 3 months and again at 6 months and if remains negative at the end of 6 months, no further testing is necessary.

Parent to Child Transmission of HIV

About 2 percent of HIV positive cases reported in India have acquired the infection through Mother to Child transmission (MTCT).

In India, prevalence rate of HIV is more than 1 percent among pregnant women in states of Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Manipur and Nagaland (high prevalence states).

Parent/mother to child transmission of HIV may occur during pregnancy, delivery or postnatally, transmission rate being 5 to 10 percent during pregnancy, 10 to 20 percent postnatally through breastfeeding, over a period of 24 months.

Risk Factors for MTCT

- *Immune status of the mother:* Lower the CD4 T-lymphocyte count, greater the risk of postnatal HIV transmission.
- *RNA viral load in plasma and breast milk:* Higher the maternal RNA viral load in plasma and breast milk, greater the risk of transmission through breast milk.
- *Anti retroviral therapy for HIV+ mothers and their babies:* ART to the mother and infant, significantly reduces the transmission through breast milk by improving CD4 count and decreasing RNA viral load.
- *Type of infant feeding:* Both breastfeeding and top feeding to the infant increases the risk of transmission twice, when compared to exclusive breastfeeding.
- *Breast conditions:* Cracked or bleeding nipples, mastitis, breast abscess is known to increase the risk of HIV transmission through breastfeeding. (According to available data, about 12% of HIV positive women experience one or more breast pathologies during breastfeeding).
- *Sexually transmitted infections during pregnancy:* Maternal STIs during pregnancy may increase the risk of HIV transmission to the unborn baby.
- *Obstetrical antenatal interventions:* Chorionic villi aspiration, amniocentesis, amnio-infusion, etc. increase the risk of HIV transmission.
- *Disruption of placental barrier integrity:* Infections of the placenta increases the risk of HIV transmission.
- *Intervention during delivery:* Artificial rupture of membrane, episiotomy, instrumentation and version increase the risk of HIV transmission.
- *Duration of breastfeeding:* Longer the duration of breastfeeding, higher the risk of HIV transmission, especially with mixed feeding.
- *Nutritional status of the mother:* Malnutrition in HIV+ mother increases the risk of transmission.

HIV–PEP evaluation

Exposure	Status of source		
	HIV+ and asymptomatic	HIV+ and symptomatic	HIV status unknown
Mild	Consider 2 drug	Start 2 drugs	No PEP or consider 2 drugs
Moderate	Start 2 drugs	Start 3 drugs	No PEP or consider 2 drugs
Severe	Start 3 drugs	Start 3 drugs	No PEP or consider 2 drugs

Dosage of drugs for PEP

Medication	2 drug regimen	3 drug regimen
Zidovudien (AZT)	300 mg twice daily	300 mg twice a day
Stavudine (d4T)	30 mg twice daily	30 mg twice a day
Lamivudine	150 mg twice daily	150 mg twice a day
Protease inhibitors		1st choice Lopinavir/Ritonavir (LPV/r) 400/100 mg twice a day or 800/200 mg once a day with meals
		2nd choice Nelfinavir (NLF) 750 mg three times a day with empty stomach.
		3rd choice Indinavir (IND) 800 mg three times a day and drink 1.5 liters of water daily

Note: If protease inhibitor is not available and the 3rd drug is indicated, Efavirenz (EFV) 600 mg once daily can be considered.

- *Infant's oral health:* Breech in the mucosal lining of the oral cavity of the infant, as it happens in the vigorous suction of the mouth after birth, cheilitis, stomatitis and oral thrush are some of the conditions carrying higher risk of transmission.
- *Multiple pregnancy:* First born among twins will have higher risk of getting HIV from the mother.

Prevention of Mother to Child Transmission of HIV

This can be discussed under primary and secondary prevention strategies.

Primary Prevention Strategies

This includes prevention of getting HIV infection among mothers, before they become pregnant. These are:

a. Intensive Information, Education and Communication (IEC) activities
   - Preventive measures of STDs
   - Informing about risk behaviors
   - Education to protect themselves from rape and sexual harassment
   - Educating the adolescent girls about reproductive health, safe sex and consequences of sexual behavior
   - Training of teachers about teaching sex education to girls.

b. Increasing access of family planning for women at risk to prevent unintended pregnancy
   - Delivery of FP Services more extensively
   - Address to adopt double contraceptive methods to protect from HIV infection and to prevent pregnancy.

c. Expanding access to HIV counseling and testing:
   - By identifying HIV infected women in the antenatal period
   - By referring them to VCTC
   - By motivating the sero negative mothers to modify their behavior.

Secondary Prevention Strategies

These are the measures to reduce or prevent the risk of HIV transmission from mother to the child.

a. Measures of Prevention of Mother to Child Transmission of HIV (PMTCT) during pregnancy
   - Administration of multivitamin supplementation to reduce the risk of LBW.
   - Avoiding invasive procedures on the uterus such as amniocentesis, amnioscopy, foetal scalp electrodes, etc.
   - Antiretroviral therapy (ART)—various regimens are recommended.
   - Avoiding ART in the first trimester of pregnancy due to known teratogenic effects.
   - Zidovudine 300 mg twice a day for the full course of pregnancy from the second trimester may be initiated.

   (Another regimen: ZDV 300 mg bd from 34th week of pregnancy till delivery).

b. Measures of PMTCT during childbirth:
   1. Antiretroviral therapy:
      ZDV 300 mg, three hourly during delivery;
      If the mother is brought during labor and if there is no history of ART during pregnancy, she is given 200 mg Nevirapine (NVP) as a single dose at the onset of labor.
      This reduces the risk of transmission from 35 to 12 percent.
   2. Prevention of premature rupture of the membranes.
   3. Mode of delivery
      - Elective cesarean section, done as early as 36 to 38 wk of pregnancy reduces the risk of transmission to less than 2 percent. Thus, it is safer than vaginal delivery.
      - If at all vaginal delivery/home delivery has to be conducted due to constraints of resources like hospital or experts or equipments or money, it should be conducted carefully by the health personnel, preferably by avoiding episiotomy.
      - If at all episiotomy is given, it needs to be sutured as early as possible to reduce the risk of occupational exposure.
      - Vaginal disinfection with chlorhexidine (0.25%) solution also helps to reduce neonatal morbidity.
      - Do not milk the umbilical cord, however cut it after cessation of the pulse.
   4. Care of the newborn
      - Suction from the throat first, followed by that from nose to prevent swallowing of the secretions.
      - Wipe the baby's body thoroughly with warm, clean towel to remove any blood stained secretions.
      - Administer single dose of NVP (nevirapine) 2 mg/kg syrup orally to the child within 72 hours after birth (or ZDV 4 mg per kg for 6 weeks).

   The protective efficacy of the drugs given during pregnancy, delivery and to the baby after delivery, is about 40 percent.

   Follow-up of the baby to check for HIV infection after 18 months of age (HIV test is not useful before 18 months of age).

Measures of PMTCT during Breastfeeding

[i.e. helping the HIV positive mother to reduce the chance of breast milk transmission (BMT)]

- Ensure adequate nutrition of the mother during postnatal period.
- She must be advised on correct positioning and attachment to prevent sore nipple.

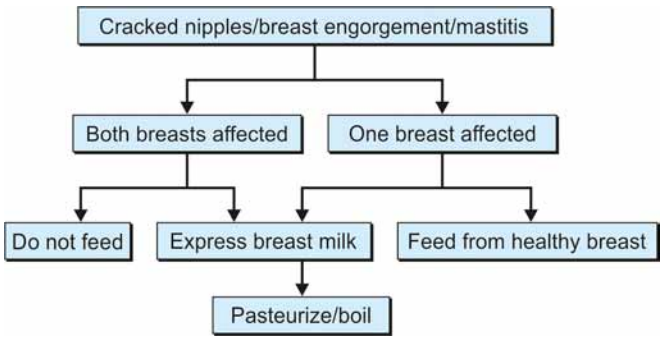
- Breast milk being the best milk for the baby, breast milk from an uninfected lactating mother (wet nurse) is the next best alternative.
- She is explained that the risk of HIV transmission through breast milk is 10 to 15 percent.
- Counseling is done and is explained the options for infant feeding.
  - If she wants to breastfeed and is able and willing to use animal milk or commercial infant formula, tell her to practice exclusive breastfeeding only upto 3 months or even less and stop breast milk abruptly and to start animal milk or commercial formula upto 6 months and to give complimentary foods from 6th month onwards upto 12 months.
  - If she is not willing to breastfeed, she can use animal milk or infant formula from birth to 6 months and supplemented by complemntary foods from 6 to 12 months.
  - If she wants to breastfeed but unable or not willing to use animal milk or infant formula, start exclusive breastfeeding an stop abruptly during 6th month and give only complimentary foods from 6th month onwards.

  Mixed feeding increases the risk of transmission.
- During breastfeeding she must practice abstinence from sex or use condom consistently during sex.
- Inform the mother to avoid breastfeeding if she has cracked nipples, mastitis or breast abscess **(Flow chart 20.5)**.

Helping a mother with unknown HIV status decide how to protect her baby from acquiring the infection.

- Ask her if she wants to know her HIV status
- If yes, refer to nearest VCTC.
- Reinforce the benefits of breastfeeding
- Counsel her to:
  - Breastfeed exclusively for 6 months.
  - Continue breastfeeding and give complimentary feeding from 6 months upto 24 months.
  - Protect herself from getting HIV by practicing abstinence from sex or use condom consistently during sex.

Flow chart 20.5 Breastfeeding in a HIV infected mother



BIBLIOGRAPHY

1. Anitha Nath. HIV/AIDS Vaccine. An Upadate IJCM 2010;35(2): 222-4.
2. Govt. of Karnataka. India Canada Collaborative HIV/AIDS Project and Karnataka State AIDS Prevention Society. Participant's Manual 2005.
3. International Baby Ford Action Network. Asia. Position Statement on HIV and Infant Feeding, 2012.
4. Manoj Jain, Dilip Mathai. Management of Infectious Diseases, Jaypee Brothers Medical Publishers (P) Ltd. 1st Edn 2000.
5. WHO. Control of Sexually Transmitted Diseases. Geneva 1985.

SURFACE INFECTIONS

RABIES

Rabies is an acute highly infectious viral disease of the central nervous system (brain and spinal cord). Basically it is a zoonotic disease, mainly of the carnivorous animals, specially the dogs as enzootic in India. All warm blooded animals are susceptible to rabies. Human beings, usually the children get the disease, accidentally by the bite or lick of the rabid animal (animal suffering from rabies). Pathologically rabies is characterized by acute inflammation of the brain and spinal cord. Clinically it is characterized by long and variable incubation period, short period of illness and the most characteristic feature being hydrophobia (fear of water). Mere sight or sound of water results in severe, painful spasms of the muscles of deglutition followed by respiratory paralysis, delirium, asphyxia and death. Death is the rule in rabies. Rabies in man is called 'hydrophobia', because of its classical feature. Hydrophobia is a most painful, agonizing, fearful and terrifying disease of all the human diseases. What converts such a faithful and best friend of man (i.e. dog) into a 'worst foe' is an extremely small microbe called 'rabies-virus'.

There is no treatment or cure anywhere in the world. Prevention is the only intervention.

Historical Perspective

The word 'Rabies' has been derived from the Sanskrit word 'Rabhas' which means 'to do violence'. Another group believes it to be originated from the Latin word 'Rebere', which means 'to rave', meaning talking irrelevantly (delirium). The disease is also known as 'Jalasanthra', which means agony caused by water. For a longtime this disease was thought to be due to supernatural force. *Shushrutha* emphasized that the antecedent cause of this condition in human being was the bite of a mad dog and it was fatal.

The disease was first investigated by Sir Louis Pasteur, who was basically a French Chemist, successfully prepared anti-rabies vaccine from the spinal cord of the infected rabbit. It was on 6th July 1885, that Sir Louis Pasteur for the first time successfully treated a 9-year-old shepherd boy namely Joseph Meister, who was severely bitten by a rabid dog and the parents had lost the hopes of his survival, with his vaccine and the child survived. Honoring his great achievement, Pasteur Institute was opened in Paris. Thus his contribution was great. This historical success paved the way, for the development of nerve tissue anti-rabies vaccines. Consequently every year July 6 is observed as 'World Zoonoses Day' (or World Rabies Free Day).

In 1903, Negri, an Italian scientist, demonstrated the viral particles, as inclusion bodies in the neurons of rabid animal, which are named after him as 'Negri bodies' and is considered pathognomonic of rabies.

In 1911, in India, David Semple, the then Director of Central Research Institute, Kasauli, Himachal Pradesh successfully developed a vaccine from the brain of the infected sheep, popularly known as 'Semple vaccine' or βPL-vaccine, which even today widely used in all government hospitals.

Later, Flury also prepared vaccine from chick embryo and duck embryo. It was cheaper but less safer and less effective than βPL-vaccine. Meanwhile the production of anti-rabic-serum of equine and human preparations (Equine and human rabies immunoglobulin) improved the quality of anti-rabic immunization practice.

In 1964, Witkor and Kaprowski, for the first time were successful in preparing Tissue Culture Vaccine (TCV) by culturing the virus in human diploid cells (human embryonic lung fibroblasts). The development of modern tissue culture vaccines have opened a new avenue in the prevention and control of rabies not only among human beings but also among animals. But attempts to find a 'Cure' for Rabies still eludes mankind.

Extent of the Problem

Rabies is present in all the continents except Australia and Antarctica. Among the remaining continents, many countries are free from rabies such as Japan, Malaysia, Oman, Qatar in Asia; Great Britain, Scandinavian countries, Spain and Portugal in Europe; Guyana, Uruguay and Jamaica in the Americas and Fiji and Papua New Guinea in Oceania. The incidence of rabies in these countries is zero because of the stringent regulations adopted for the dogs.

According to recent reports (1999) about 50,000 deaths occur due to rabies, annually, globally.

India alone accounts for nearly 30,000 deaths. Rabies is reported from all parts of India except Andaman, Nicobar and Lakshadweep Islands. If unreported cases are also taken into consideration, this number exceeds 2-3 times more. Nearly 3 million people take anti-rabic treatment every year in India.

Etiology

The causative agent is a RNA virus, a Lyssa virus type I, belonging to the family Rhabdoviridae. It is a bullet shaped virus, single stranded, nonsegmented, measuring 120 mμ length and 80 mμ breadth. A sheath of lipid envelops the body of the virus. The body surface has spikes like structures of 10 nm size, projecting all over. These spikes contain glycoprotein, which is the antigenic substance **(Fig. 20.68)**.

It is a neurotropic virus, having a tendency to affect the central nervous system. It is with the help of these spike like projections, the virus establishes itself in the cytoplasm of nerve cells (axoplasm). In the neurons of the brain, these viral particles are seen as inclusion bodies, called 'Negri bodies', which is pathognomonic of rabies. Presence of Negri bodies is confirmative of rabies and its absence does not rule out the diagnosis. Even though the viruses are neurotrophic, they are often found in the various body fluids like saliva, milk, urine and lymph of rabid animals and in saliva, semen, sweat and tears among affected persons. Saliva is rich in virus compared to other body fluids.

Because of the lipid content of the sheath, the virus is readily inactivated (killed) by fat solvents like disinfectants, (e.g. Dettol, Savlon, Tincture iodine, Povidone iodine) detergents, acids and alkalies, ultraviolet rays, heat at 60°C for 30 seconds as in Pasteurization, and 40 percent alcohol–like surgical spirit, after-shave lotion, and even alcoholic drinks like rum, gin and whisky. However, the virus is highly resistant against cold, dryness, decay and is known to remain infectious for weeks in cadavers.

The wild virus present in the saliva of rabid animal is called 'Street virus' (or Field virus). This is highly pathogenic. It is virulent to both human beings and animals. It is capable of producing Negri bodies in the neurons. It has long and variable incubation period, varying from 3 weeks to 3 months.

By successive passage through the brain of the laboratory animal, the street-virus is made to loose its pathogenicity (virulence) and capacity to produce Negri bodies (Attenuated); however still retaining its antigenicity. It becomes avirulent to human beings but virulent to only laboratory animals. The incubation period of this virus becomes short

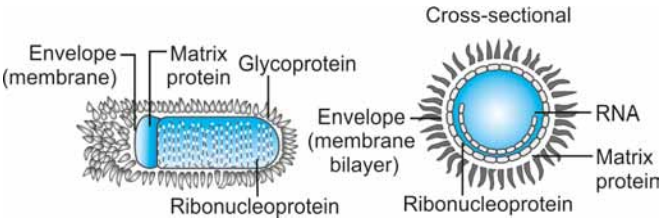


Fig. 20.68 Rabies virions are bullet-shaped with 10 nm spike-like glycoprotein peplomers covering the surface. The ribonucleoprotein is composed of RNA encased in nucleoprotein, phosphorylated or phosphoprotein and polymerase

and fixed, i.e. 5 to 6 days, in the laboratory animal. This modified virus is called as 'Fixed virus' or 'Seed virus' which is employed in the preparation of the vaccine.

The 'fixed virus' differs from 'Street-virus' (wild virus) in that:

- It is avirulent to human beings but virulent to lab. animals
- It has lost its pathogenicity on human beings but retains its antigenicity
- It has lost its capacity to produce 'Negri bodies' in neurons
- It has lost the power of invasion and multiplication
- The incubation period in lab. animal is reduced and is fixed, i.e. 5 to 6 days.

These advantages of the fixed virus (seed virus) are made use of in the preparation of the vaccine.

Reservoir of Infection

The principal reservoir of rabies in India are the rabid, wild, carnivorous animals (like tigers, wolves, foxes, etc.) and the rabid stray dogs of the urban and rural areas.

The common reservoirs, countrywise are as follows:

Dogs—in most parts of the world, particularly in Asia, Latin America and Africa.

Foxes—Europe, Arctic and North America

Reccoons—Eastern United States

Skunks—Western Canada

Coyotes—Asia, Africa and North America

Bats—Vampire bats in South America, insectivorous bats in North America and Europe.

Carrier state does not exist among animals but can occur exceptionally, which is proved by the fact that bitten animals have remained healthy whereas the bitten persons have developed rabies and died. However, the carrier state of rabies among animals is yet to be conclusively established. Fortunately carrier state does not exist among human beings, only clinical cases occur.

However, cases of hydrophobia constitute the potential sources of infection because of the excretion of the virus in the saliva and presence of rabies antigen in the cornea.

All warm blooded animals, from a small mouse to massive elephant, including human beings, are susceptible to rabies, can get the disease and act as a source of infection to others.

In certain caves of the forests of Latin American countries, carnivorous vampire bats have been found to be the carriers of rabies. They attack men and animals (cattle), who enter those caves. They feed on the blood of animals and man by bite and spread the disease. They also often transmit by aerosol route.

Vampire bats have not been reported in India. The epidemiological importance of bats is that they act as a constant source of infection for human beings and wild animals, thus enabling the virus to persist in nature.

In India, dogs constitute the principal reservoirs and there is no evidence of bat rabies.

Infective Material

Among the rabid animals, the highly infectious material is the saliva. Less infectious materials are other body fluids like serum, urine and milk. The viruses are mainly excreted in the saliva. However, the milk of the rabid animal is potentially infectious.

Among the human cases, the saliva, sweat, semen and tears contain the viruses but for all practical purposes they do not constitute as highly infective material, probably because the viruses are not in optimum number. Thus a human case is only potentially infectious others.

However, cornea of human cases constitutes an infective material, because rabies antigen has been detected in the corneal cells.

Period of Infectivity

The rabid animal is infectious to others during the last 3 to 5 days of incubation period and also during the entire period of illness, which is of about 8 to 10 days. Thus the total period of infectivity is about 12 to 15 days. The rabid animal remains infectious till it dies. Human cases are potentially infectious during the period of illness.

Susceptibility

Susceptibility is universal. All warm blooded animals including human beings are susceptible. However not all the persons bitten by rabid animals will get the disease, but only 15 to 20 percent will get the disease, because the virus is not excreted continuously but intermittently in the saliva of rabid animals. But among those who get the disease, mortality is 100 percent.

Modes of Transmission

The disease is transmitted from animal to animal and from animal to human being by the lick or by the bite of a rabid animal. From the wild animals (sylvatic cycle) it is transmitted to domestic animals (urban cycle) and accidentally to human beings. However, the disease is not transmitted from person to person (even though the saliva is potentially infectious material) because the person suffering from this disease will not have biting tendency and the saliva also does not contain the virus in optimum number. Therefore, rabies in man is a 'Dead end disease'. Thus human cases of rabies constitute only a potential source of infection. However, man to man transmission is possible through corneal grafting, because rabies antigen has been detected in the corneal cells of a case of hydrophobia. In 2004, three cases of human rabies deaths were reported in USA following liver and kidney transplantations.

In forests of Latin America, rabies is also transmitted by the bite of insectivorous (carnivorous) bats and by aerosol route by the vampire bats to wild animals and human beings whenever they enter those caves in the forests.

Transplacental transmission has been proved in animal studies but not in human beings.

Since the virus never enters the circulation, hematogenous route of transmission is also ruled out.

Oral transmission through drinking raw milk of a rabid cattle is less likely because the virus is destroyed by gastric hydrochloric acid. However it can be dangerous if there are aphthous ulcers or abrasions in the mucous membrane of the pharynx.

Sexual transmission has also not been reported so far in both human beings and animals, even though the virus has been isolated from the semen and vaginal secretions of hydrophobia patients.

Route of Entry of Virus

Invariably it is the percutaneous route.

Pathology and Pathogenesis

Having entered the body through the percutaneous route, the viruses which are deposited at the site of bite, multiply in the muscle cells and then reach the motor end plates (nerve endings). From there, the virus travels along the endoneural lymphatic ducts of the nerve sheaths (axoplasm) centripetally, slowly, at the rate of 3 mm per hour, and reaches the spinal cord (posterior horn cells) innervating the area of bite, resulting in myelitis. From there it ascends upwards to reach the brain, resulting in encephalitis. It affects the limbic system, mainly the Hippocampus. From the brain, the virus passes centrifugally along the cranial nerves and reaches salivary glands and cornea.

The essential pathology in the neurons is the necrosis, disappearance of Nissl granules and appearance of Negri bodies, which are the viral particles and pathognomonic of rabies. They are found mainly in the Hippocampal gyrus.

Throughout the passage to the brain tissue, the virus never enters the circulation. Hence, there is no viremia and therefore there is no production of antibodies. Therefore there is no recovery also once the virus enters the nerve(s) it becomes inaccessible to immune mechanism, viz. to vaccine and sera.

However during its centrifugal passage from CNS to the salivary glands and other organs like liver, kidney, etc. antibodies are produced. Since the production of antibodies is too late, they are not beneficial.

Once the neurons are destroyed (necrosed) they never regenerate, nor are there drugs to stimulate nerve cell regeneration. Thus once a pathology is a permanent pathology, consequently becomes 100 percent fatal.

Incubation Period

Usually it varies from 3 weeks to 3 months. But it can vary from 15 days to 1 year. In no other disease, the incubation period is so variable. It depends upon the following factors:

- *Site of the bite:* Nearer the site of bite to CNS, shorter the incubation period, as in bites in head and neck region.
- *Severity of bite:* More severe the bite, shorter the inc. period, because more of saliva is deposited.
- *Species of the biting animal:* Bites by the wild animals will have short inc. period than those of domestic animals because the former bite more severely.
- *Richness of the nerve supply:* Bites over the highly innervated areas like perineum, palms and fingers will have a short incubation period.
- *Amount of saliva deposited:* More the quantity of saliva deposited over the wound, shorter will be the inc. period.
- *Protection through clothes:* Bites through clothes will have long incubation period than bites over bare skin.
- *Partial treatment taken if any:* Incomplete course with antirabies vaccine will prolong the inc. period.

Clinical Features

The disease is called 'Rabies' in dogs (animals) and 'Hydrophobia' in humans.

In dogs: The manifestations are of two types—namely 'Furious' or 'Frank' rabies and the other 'Dumb' rabies, depending upon the behavior of the animal. The inc. period varies from 2 weeks to 2 months.

a. *Furious rabies (Frank rabies; mad dog syndrome):* This is observed in 80 to 90 percent of cases. In the early prodromal stage, the dog starts behaving differently and abnormally, goes to dark corners, becomes restless, shows unusual agitation and develops fever. It may look more affectionate also. Later it becomes dangerously aggressive, irritable, more ferocious, eyes looking red, runs here and there for no reason (running amuck), develops perversion of taste and starts biting its own chain, stone, paper, wood, iron and metal objects and in this process it even bites man and other animals, whomsoever it encounters (attacks without any provocation).

   Later, in the clinical stage, it develops paralysis of the lower jaw giving rise to protrusion of tongue, drooling of viscid saliva from its mouth, foaming at the angle of the mouth and paralysis of the vocal cord leads to change in tone of the bark. Later it develops paralysis of limbs and trunk. Death occurs mostly due to respiratory paralysis and convulsions. Mortality is 100 percent among animals also.

b. *Dumb rabies (Paralytic rabies):* This occurs in 10 to 20 percent of animals. The features are all opposite to those of furious rabies. The dog becomes silent,

withdraws itself from being disturbed or seen. It sleeps in a corner. Paralysis of muscles starts with that of head and neck region. The animal develops difficulty in swallowing and the owner out of ignorance tries to help the dog and exposes himself to infection. Death results from general paralysis. Mortality is 100 percent in this type also.

Hydrophobia is not a feature in dogs. On the other hand, they drink copious quantity of water and even swim.

In man: The features of classical hydrophobia develop in the following stages in 80 to 90 percent cases:

a. *Prodromal stage:* This is characterized by headache, restlessness, fever, tingling and numbness at the site of bite and malaise. Itching at the site of bite remains even if the bitten wound has healed.
b. *Stage of excitement:* In this stage, CNS is affected in this order.
   i. *Sensory system:* High fever continues. The patient becomes restless, irritable, anxious and nervous. He is irritable if disturbed or examined. He becomes sensitive to sensory stimuli like touch, pain, cold and hot. Therefore he may even get convulsions on strong sensory stimuli.
   ii. *Motor system:* Later involvement of motor system results in increased tone and spasticity of muscles giving exaggeration of deep reflexes, jerks, tremors or tic like movements.
   iii. *Sympathetic system:* Still later, involvement of sympathetic system results in excessive perspiration, lacrimation, salivation and increased libido. Temperature, pulse and respiration increases.
   Meanwhile he develops aerophobia (fear of air/breeze) and photophobia.
c. *Stage of paralysis:* Still later, he develops paralysis of the muscles of deglutition resulting in difficulty and pain in swallowing the food. An attempt to swallow gives rise to choking sensation in the throat. So the patient cannot take food and drinks, even though he is thirsty and hungry. As the condition progresses an attempt to swallow food and water, reflexly results in painful spasm of the muscles of deglutition, so much so he is scared of taking food and water. Finally even the sight or sound of water results in severe painful spasms of the muscles of deglutition. This characteristic feature is called 'Hydrophobia' (fear of water). The patient is simultaneously tormented with both thirst and fear of water, which does not occur in any other disease. Ultimately, there is change in voice, frothy saliva, hypersalivation, anxious look, fear of death, respiratory paralysis, asphyxia, cardiac arrest and death. Death is the rule in hydrophobia.

Throughout the period of illness, the patient is conscious, never behaves like a dog, nor he develops biting tendency. Death occurs within about 8 to 10 days.

Clinical Features of Dumb Rabies (Paralytic Rabies)

This occurs in about 10 to 20 percent of human cases. This is seen mostly among partially immunized persons. The common clinical features include:

- Gradual ascending paralysis
- Constipation and urinary retention
- Stupor, coma and death within 1 to 2 weeks
- Hydrophobia is usually absent.

Laboratory Diagnosis

Antemortem

- Skin biopsy (nuchal region) from along the hairline of neck and Fluorescent Antibody Test (FAT) to demonstrate the presence of viral antigen.
- Corneal impression, saliva smear for FAT (less reliable) (in the second type, negative test does not rule out the diagnosis).

Postmortem

- Biopsy of brain and seller's stain for Negri bodies.
- Fluorescent Antibody Test.

However in majority of cases, the diagnosis is based on clinical manifestations, corroborative evidence of animal bite, death of the animal and incomplete or no immunization at all following exposure.

Management of Hydrophobia Case

There is no treatment or cure for hydrophobia. Prevention is the only intervention. Symptomatic treatment with supportive treatment and sedation can ensure peaceful death to the victim.

- Admission in a quiet room of a hospital (usually at the Isolation hospital).
- Sedatives, antipyretics, analgesics, antihistaminics and anticonvulsants.
- IV rehydration, steroids and osmotic diuretic like mannitol.
- Expert nursing care is of supreme importance.
- Mechanical ventilation of lung if facilities are available.
- Medical attendants should ideally receive pre-exposure prophylaxis with anti-rabies vaccines and are advised to wear glasses, masks, gloves, shoes and plastic apron. They should avoid contact with saliva, urine and tears of the patient.
- Family attendants should also receive pre-exposure prophylaxis immunization and avoid contact with the infectious materials.
- Concurrent disinfection of the patient's belongings like clothes, bedsheets, utensils, etc. is carried out.

After death of the patient:
- The dead body should be covered by white cloth, soaked in antiseptic before disposal.
- Body is best disposed by burning.
- Terminal disinfection of the room should be done.

Prevention of Rabies in Man

There are two broad approaches.
1. Postexposure Prophylaxis (PEP) (Prevention of the disease in an infected person)
2. Pre-exposure Immunization (Prevention of the infection in a healthy person)

Postexposure Prophylaxis

PEP has the following four broad components:
- Wound treatment.
- Observation of the animal, wherever possible.
- Antirabies immunization.
  - Active immunization (with antirabies vaccine)
  - Passive immunization (with antirabies sera/immunoglobulin) in class III exposure (vide below)
- Advice to the patient.

Principles of PEP

- To reduce viral load by elimination of the virus from the wound
- To neutralize the virus at the site of entry
- To prevent infection of the nerves
- To induce systemic immunity.

Wound Treatment (First Aid Treatment)

Steps

i. Gentle washing of the wound using a detergent soap, preferably under running tap water for at least 10 minutes, so that the viruses are mechanically removed out (Physical step).

ii. Application of the viricidal agents like 70 percent alcohol, povidone-iodine, tincture iodine or other antiseptics like Dettol or Savlon, to destroy the remaining viruses **(Fig. 20.69)** (Chemical step).

iii. In case of extensive, deep wounds, thorough exploration, debridement, removal of dirt, dead tissue and foreign bodies may be required, often under anesthesia.

iv. Saturing of wounds shall generally be avoided. If there is severe, lacerated injury requiring sutures, suturing should be postponed for about 2-3 days because surgical intervention may facilitate the virus to reach CNS soon. The suture should be loose and minimal and not interfere with free bleeding and drainage. The suturing should be done only after local infiltration of Equine or Human Rabies Immunoglobulin in class III exposure (vide below). If RIG is not available, the wound must be thoroughly flushed with antiseptic lotion like povidone iodine or tincture iodine. Local infiltration with Rabies Immunoglobulin (RIG) neutralizes the residual virus (Biological step).

v. Generally the animal bite wound should not be dressed or bandaged and if unavoidable it should be loose and not occlusive.

vi. Immunization against tetanus is given as a routine, if the patient is not immunized. Active or active and passive immunization is given against tetanus depending upon the case.

vii. Prophylactic antibiotics is given to prevent secondary infection.

viii. Cauterization of the wound with acids and alkalis is no longer recommended because of the advent of the vaccines and sera.

ix. Analgesics and antiinflammatory drugs to be given, if the wound is painful.

In case of licks, to know whether there is microscopic abrasion, application of spirit/brandy resulting in irritation (burning sensation) confirms.

The wound treatment is very valuable and by itself, can prevent rabies by eliminating or inactivating the inoculated

Fig. 20.69 In cases of an animal bite/scratch follow these simple first aid steps

virus. Hence, wound treatment must be done as early as possible. Eliciting the history of previous anti rabies vaccination is relevant and influences the course of present anti rabies treatment.

Observation of the Animal (Wherever Possible)

This is applicable only to dogs and cats and not to other animals. The bitten animal should be observed for 10 days. The rationale is that if the animal is infected, its saliva is infective up to 5 days before the signs of rabies appear in it and once the signs of rabies appear, it will invariably die in about another 5 days maximum. In India, the dogs and cats including pets are presumed to be rabid/infective (even if vaccinated) at the time of biting. Hence it should not be killed or chased away but be observed for the following signs for 10 days.

- Change in its behavior—aggression or depression.
- Running amuck and biting without any provocation.
- Withdrawing itself to a corner.
- Excessive salivation.
- Change in its tone of the bark.
- Eating unusual objects.
- Death of the animal.

Occurrence of any one of the above signs, strongly indicates rabies. If facilities are available, the animal is humanly killed and the brain is examined for Negri bodies. If facilities are not available, the animal is suspected to be rabid and correct and complete postexposure immunization is done.

Antirabies Immunization

This procedure is unique in that the immunization is given only after exposure to the disease, unlike all other vaccines which are given before exposure to the disease.

Even though rabies is 100 percent fatal, common among children, vaccines are available, immunization against rabies is not included under Universal Immunization Programme because of the following reasons:

- The incubation period of rabies is long, which can be utilized to induce immunity before the virus reaches CNS.
- The immunity with anti-rabies tissue culture vaccines is hardly 3 years.
- The vaccines are costly.

Indications for Antirabies Immunization

This should be started immediately when a person is bitten, scratched or licked by the animal under the following conditions:

- The animal is not available for observation (presumed rabid).
- The animal shows signs of rabies (suspect rabies).
- The animal proved positive for rabies by lab. exam. (confirmed rabies).
- The person drinking raw milk of a rabid animal.
- Immunization should not be denied even if the patient comes late.

Situations where Antirabies Immunization is not Indicated/ Required

- Drinking heated or boiled milk of rabid animal.
- Bitten animal remaining healthy and alive for 10 days after the bite.
- Touching the rabid animal but no definite contact with the saliva.
- A bite or scratch over the clothes and no injury of the skin.
- Unprovoked and accidental bites by rodents, birds, bats and insects.

For immunization purposes, the bitten persons are grouped into three categories as 'No risk', 'Low risk' and 'High-risk'.

No immunization is given in 'No risk' group (Cat I).

Only active immunization in 'Low risk' group (Cat II)

Both active and passive immunization in 'High-risk group' (Cat III).

Active immunization is given by Antirabies Vaccines (ARVs).

Passive immunization is given by Rabies-Immunoglobulins (RIG), which are of two types—Equine Rabies Immunoglobulin (ERIG), dose = 40 IU/kg and Human Rabies Immunoglobulin (hRIG), dose 20 IU/kg.

Rabies Vaccine History

Vaccines Prepared from Animal Tissues

1885: Louis Pasteur developed the first rabies vaccine (from the spinal cord of rabbit).
1911: Semple vaccine (from sheep and goat brains) (BPL – Vaccine)
1955: Fuenzalida vaccine (from suckling mouse brain)
1955: Powell prepared Duck Embryo cell vaccine (from embryonated eggs) (Flury's vaccine).

Vaccines Prepared from Primary Animal Cells (Modern Tissue or Cell Culture Vaccines)

1960–1965: Purified Chick Embryo Cell Vaccine (PCEC-V) by Kondo.

Primary Hamster Kidney Cells Vaccine (by Kissling).

Primary Dog Kidney Cell Vaccine.

Vaccines Prepared from Standardized Cell Lines (Cell Bank)

1964: Human Diploid Cell Vaccine (HDCV) by Witkor.
1972: HDCV was also prepared by Wistar and Merieux Institutes.
1985: Purified Vero-Cell Rabies Vaccine (PVRV) (Vero-Cell line) by Merieux Institute.

Recombinant antirabies vaccines are under trial.

Active Immunization

Antirabies Vaccines (ARVs)

All anti-rabies vaccines are killed vaccines, wherein the Virus is killed or inactivated by Beta Propriolactone (BPL). They are broadly classified into three categories.

1. Nerve tissue vaccine (NTVs)
2. Duck embryo vaccine (DEV)
3. Modern tissue (or Cell) culture vaccines (TCVs or CCVs).

THERE IS NO SINGLE DOSE VACCINE OR A VACCINE GIVING LIFELONG IMMUNITY

The vaccines againt rabies are grouped into three groups as follows:

1. Nerve tissue vaccines
   These are prepared from the animal tissues.
   These are of the following types.
   a. BPL–Vaccine (Semple–vaccine)
   b. Suckling mouse brain vaccine (Fuenzalida vaccine).
2. Duck embryo vaccine (Flury Vaccine)
3. Cell Culture Vaccines
   a. Human diploid cell vaccine (HDCV)
   b. Purified chick embryo cell Vaccine (PCEC-V)
   c. Purified vero-cell rabies Vaccine (PVRV)

   } Nonhuman cell vaccines

There is no single dose vaccine or a vaccine which gives lifelong immunity.

Nerve Tissue Vaccines

These are prepared by inoculating the fixed virus into the nervous system of the sheep, goats, rabbits or mice, killed on 7th or 8th day, brain is removed and 5 percent emulsion is prepared with saline and the virus is killed by using Beta Proprio Lactone. Hence, the name BPL-vaccine. In Semple vaccine sheep is employed.

These are provided free of cost through Govt. hospitals, health centers and Municipal and Corporation centers.

The dosage schedules vary according to the manufacturer, from 1 to 5 mL, daily, subcutaneously, around the umbilicus, for 7 to 10 days, followed by one or two booster doses. However in pregnant women, it is given, either in the thigh region or in the back in the interscapular region.

Demerits are it is a killed vaccine, hardly 50 percent effective, injections are painful, immunity develops slowly, lasts hardly for 6 months and cause neuroparalytic reactions.

Neuroparalytic reactions are due to the presence of neuroparalytic factor (or myelin content) in the vaccine.

Thus, the nerve tissue vaccines are less efficacious and more reactogenic.

Though this vaccine is recommended for discontinuation by the WHO because of the demerits, this continues to be the mainstay of antirabies vaccination in India today, only because it is supplied free of cost and modern vaccines are costly.

Dosage Schedule

Two different dosage schedules are followed in India, as recommended by Coonoor and Kasauli Institutes respectively **(Tables 20.27 and 20.28)**.

WHO Guidelines for Postexposure Treatment (PET)

Category	Type of contact with a suspect or confirmed rabid animal or animal not traceable	Recommended treatment
I (No risk)	Touching or feeding of animals. Licks on intact skin	Nothing required
II (Low risk)	Nibbling of uncovered skin, Scratch or abrasion without bleeding; Licks on broken skin.	Administer ARV immediately; Stop treatment if the animal is found healthy for 10 days after the bite or if the animal is euthanized and found to be negative for rabies by laboratory techniques.
III (High risk)	Single or multiple transdermal bites or scratches with bleeding; Contamination of mucous membrane with saliva, Licks on mucous membrane	Administer both ARV and Rabies Immunoglobulin (RIG) immediately. Stop treatment if the animal is found healthy for 10 days after the bite or if the animal is euthanized and found to be negative for rabies by lab. techniques.

Table 20.27 Dosage schedule of BPL-vaccine; recommended by Pasteur Institute, Coonoor

Category	Dosage per day		Duration of treatment	Booster dose
	Adult	Child		
I	2 mL	1 mL	7 days	Nil
II	3 mL	3 mL	10 days	1 BD about 3 wk later
III	5 mL	3 mL	10 days	2 BD 1st BD about 1 wk later and 2nd BD about 2 wk after first booster dose

Table 20.28 Dosage schedule of BPL-vaccine; recommended by Central Research Institute, Kasauli

Category	Dosage per day		Duration of treatment	Booster dose
	Adult	Child		
I	2 mL	2 mL	7 days	Nil
II	5 mL	2 mL	10 days	1 BD about 3 weeks later
III	5 mL	2 mL	10 days	2 BD 1st BD about 1 week later and 2nd BD about 2 weeks after 1st BD

Suckling Mouse Brain Vaccine

This is prepared by inoculating the fixed virus into the brain of young suckling mice (of less than 9 days old). This is safer than Semple vaccine, because it does not contain myelin content (neuroparalytic factor) or contains minimum content in the neonatal mouse. Dosage schedule is same. It is extensively used in Latin America. Not recommended by WHO.

Duck Embryo Vaccine or Flury's Vaccine

This has been developed in an attempt to prepare a vaccine free from neuroparalytic factor. Thus it is superior to nerve tissue vaccine. However it has its own limitations of causing allergic reactions among those who are sensitive to egg protein. This is not used in India.

Cell Culture Vaccines

These are modern tissue culture vaccines – Introduction of these vaccines is a great advance in rabies prophylaxis. This has opened a new avenue in the prevention and control of rabies. Compared to other vaccines, these are highly potent, highly safe, highly stable, highly effective and least reactogenic. Total number of doses are less with smaller volume, making the injections almost painless, given with spaced intervals. Dose is same irrespective of age and sex. They are freeze-dried vaccines. They are always supplied in single dose, single unit packs alongwith the diluent and sterile disposable syringe. It is given intramuscularly in the deltoid region or in small children, in the lateral aspect of thigh but never given in the gluteal region, because of the presence of subcutaneous fat, which interferes with the vaccine uptake, resulting in vaccine failure.

The vaccines are interchangeable. That means immunization can be started with one cell culture vaccine and switched over to other type of cell culture vaccine.

Immunity is developed after 8 days and lasts for about 3 years.

These vaccines are used for both preexposure prophylaxis and postexposure treatment.

Absolutely there are no contraindications because the risks of rabies outweigh all other considerations.

The dosage of HDCV and PCEC-vaccine (RABIPUR) is 1 mL while that of PVRV (Verorab; Abhyarab; Verovax. R) is 0.5 mL. The diluent is Sterile Distilled water for PCEC – vaccine and Sterile Normal Saline for PVRV. HDCV is available as liquid vaccine (**Fig. 20.70**).

Important precautions to be noted are:

- The diluent should be added to the vaccine along the side wall of the vaccine vial
- The vaccine should not be shaken after adding the diluent, but only rolled between the palms, because shaking the vial results in the formation of foam which cannot be aspirated in the syringe, resulting in underdose and vaccine failure.
- Vaccine is administered soon after dilution.
- Storage temperature of the vaccines is +2 to +8°C in refrigerator (This should never be kept in the freezer chamber).

The vaccines maintain the potency of 2.5 IU per dose and the protective antibody titer is 0.5 IU per mL of serum.

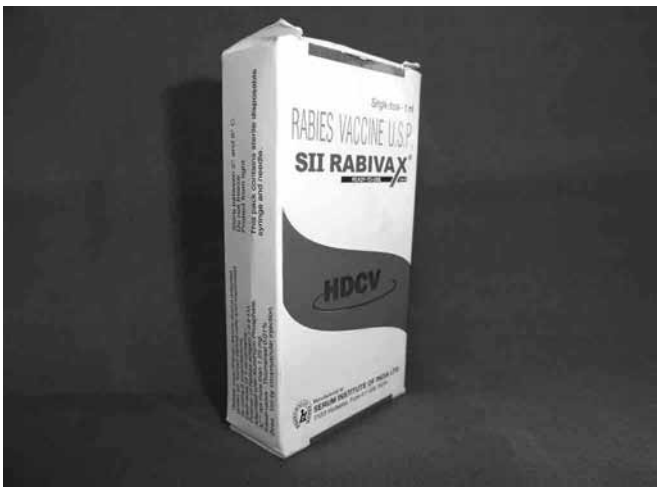


Fig. 20.70 Human diploid cell vaccine (Rabivax)

Because of the low volume (0.5 mL) and the microcarrier technique involved in the purification process (to make it free from reactions) PVRV has resulted in great economy. It has hit the international market and is therefore PVRV is now referred to as 'WHO-Reference Vaccine'. However HDCV is the 'Gold standard' antirabies vaccine in its efficacy and safety, because it is human preparation. It provides 100 percent seroprotection by day 14 (1.97 IU/mL) and is extremely low reactogenic.

The only limitation of the cell culture vaccines is that it is costly. But still it cannot be said so because it is not costlier than the life of the individual and nothing to compromise life.

Since rabies (hydrophobia) is 100 percent fatal and post exposure treatment is life saving, it is the boundant duty of the physician to inform the patients about the superiority of the cell culture vaccines and persuade them to opt for these modern vaccines.

Because of all these merits, WHO has recommended for discontinuation of nerve tissue BPL vaccine and to use only modern tissue culture vaccines, in the international conference on Rabies, held at Essen (Germany) in 1984.

Dosage Schedules

There are two broad categories of dosage schedules—namely Intramuscular and Intradermal schedules.

Intramuscular Schedules

These are of two types–Essen schedule and Zagreb schedule.

Essen schedule: It is so called because, this protocol (schedule) was recommended by WHO at a place 'Essen' in Germany, where International Conference on Rabies was held, in 1984.

This consists of 5 doses, each dose on days 0, 3, 7, 14 and 28/30 **(Fig. 20.71)**.

Day 0 is the day of 1st dose of the vaccination and not the day of bite. Subsequent numbers are the number of days to be added to day 0 and given (e.g. day 7 is added to day 0 and not to day 3).

The first three doses are given on the indicated dates only. Given late may result in vaccine failure. However last 2 doses can be given late by 1 or 2 days. Two doses can be given in Day 0 to those who are immunodeficient or in whom passive immunization (in Cat III) is indicated, but Rabies Immunoglobulin (RIG) is not available, or those who seek treatment after a delay of 48 hours or patients taking immunosuppressive drugs or severely malnourished patients or patients with underlying chronic diseases.

If the animal is found to be healthy and alive after 10 days of bite, schedule can be stopped after 3 doses. If the animal is not traceable it is presumed to be rabid and complete course is given.

Suppose the bitten dog were to be a carrier (which is exceptional), in that case also 3 doses are enough to protect the individual, because it is said that the virulence of the virus in a carrier dog is lesser than that of the case dog.

Even though immunity is developed after 8 to 10 days and lasts for 3 years, immunization will be effective totally only on completion of the entire treatment schedule. Hence, immunization should not be stopped midway. Total quantity of the vaccine/vials required = 5 vials/5 visits.

Zagreb schedule (2:1:1–protocol): This abbreviation represents that two doses are simultaneously given on day 0, one in the right deltoid and the other on the left deltoid region and one dose each on day 7 and day 21 **(Fig. 20.72)**.

Since 2 doses are given on day 0, this schedule induces an early antibody response. This may be particularly effective when rabies immunoglobulin is indicated but not available, as in Category III patients. This schedule is also equally effective with hardly 3 visits. The total quantity is also less (4 vials). This schedule is practiced in Paris and Thailand. But WHO has not recommended for worldwide use.

Intradermal Schedules

These schedules are also called 'Multisite Intradermal Protocols'. These are of two types—namely 2-site intradermal schedule and 8-site intradermal schedule. The volume of, ID dose is 0.1 mL irrespective of the type of the vaccine.

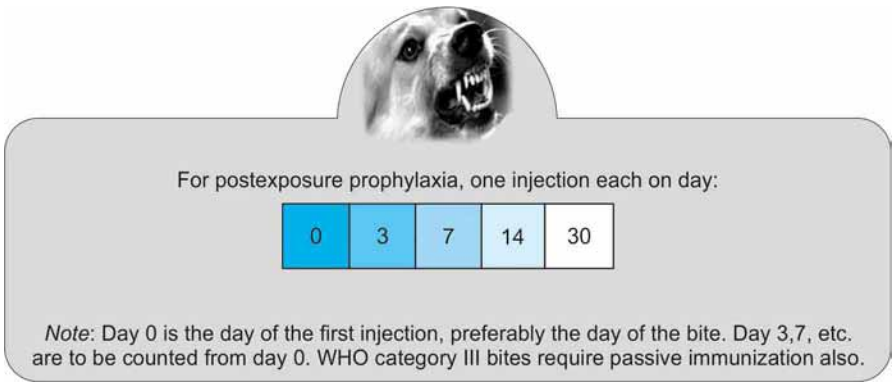


Fig. 20.71 Essen schedule

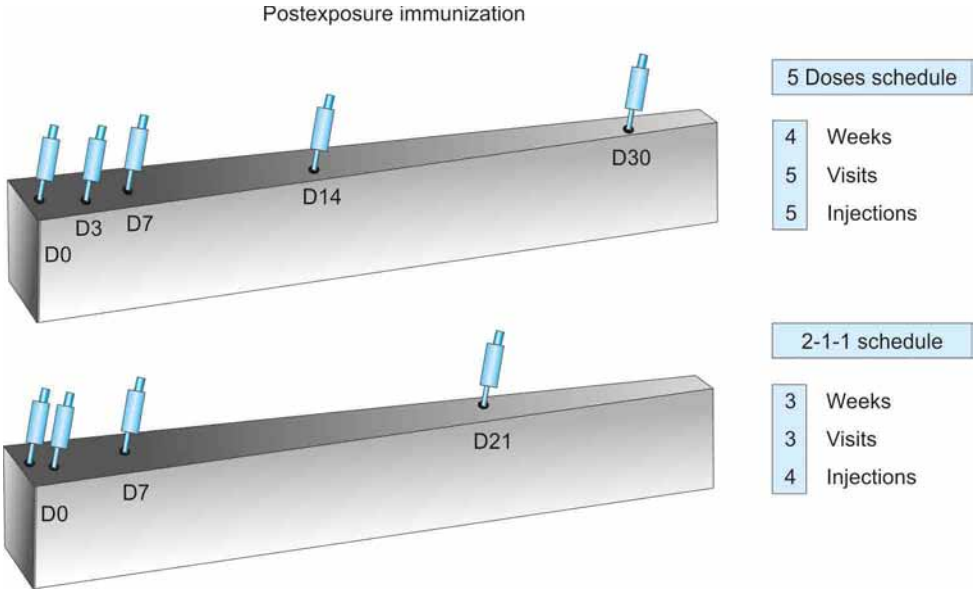


Fig. 20.72 Essen schedule and Zagreb schedule

2-site intradermal schedule (Thai Red Cross ID Schedule): This is abbreviated as 2:2:2:0:1–Schedule. This consists of administration of 2 doses, each of 0.1 mL, simultaneously, intradermally, on two sites, on day 0, 3 and 7; nil on day 14, and one dose each, on one site, on day 28.

Total visits are 4 but the quantity required is less than two vials.

8-site Oxford intradermal schedule (8:0:4:0:1:1): This is recommended with HDCV or PCEC—vaccine and not PVR-Vaccine.

On day 0, eight doses, each of 0.1 mL given intradermally, at eight different sites, simultaneously, over both deltoid, both lateral thigh, both suprascapular region and both lower quadrant of the abdomen. Nil on day 3.

On day 7, 4 doses, each of 0.1 mL given intradermally, at four sites, over both deltoid and both thighs. Nil on day 14.

On day 28 and 30, one dose, 0.1 mL is given intradermally (I Dly), at one site over deltoid region.

The total visits are 4 and quantity of the vaccines is less than 2 vials.

The concept of intradermal protocol is based on the observation that the intradermal administration is as effective as intramuscular route of administration. Advantage is that the total quantity becomes very less and therefore it becomes economical. The only disadvantage is that it requires the services of a skilled personnel. However WHO has not recommended ID protocol (If the vaccine goes subcutaneously, it may result in vaccine failure). Only PCEC and PVRV have been accredited for ID use by WHO and Drugs Controller General of India (DCGI).

The only contraindication for ID route is the patient on immunosuppressive drugs (like steroids, anti cancer drugs, radiotheraphy, etc.) In such cases vaccine is given intramuscularly (I Mly). Mixed schedule involving IM and ID routes is not recommended.

Failure with Cell Culture Vaccine

- Absence of wound care
- Lack of cold-chain maintenance
- Incomplete infiltration of the wound with RIG
- Delay in commencement of vaccine treatment
- Incomplete or irregular schedule
- Faulty technique (giving subcutaneously or in the gluteal region).
- No vaccine is full proof; so also this vaccine.
- Using date expired vaccines.

Synthetic and recombinant vaccines are under trial.

Passive Immunization

This consists of administration of readymade antirabies antibodies, antirabies Sera (ARS) or Human Rabies Immunoglobulin (hRIG) in all Cat. III cases (High-risk cases). This provides immediate protection. Even the best of modern tissue culture vaccine requires minimum 10 days to produce protective antibody titer. In Cat III cases, this is to be given on day 0, alongwith active immunization, irrespective of the interval between exposure and beginning of the treatment (vaccination). However serum alone (without vaccine) is never to be administered.

There are two types of Rabies Immunoglobulin (RIG):

1. Equine Rabies Immunoglobulin (ERIG)/ARS (Equine origin) [Marketed as Ionorab]
2. Human Rabies Immunoglobulin (hRIG) (Human origin) [Marketed as Rabivax; Imogam Rab; Beri-rab].

An intradermal test is a must before ERIG is given.

Dose: 40 IU/kg body wt for ERIG and 20 IU/kg body wt for HRIG. As much as possible of the recommended dose should be carefully instilled into the depth of the wounds and also infiltrated around the wound. Remaining RIG should be administered intramuscularly into the gluteal region, in a single dose on day 0 along with active immunization, followed by a complete course.

RIG/ARS is known to have local viricidal/neutralizing effect and prevents the virus from entering the susceptible nerve cells. Thus the use of RIG is life saving and failure to use RIG amounts to deriliction of duty under Consumer Protection Act. Under this Act, the animal bite is considered as 'Medical priority'.

Advice to the Patient

- About the importance of taking the treatment correctly and completely.
- To avoid steroids, spicy food, spirit (alcohol), smoking and strain (physical and mental) during the treatment period because of interference with the development of immunity.

Re-exposure to Rabies

History of previous immunization against rabies is obtained. If the patient has received a complete course of either pre-exposure or post exposure prophylaxis, either by IM or ID route, irrespective of the time interval between the previous immunization and the re-exposure now, requires only two doses of the vaccine on day 0 and 3 by IM. Alternatively 2 doses of IDRV may also be given. RIGs are not needed in theses cases, because the vaccine elicits a quick anamnestic response (WHO). If the previous immunization is incomplete, then it is treated as a "fresh case."

Pre-exposure Immunization

Only modern TCVs are recommended for this purpose. This is given for those who are not infected with rabies virus, and they are 'at risk' of getting the infection. In other words, it is given to prevent the infection in an healthy individual.

The 'at risk' group are:

- Veterinarians
- Animal handlers and zoo employees
- Forest staff and hunters
- Taxidermists and slaughter house workers
- Dog handlers and municipal sweepers
- Laboratory personnel working with rabies virus
- Pet owners, post-men, joggers and school children.

WHO has recommended only 3 doses of TCV, to be given respectively on day 0, 7 and 28 **(Fig. 20.73)**

Thus, pre-exposure immunization

- Protects even in case of inapparent exposure
- Simplifies postexposure therapy
- Avoids the use of RIG (RIG is not always available).

Control of Rabies in Dogs

- Elimination of all stray, sick, dead and ownerless dogs.
- Enforcing registration and licensing of pet dogs (collar for identification) from the municipal health officer.
- Pre-exposure immunization of all pet-dogs, with a primary course of 2 TCV injections, first—one to be given at 2 months of age, second dose after one month, followed by booster dose, regularly, once in a year.
- Postexposure immunization consists of 5 doses, respectively on day 0, 3, 7, 14 and 28/30 with an optional dose on day 90.
- Quarantine of imported dogs.
- Health education of people about rabies.

Two kinds of veterinary vaccines are available.

1. *Nerve Tissue Vaccines (NTV)*—20 percent NTV for pre-exposure and 5 percent NTV for post-exposure immunization. Because of low efficacy, not recommended.
2. *Tissue Culture Vaccines (TCV)*—marketed as Raksharab, Nobivac-R, Robigen and Rhabisin.

Personal Protection against Rabies

- Do not touch the animal bitten wounds with bare hands.
- Do not touch the fomites, viz. chain, food plate, etc. of the animal suspected or proven of rabies.
- Do not touch sick or stray animal.
- Do not provoke any animal.

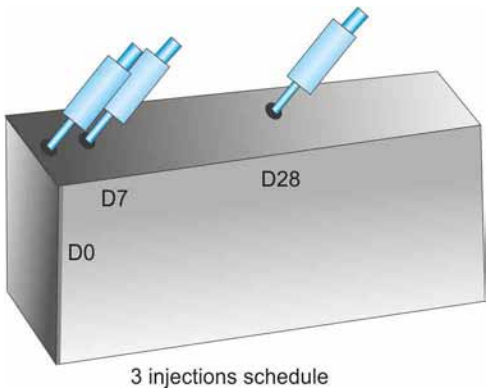


Fig. 20.73 Pre-exposure vaccination

- Avoid contact with saliva, urine, tears, semen or vaginal secretions of a hydrophobia patient.
- Take pre-exposure immunization if you belong to 'at-risk' group.
- Provide pre-exposure immunization to the medical staff nursing staff and family attendants of hydrophobia patient.
- Veterinarians should receive pre-exposure prophylaxis and wear gloves, glasses, masks and long sleeved aprons while examining rabid animals.
- Suppose the pet dog has bitten the owner, and the immunization status of the dog is questionable, it calls for complete immunization schedule not only for the owner but also for the dog.
- A bite by even a vaccinated dog in rabies endemic areas is suspected to be rabid and the bitten person is given two doses of post exposure immunization on D0 and 3 and after D7, if the dog is healthy/alive, no further vaccination is required. However, the dog must be observed for 10 days from the date of bite. If it is alive nothing is required. However if the person is in constant touch with the animal, he/she is adviced to take 3rd dose also on D21 or 28.
- Last but not the least is to protect from dog bites.

LEPROSY

(In Greek, 'Leper' means Scaly)

Leprosy is a chronic, granulomatous, infectious disease, caused by *Mycobacterium leprae*. Leprosy is the oldest disease of the mankind and not a disease of modern civilization. The causative organisms affect mainly the superficial tissues like skin and peripheral subcutaneous nerves, unlike *M. tuberculosis*, which affect deeper tissues like lungs, bones, joints, etc.

It is a disease of human beings only and not of animals. Man gets the infection from infected persons. Clinically, it is characterized by one or more of the following features:

- Hypopigmented patch/es
- With loss of sensation
- Thickening and enlargement of the nerves
- Demonstration of *M. leprae* (AF Bacilli) from the cutaneous lesions.

In the advanced stage, there will be associated features like nodules over the face, claw hands, loss of fingers or toes, foot-drop, trophic ulceration giving rise to ugly disfigurement with deformities leading to permanent disability and handicap of the individual if not treated in time.

Leprosy is a health problem, social problem and an economic problem.

History

In India, leprosy is existing since ancient times and is described as *Kushta roga* in *Sushruta Samhita*. The name *Kushta* is derived from *Sanskrit* word '*Kushnati*' which means eating away.

In 1873, the pathogen *M. leprae* was discovered by GH Armaer Hansen of Norway. So this disease is often called 'Hansen's disease'.

In 1916, Mitsuda, described 'lepromin test', which helped in the classification and assessment of prognosis of leprosy.

In 1943, Sulphones were introduced for the treatment of leprosy and marked the beginning of a new era, i.e. era of case finding and domiciliary treatment.

In 1955, Govt of India launched National Leprosy Control Programme (NLCP).

In 1960, Shepard discovered that *M. leprae* could multiply to a limited extent, when injected into the foot-pad of mice.

In 1971, Kircheimer (USA) reported that the disease could be transmitted successfully to an animal armadillo (ant eater in South America).

In 1981, Multidrug Therapy (MDT) was introduced for the treatment.

In 1983, NLCP was redesignated as National Leprosy Eradication Program (NLEP).

In 1997, NLEP was appraised to National Leprosy Elimination Campaign (NLEC). The disease is said to be 'Eliminated', when the prevalence rate of leprosy is reduced to less than 1 per 10,000 population. That means the disease transmission is deemed to have been arrested.

Magnitude of the Problem

World

Leprosy is considered as a major public health problem in those areas, where its prevalence rate is at least 1 per 1000 population, as per WHO guideline. Accordingly, out of 6 billion population of the world, about 12 million cases of leprosy were existing during 1985 and more than 1 billion people were living in those areas, where the prevalence of leprosy is more than 1 per thousand population. These 1 billion people are distributed over 93 countries, of which 25 countries account for 95.2 percent of total cases.

Since 1985, there has been a steady decline, in a natural way, in the developed countries due to improved socio-economic conditions, improved nutritional status, effective isolation of infectious cases and quality of life of the people. Northern Europe was the first to experience the natural decline of leprosy.

South Asia and Africa are considered to represent the ancestral home of leprosy, tracing back to 2500 years BC.

Introduction of Sulphones since 1943, opened a new avenue in the control of leprosy. During 1966, globally the prevalence rate of leprosy was 8.4 cases per 10,000 population. It was increased to 12 per 10,000 during 1985 due to increased detection. Since then there was a steady decline.

Since 1985, the total number of leprosy cases has dropped dramatically by 85 percent and by 67 percent since 1991. During 1996, the global leprosy level was 1.8 million patients.

By 2002, the global prevalence rate of leprosy was below 1 per 10,000 population and total number was around 5,34,000 cases.

India

During 1981, the prevalence rate was 57 per 10,000 population and by 2004, it reduced dramatically to 2.3 per 10,000 population, due to the change in the strategy of leprosy control from DDS monotherapy to multidrug therapy. The disease is said to be eliminated when the prevalence rate is reduced to less than 1 per 10,000 population. Leprosy elimination has already been achieved in 16 states and 7 states are very near to this goal. These 7 states are Goa, Gujarat, Madhya Pradesh, Karnataka, Tamil Nadu, Lakshadeep and Andaman and Nicobar islands where the prevalence rate is between 1 and 2 per 10,000 population.

The goal is to eliminate leprosy by the year 2005.

During 2005, the prevalence rate was 1.3/10,000 population, 0.84/10,000 population during 2006 and during 2011 it was reduced to 0.69/10,000 population. So leprosy is now said to be eliminated.

Agent

The disease is caused by *M. leprae* bacilli. It is gram +ve, acid fast bacillus, having parallel sides and round ends. Morphologically it resembles tubercle bacilli. *M. leprae* is an obligate intracellular organism having special affinity for Schwann's cells (i.e. neurilemmal cells of peripheral nerves) and the cells of reticuloendothelial system, where it remains dormant and becomes the seed of future relapse. The bacilli are seen both intracellularly and extracellularly. Within lepra cells the bacilli are found in groups, looking like a 'bundle of cigars' or a 'palisade' appearance. Extracellularly the bacilli are seen in clumps called 'globi'.

The bacilli are better seen by Ziehl-Neelson stain. Lepra bacilli are less acid fast and less alcohol fast than tubercle bacilli. Viable bacilli take uniform stain (solid bacilli) while the dead bacilli look granular (Non-solid bacilli). The percentage of solid stained bacilli is interpreted as 'Morphological index'.

Till date, more than 20 antigens have been isolated by electrophoretic techniques of which phenolic glycolipid (PGL) is the most specific for *M. leprae*.

One gram of leprous tissue from lepromatous leprosy nodule yields around 2 to 7 billion bacilli. The organisms multiply very slowly and hence the long incubation period and the slow evolution of the disease. The organisms can survive outside the body for more than 8 days. So far it has not been cultured on artificial medias but it is successfully cultivated in a fluid medium containing hyaluronic acid, giving a hope that it may satisfy Koch's postulates.

Reservoir of Infection

Both human and nonhuman (animal) reservoirs have been described. A human reservoir is a one who is suffering from the disease. It was thought that only infectious cases constitute the source of infection. However the current consensus is that all active cases of leprosy must be considered infectious. The non-human reservoirs implicated are Mangby monkeys, rhesus monkeys, African green monkeys and chimpanzees. The possibility of human infection from these sources is yet to be proved. Epidemiologically, man is the only source of infection.

Bacillary discharge is maximum from the nasal mucosa during blowing of the nose and sneezing. Ulcers and abraded cutaneous lesions of leprosy cases also discharge bacilli. Intact skin may also discharge bacilli from bacilliferous cases through hair follicles.

An infective patient can be rendered non-infective by treatment with Dapsone by 90 days and with Rifampicin within 3 weeks.

Age Incidence

Leprosy is a disease of all the age groups. However, the incidence is maximum between 20 and 30 years of age. In endemic areas, the infection is acquired during childhood, as intrafamilial infection. Because of the long incubation period, the disease is manifested during adult age. In non endemic areas, the disease appears at a still later age. However, presence of leprosy among children is a strong evidence of active transmission of leprosy in that area, thus constituting considerable epidemiological importance.

Sex Incidence

Leprosy is twice as common among males than among females (in the ratio of 2:1). However, the incidence is equal in both the sexes among children.

Race

There are racial differences in the occurrence of leprosy. But the exact cause is not known.

Malnutrition

Malnutrition lowers the cell mediated immunity and thereby increases the susceptibility for the disease.

Immunity

There is no inherited immunity but only acquired immunity. The humoral immunity is never protective. The cellular immunity is mediated through T-lymphocytes. Those persons in whom there is complete absence or breakdown of cell mediated immunity, they develop infectious type of leprosy (explained under pathogenesis).

Environmental Factors

M. leprae remain viable outside the body, in the dried nasal mucosa for about 8 to 10 days minimum and for about 45 days in moist soil. High humidity, overcrowding and poorly ventilated living conditions favor the transmission of leprosy.

Social Factors

There are many social factors which are contributing for the prevalence of leprosy in our country. They are poverty, illiteracy, ignorance, over-crowding, poor standard of living conditions, lack of knowledge, etc.

The real tragedy with leprosy is that, somehow, it has got shrouded in deep-rooted myths and misbeliefs, right from the ancient times giving rise to pointing the lepers as 'social stigma' resulting in untouchability and 'away from lepers'. Added to this, the lepers consider the disease as incurable and is the result of curse or punishment by God. The deformities, the disfigurement and mutilations caused in neglected cases has reinforced this concept (myth) and inspired an aura of dread or horror among the patients resulting in alienation from their societies. This has contributed to frustration and misery of patients and condemned them to destitution, squalor and beggary (poverty). So the patients try to conceal the disease due to social ostracization and stigma attached to the disease.

Thus, the stigma of leprosy is worse than the disease itself. The stigma attached to the disease is so great that even the medical profession takes an unsympathetic and unscientific view of leprosy. Thus the social factors, the prejudice, the apathetic and indifferent attitude towards the patients, the social stigma are all the legends, which have hampered the control of leprosy in the country. Unless this negative attitude towards leprosy changes, it is not possible to eradicate this disease.

Infectivity

Not all the cases of leprosy are infectious. Those cases, who are shedding bacilli either from the nose and throat or from the ulcerative, cutaneous lesions are infectious to others. However all active cases of leprosy are considered infectious. But once the treatment is started, very soon they become noninfectious. Again, all those who are exposed to infectious case, do not develop the disease. Generally 95 to 97 percent of human beings are not susceptible to leprosy. Only 3 to 5 percent are susceptible to leprosy. Among the susceptibles 80 to 85 percent patients get self-healing. Only remaining 15 to 20 percent develop the disease.

Modes of Transmission

Major route of transmission is by droplet mode. This is based upon the fact that the organisms have been found in nasal secretions and throat secretions of lepromatous type of leprosy patients, like an open case of pulmonary tuberculosis.

The other usual mode of transmission is by direct skin-to-skin contact with the ulcerative lesions of leprosy patients. The bacilli may also be released through the lesions by trauma, super added infection and exacerbated skin lesions observed during lepra reactions.

The indirect mode of transmission through fomites are based upon the fact that the organisms are capable of surviving outside the body for about 8 to 10 days.

The other hypothetical modes of transmission are vector borne, breast-milk borne, soil borne, fomite borne and vertical or transplacental. However these are not proved.

The factors which influence the contact transmission are the closeness of the contact, duration of exposure and the individual susceptibility.

Thus, the skin and the nasal mucosa constitute the portals of exit as well as the portals of entry.

Pathology and Pathogenesis

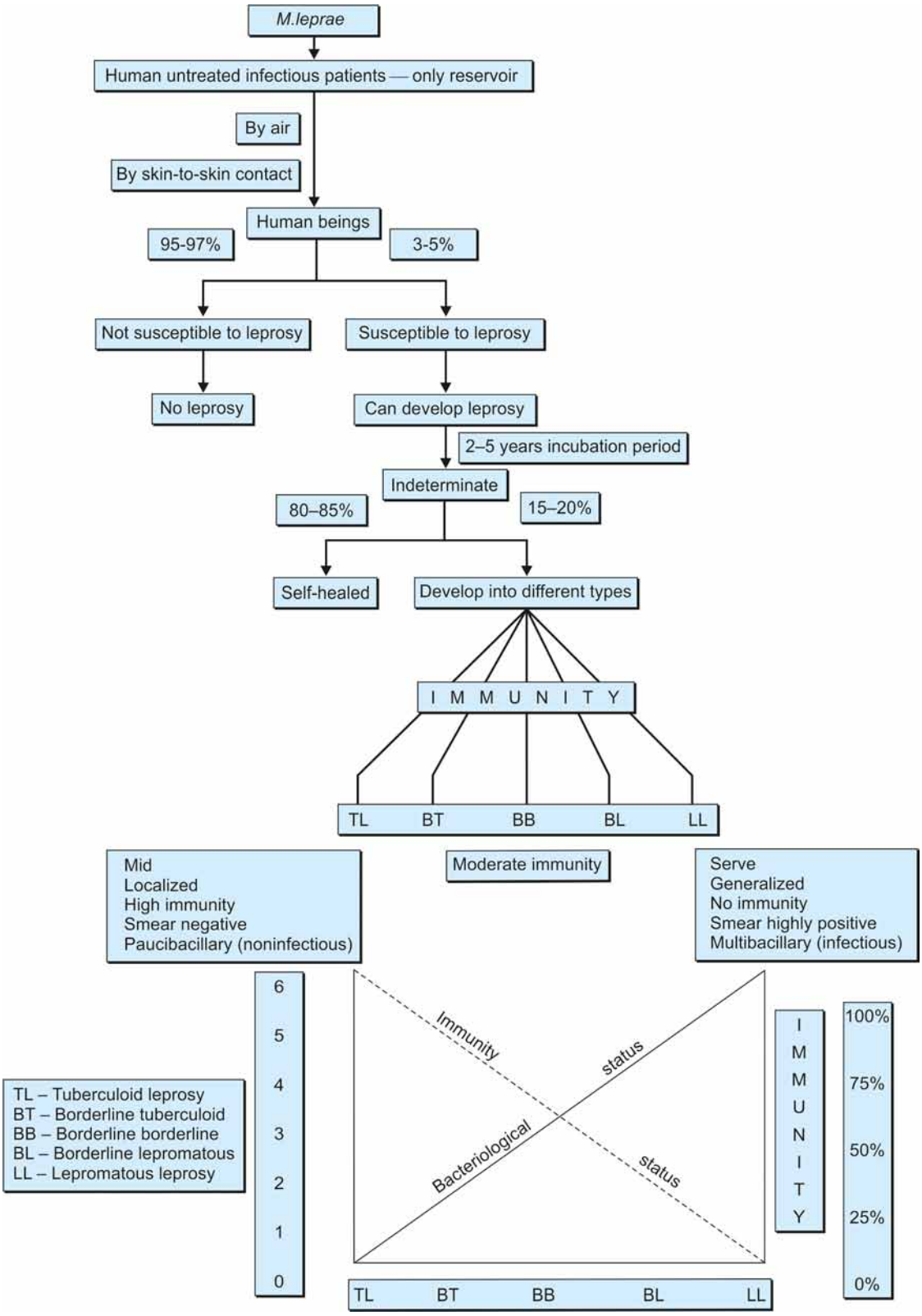
Having entered the body the bacilli are encountered, engulfed and destroyed by monocytes and histocytes. Only in 3 to 5 percent of individuals they get a foot hold. The lepra bacilli show a special predilection towards the skin and peripheral nerves. They are the only bacteriae to have the capacity to enter the nerves via endoneurial blood vessels. The target cell is Schwann cell. Once the bacilli have been engulfed by the Schwann cells, the organisms produce a clinically apparent primary lesion, referred to as 'indeterminate leprosy'. It is so called because the pathology is not determined to which type and how it is going to evolve in future.

The subsequent fate and the development of leprosy depends upon the existing immunity of the individual as follows:

Out of 3 to 5 percent susceptible population, who develop primary lesion, the lesion undergoes silent, self-healing in 80 to 85 percent of such people. In the remaining 15 to 20 percent of infected persons, the future course is determined by the immune response (cell-mediated immunity) of the host **(Flow chart 20.6)**.

At one extreme of the spectrum are the patients possessing good cell mediated immunity (CMI) response and so the organisms are confined to skin and nerves and are not allowed to multiply. Therefore they are not demonstrable in the smear examination. This type of response is called tuberculoid type

Flow chart 20.6 Pathogenesis of leprosy



Source: Karnataka State Leprosy Society. Manual of Prevention of Deformity. DHFWS, Bangalore.

of response and it results in Tuberculoid type of leprosy (TL). It is also called as 'Paucibacillary' type of leprosy and is non-infectious.

At the other extreme of the spectrum are the patients not possessing immunity at all and fail to evoke CMI response, thereby allowing the organisms to multiply easily and even pass the skin barrier, enter the lymph stream, blood stream and invade the reticuloendothelial system, later affecting the liver, spleen and bone marrow. Eyes, nose, kidneys, testes, etc. may also get invaded. The organisms are numerous in the skin and so are easily demonstrable in the skin smear. This type of response is called lepromatous type of response and it results in Lepromatous type of leprosy (LL). It is also called multibacillary type of leprosy and is highly infectious.

In between the two extremes, a sizeable portion of patients, who have good CMI response to startwith (tuberculoid type) but in due course of time, will develop breakdown of immunity leading to the development of lepromatous type of leprosy. At a particular stage they will have a CMI response midway between TL and LL, having features of both, is called 'Dimorphic' or 'Borderline' type. This is infectious at this stage. Borderline leprosy is unstable. With the influence of indigenous or exogenous factors, it changes over to tuberculoid or lepromatous form of leprosy. The Borderline type could be Borderline tuberculoid (BT), borderline borderline or midborderline (BB) or borderline lepromatous (BL) type.

Incubation Period

It is very long and variable. On an average it is about 5 to 7 years; on the minimum side it is 2 to 3 years and on the maximum side it is 40 years or even more. The unique length of the incubation period is attributable to a very slow multiplication rate of *M. leprae* and an enormous size of bacterial population needed to make the disease clinically apparent.

Classification of Leprosy (Clinical Spectrum of Leprosy)

Since the disease has varied type of manifestations, classifications are also of varied types. Important classifications are as follows, based on clinical, bacteriological, immunological and histological status of patients **(Table 20.29)**.

WHO Classification

This is based on number of skin lesions and bacteriological status.

a. Single skin lesion, paucibacillary leprosy
   - Single skin lesion
   - No nerve involvement
   - Skin smear for AFB negative

Table 20.29 Important classification of leprosy

Madrid classification	Indian classification	Ridley and Jopling classification
Lepromatous type (L)	Lepromatous (L)	Lepromatous lepromatous (LL)
Tuberculoid type (T)	Tuberculoid (T)	Tuberculoid tuberculoid (TT)
Indeterminate (I)	Indeterminate (I)	Borderline tuberculoid (BT)
Borderline or Dimorphous (B)	Borderline (B)	Borderline borderline (BB)
	Pure polyneuritic type	Borderline lepromatous (BL)

b. Paucibacillary leprosy (PBL)
   - 2–5 lesions (skin and nerves)
   - Only one nerve trunk
   - Skin smear for AFB negative

c. Multibacillary leprosy (MBL)
   - More than 5 lesions (i.e. 6 and above)
   - More than one nerve trunk involvement
   - Skin smear positive.

Field Workers' Classification

To avoid confusion among field workers in India, leprosy patients are grouped into only two groups, namely bacteriological positive cases as infectious (open or MBL) cases and negative cases as noninfectious (closed or PBL) cases. Following is the outline of this classification:

- Indeterminate
- Tuberculoid
- Polyneuritic

} Noninfectious (Closed or PBL); smear negative

- Borderline tuberculoid
- Borderline borderline
- Borderline lepromatous
- Lepromatous lepromatous

} Infectious (Open or MBL), smear positive

Clinical Presentation

The changes are seen in the skin, mucous membrane, nerves and bones.

- *Skin:* The lesions appear as macules, papules, nodules or ulcers. The macules are hypopigmented lesions that are in level with the skin, having smooth surface and margins merge imperceptibly with the surrounding skin.
  The plaques are infiltrated lesions raised above the surface of the skin; they may be erythematous and shiny with margins slopping away peripherally to merge with the surrounding skin.
  The nodules which appear in advanced leprosy, mostly crop up on the face, nose and ears giving rise to leonine

facies (leontiasis; facies leonine) caused by deepening of furrows and wrinkles. Nodules may either get absorbed or undergo superficial necrosis producing ulcers, which serve as portals of exit for leprosy bacilli.

- *Mucous membranes:* Nodules may appear on the mucous membrane of nose, lips, tongue, palate and larynx followed by ulceration. The ulceration of nasal septum may advance to perforation and destruction of the septal cartilage eventually leading to saddle-nose deformity. Involvement of the larynx may result in hoarse cough, husky voice and stridor.
- *Nerves:* Leprosy can cause inflammation, thickening and loss of functioning of peripheral nerves resulting in various complications. Infiltration of nerves leads to peripheral neuritis associated with the loss of sensory, motor and autonomic function; sensory loss is more pronounced than the motor loss. Sensations of light touch and temperature first disappear followed by loss of pain and pressure sense and hypotonia; later ending in paralysis and atrophy. Paralysis of the muscles of hands and feet leads to deformities. Autonomic dysfunction produces dryness of skin resulting in cracks and fissures. Associated anesthesia predisposes to injuries, burns and trophic ulcers, usually over soles of feet. Inflammation of the nerves is characterized by heaviness, tingling, numbness and severe pain along the course of the affected nerves, which undergo thickening. Thickening of the nerves is restricted only to the cool, superficial areas where the nerves can be easily palpated. Thickening of the deeper nerves never occurs. Nerve thickening can be easily felt at key points. The supraclavicular nerves near the clavicles, the ulnar nerves just above the elbows, the radial and the median nerves at the wrist joints, the common peroneals (lateral popliteal) nerves round the neck of the fibulae, the superficial peroneals (musculocutaneous nerves) in front of the ankles and the posterior tibial nerves just below the medial malleoli.
- *Bones:* Bone changes are essentially due to deposition of bacilli in the medullary cavities, the periosteum and the nutrient vessels. The involvement of nutrient vessels results in the enlargement of the nutrient foramina, aseptic necrosis of bones and the appearance of cysts. Involvement of periosteum results in leprous periostitis. Neurotrophic atrophy and resorption of bone tissue is seen in the phalanges of hands and feet as well as in metatarsals. The disappearance of affected bones results in shortening of fingers and toes. Coexisting muscular paralysis results in disuse atrophy, producing osteoporosis and ankylosis.

Case Evaluation

This is done by bacteriological examination and lepromin test.

Bacteriological Examination

This is employed for classifying the disease as multi or paucibacillary, for instituting the treatment schedule and to monitor the progress by the indicators namely bacteriological index and morphological index.

Bacteriological examination of the smears is done by 'slit and scrape' method from 4 skin lesions, two from the ears (one each from right and left ear) and one from nose (nasal smear), thus totaling 7 sites/smears. The material obtained by slit and scrape method, is uniformly spread on a clean glass slide, dried over flame and stained with Ziehl-Neelson method and at least 100 fields are examined under the microscope before recording a negative result.

Bacteriological index (BI): BI is a measure of bacterial load of a lesion, which is expected to decrease under successful chemotherapy and thus is the only objective way of monitoring/determining the benefit of treatment.

To determine the index, the film is examined under oil immersion in a zig-zag fashion. Bacilli are counted in each of the microscopic field, including those in groups or globi. Since it is not possible to identify the bacilli in globi, 100 bacilli are counted for a large globus, 60 for a moderately large globus and 30 for a small globus. The BI is expressed arbitrarily in plus (+) units. According to Ridley's logarithmic scale, smears are graded as under **(Fig. 20.74)**.

'0' = No bacilli in any of 100 oil immersion fileds

1+ = 1 to 10 bacilli, on average in 100 oil immersion fields (at least 1 bacillus in every 100 fields)

2+ = 1 to 10 bacilli, on average in 10 fields (at least 1 bacillus in every 10 fields)

3+ = 1 to 10 bacilli, in an average field (at least 1 bacillus in every field)

4+ = 10 to 100 bacilli, in an average field (at least 10 bacillus in every field)

5+ = 100 to 1000 bacilli, in an average field (at least 100 bacillus in every field)

6+ = 1000 to 10000 bacilli, in an average field (at least 1000 bacillus in every field)

The BI is calculated by the following formula:

$$\text{BI} = \frac{\text{Total number of +}}{\text{Total number of smears, i.e. 7}}$$

(Denominator always remains constant)

Example:

First skin lesion	=	+++
Second skin lesion	=	++
Third skin lesion	=	+++
Fourth skin lesion	=	++
Right ear	=	+++
Left ear	=	+++
Nasal smear	=	+++

$$\text{BI} = \frac{19}{7} = 2.7$$

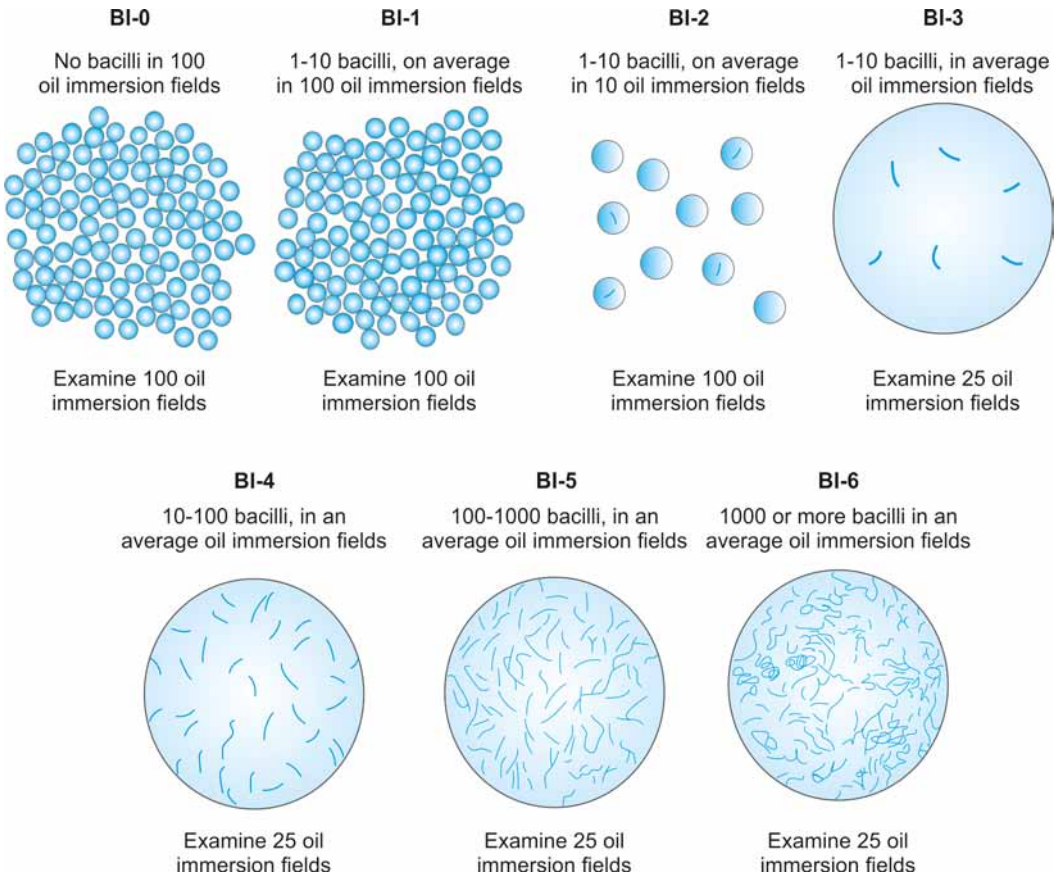


Fig. 20.74 Bacteriological index (BI): grading 0 to 6
Source: Karnataka State Leprosy Society. Manual of Prevention of Deformity. DHFWS, Bangalore.

If the ratio is less than 2, it is considered as paucibacillary leprosy and if more than 2, it is considered as multi-bacillary leprosy. A decrease in BI in follow-up study is an indicator of good prognosis.

Morphological index (MI): It is defined as the percentage of 'solid stained bacilli', in a stained smear. A solid bacillus is a one which has parallel lines, curved ends and has taken an uniform stain. Irregularly stained bacilli showing granular appearance of stain are non-solid bacilli.

$$\text{MI} = \frac{\text{Number of solid bacilli}}{\text{Total number of AFB}} \times 100$$

A decrease in MI in follow-up study indicates good prognosis. If this index rises after having fallen, it indicates that either the patient has not taken the drugs or the drug is not absorbed or bacilli have developed resistance.

Lepromin Test

It is an intradermal test employed for detecting the cell mediated immunity against leprosy. It is not a diagnostic test as it may give positive result in non-cases and negative results in lepromatous patient. However it helps in classifying leprosy patients and also in assessing prognosis with treatment and vaccine.

The test material is 'lepromin', which is a mixture of leprosy bacilli, cellular matter and fat content, obtained from the lesions of lepromatous type of leprosy patients and triturated into a fine suspension by using isotonic saline. The bacilli are then killed by heating.

There are two types of antigen. The original Mitsuda lepromin is a crude preparation containing tissue particles and fatty material. This evokes late reaction. One milliliter of this material contains 160 million lepra bacilli.

The refined Dharmendra lepromin is devoid of fat content. It evokes early reaction. This preparation contains 10 million bacilli per mL. Both lepromins contain specific antigen. The material obtained from human source is lepromin-H. Because of the widespread use of chemotherapeutic drugs it is difficult to produce lepromin-H on large scale. Therefore, infected armadillo is being used as an alternative source of lepromin (lepromin-A). This contains 40 million lepra bacilli per mL, inactivated by radiation with cobalt-60.

Procedure: 0.1 mL of the antigen Dharmendra (lepromin) is injected intradermally into the flexor surface of the forearm using a 25 gauge hypodermic needle. Lepromin evokes two types of positive reactions: one an early Fernandez reaction and the other a late Mitsuda reaction.

Early reaction (Fernandez reaction): This occurs within 24 to 48 hours and disappears after 3 to 4 days. It is evidenced by erythema (redness) and induration. It is a manifestation of delayed hypersensitivity to the 'soluble' constituents of the lepra bacilli. Diameter of the erythema is taken into consideration for interpretation and not the induration unlike in PPD test with tubercle bacilli.

Interpretation: The reaction is considered as positive if erythema is more than 10 mm in diameter at the end of 48 hours. A diameter of 10 to 15 mm denotes mild positivity (+) or weakly positive – Borderline leprosy. A diameter of 15 to 20 mm – moderately positive (++) – Indeterminate leprosy. More than 20 mm diameter – Strongly positive (+++) – Tuberculoid leprosy. Less than 10 mm – Negative reaction (–) denotes lepromatous leprosy.

Late (Midsuda) reaction: This becomes positive after 3 to 4 weeks, appearing as nodule. It is a manifestation of cell mediated immunity. If the diameter of the nodule is 3 to 5 mm it denotes mild (+) positivity, if it measures 5 to 10 mm it denotes moderate (++) positivity and if it exceeds 10 mm, it denotes strong (+++) positivity. The nodule may even ulcerate and may heal with scarring if the antigen is crude.

It is to be noted that the diameter of the erythema in early reaction and the diameter of the nodule in the late reaction are measured for interpretation. The early reaction is induced by the soluble constituents of the leprosy bacilli and the late reaction by the bacillary component of the antigen. It indicates cell mediated immunity.

Applications

In lepromin test, Midsuda reaction is preferred over Fernandez reaction. The test has a limited diagnostic value because it gives positive reaction among non-cases (false-positive). However it helps in classification of leprosy.

The test is strongly positive in tuberculoid leprosy (showing good CMI) and negative in lepromatous leprosy (showing failure of CMI). It is variable in borderline and indeterminate leprosy.

The test has a prognostic value, because it shows an immunological shift in the behavior of a case. For example, the reaction which is negative in lepromatous leprosy when becomes positive after treatment it indicates that the patient has developed immunity and has improved. It does not mean that the patient has developed tuberculoid leprosy. However it must be born in mind that BCG vaccination can also result in positive result of the test.

The test has predictive value as well. It gives an indication of the risk of the disease among contacts of open cases. It is observed that healthy individuals who are lepromin positive usually escape contracting the disease or develop paucibacillary leprosy and individuals who are lepromin negative run the risk of developing a progressive multi-bacillary leprosy.

The test has an epidemiological value as well. It indicates the incidence and prevalence of infection among children. In the first 6 months of life, most children are lepromin negative. They become positive progressively as their age advances. In endemic areas, it is positive in 20 percent of under 5 children, increases to 60 percent by 14 years of age, and to 80 percent by 20 years of age. BCG vaccination is capable of converting the lepromin reaction from negative to positive in a large proportion of individuals.

Clinical Spectrum (Figs 20.75 to 20.81)

Indeterminate leprosy: It is the unstable, earliest stage, characterized by one or two vague flat lesions (macules), usually hypopigmented and anesthetic (sensory loss). The margins are vague and ill defined. Size of the lesions vary from 1 to 5 cm in diameter. Bacteriologically the lesions are negative. Nerve involvement may occur in long standing cases. The cytology is not specific (i.e. uncharacteristic histology). The pathology is not determined to which type it is going to evolve. Lepromin test is moderately positive (15-20 mm erythema).

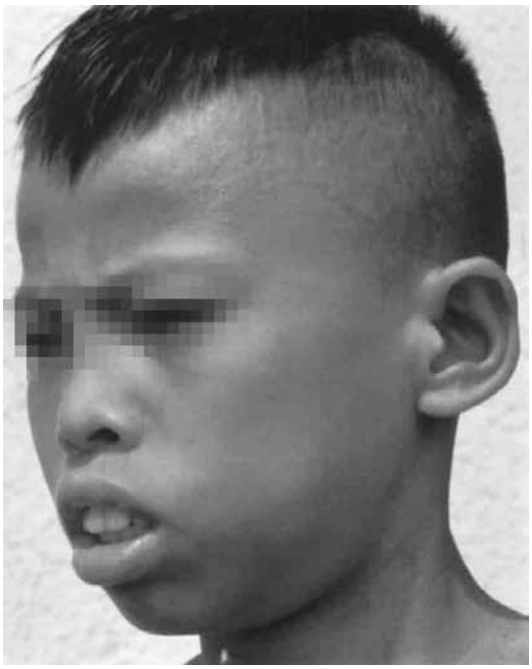


Fig. 20.75 Indeterminate (I)—solitary, ill-defined, hypopigmented macule on left cheek; only partially anesthetic

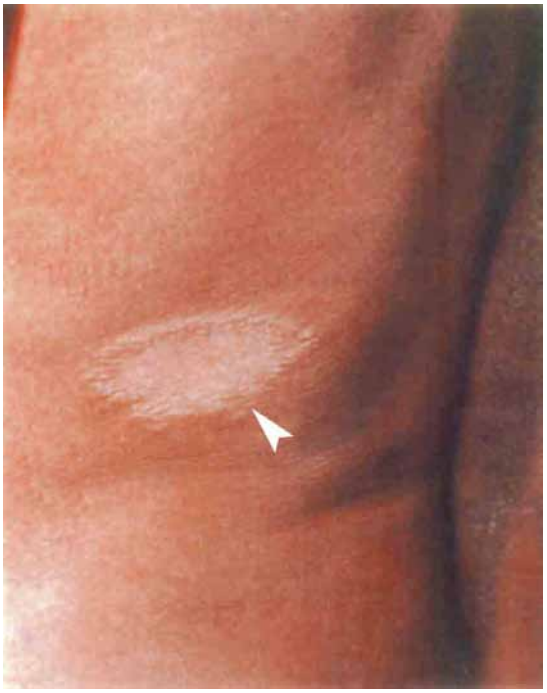


Fig. 20.76 Tuberculoid (TT)—well-defined, hypopigmented lesion with dry surface and moderately raised granular margins; completely anesthetic (arrow head)

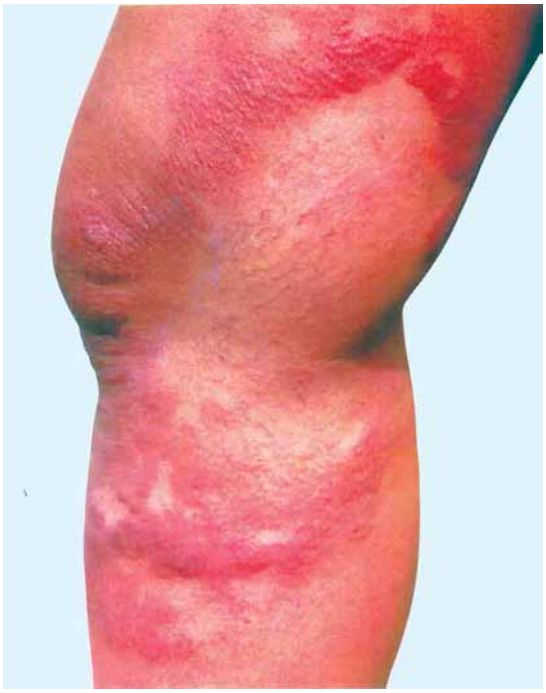


Fig. 20.78 Borderline (BB)—classical 'punched-out' lesions of borderline leprosy; central 'immune' areas are anesthetic

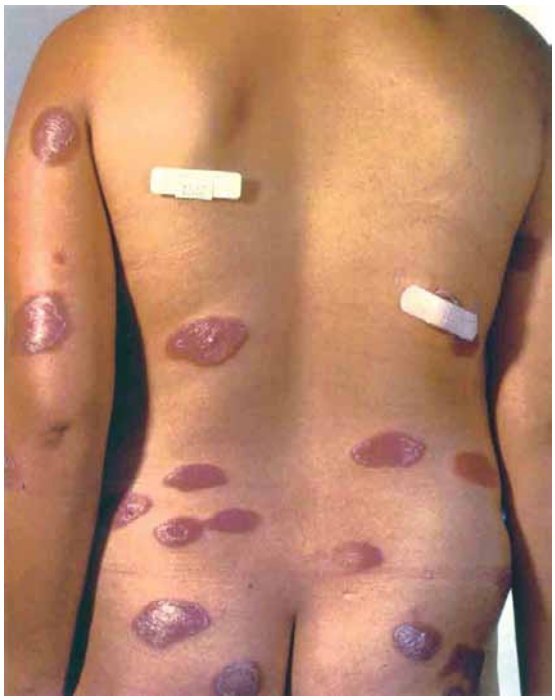


Fig. 20.77 Borderline tuberculoid (BT)—multiple, sharply-demarcated, scaly reddish-brown plaques; these subsiding lesions are only partially anesthetic

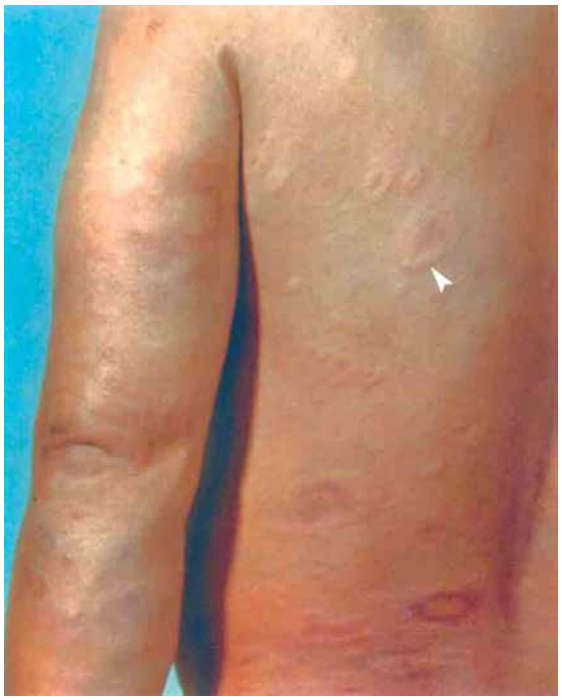


Fig. 20.79 Borderline lepromatous (BL)—numerous and widespread borderline type plaques, annular lesions, papules and macules; center of large lesions show some loss of sensation (arrow head)

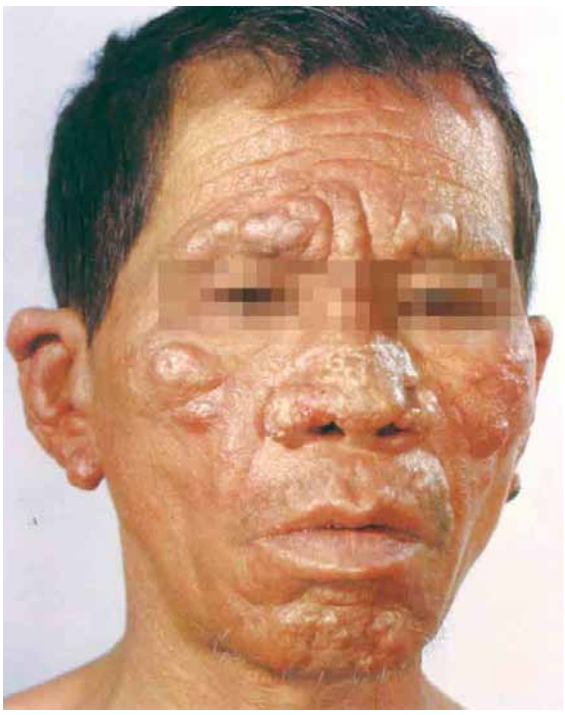


Fig. 20.80 Polar lepromatous (LLP)—advanced lepromatous leprosy with diffuse infiltration coupled with nodules over eyebrows, cheeks, ala nasae and chin, as well as ear lobes

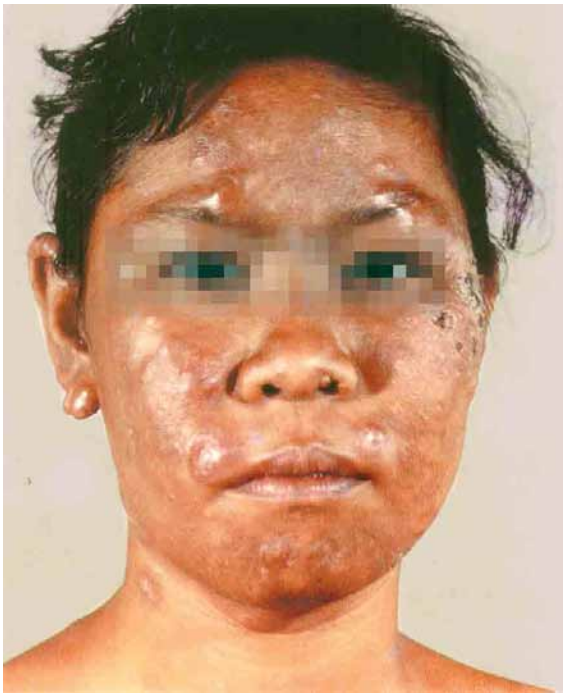


Fig. 20.81 Erythema nodosum leprosum (ENL)—multiform, subcutaneous and erythematous ENL lesions in patient with lepromatous leprosy

Tuberculoid leprosy: It is stable form of leprosy characterized by one or two well defined, hypopigmented (or erythematous) asymmetrically placed, maculoanesthetic lesions, round or oval in shape, may be flat or raised, surface appearing dry and rough due to impaired sweat functions, usually seen on the lateral aspects of legs, arms and shoulders. Nerves are thickened unilaterally and asymmetrically. Lesions are bacteriologically negative and lepromin test is strongly positive (>20 mm erythema). It is so called 'tuberculoid' because the dermis is infiltrated with epitheloid cells (giant cells) in the central part as in lesions of tuberculosis. The lesions are stable in the evolution. It is one polar type of leprosy.

Lepromatous leprosy: It is the other extreme polar type of leprosy. The cutaneous lesions are small, numerous, shiny widely distributed and symmetrical. Following types of lesions may be found or more than one type may also be found. The lesions are bacteriologically strongly positive and the lepromin test is negative. This is another polar type of leprosy.

Skin Lesions

Macules: These are flat lesions, the surface being smooth and shiny, showing no loss of sensations and bacteriologically positive.

Diffuse infiltration: There is thickening and shiny appearance in the skin. Increased thickening gives the characteristic leonine appearance.

Plaques: The thickened plaques differ from that of tuberculoid ones in that they are soft and shiny with sloping margins, no loss of sensations and bacteriologically strongly positive.

Nodule: It is a definitely thickened, rounded and circumscribed mass of leprous tissue usually appearing at an advanced stage of the disease, not commonly seen in children. The nodules usually appear on top of macules or thickened plaques. However they may appear on normal skin also.

- *Nerves:* Usually multiple nerves are involved. Nerve involvement is late. Therefore deformities are not evident till late in the disease.
- *Nose and eyes:* The lesions in these organs in lepromatous leprosy are characteristic.

Borderline leprosy: This is a very unstable stage of leprosy, midway between the two extreme polar types, i.e. tuberculoid and lepromatous leprosy, thus having the features of both the types of leprosy. The lesions are big and small, numerous, showing great pleomorphism, widespread, bilateral with a tendency to be symmetrical. The lesions are usually erythematous, surface being smooth and shiny. They may be papular or macular. Areas of infiltration are also seen. Sensory changes are variable. Multiple nerves are affected and

thickened. Smears show scanty bacilli. Depending upon the change in host immunity the borderline leprosy may undergo upgrading towards tuberculoid type or downgrading towards lepromatous type. The lepromin reaction is variable (10–15 mm erythema, weakly psoitive). Depending upon the clinical characteristics, the borderline leprosy cases are classified into three categories: borderline tuberculoid (BT), mid borderline (BB) and borderline lepromatous (BL).

Diagnosis

This is done by thorough clinical examination of the patient, in good day light with minimum clothes by palpation of peripheral nerves and for the presence of lesions and testing the lesions for the loss of sensations like touch, pain and temperature (hot and cold). A clinical diagnosis of leprosy is made by looking for the cardinal signs such as lesions with partial or total loss of sensation, thickened nerves with or without tenderness and demonstration of lepra bacilli (AFB) in the smear of cutaneous lesions **(Flow chart 20.7)**.

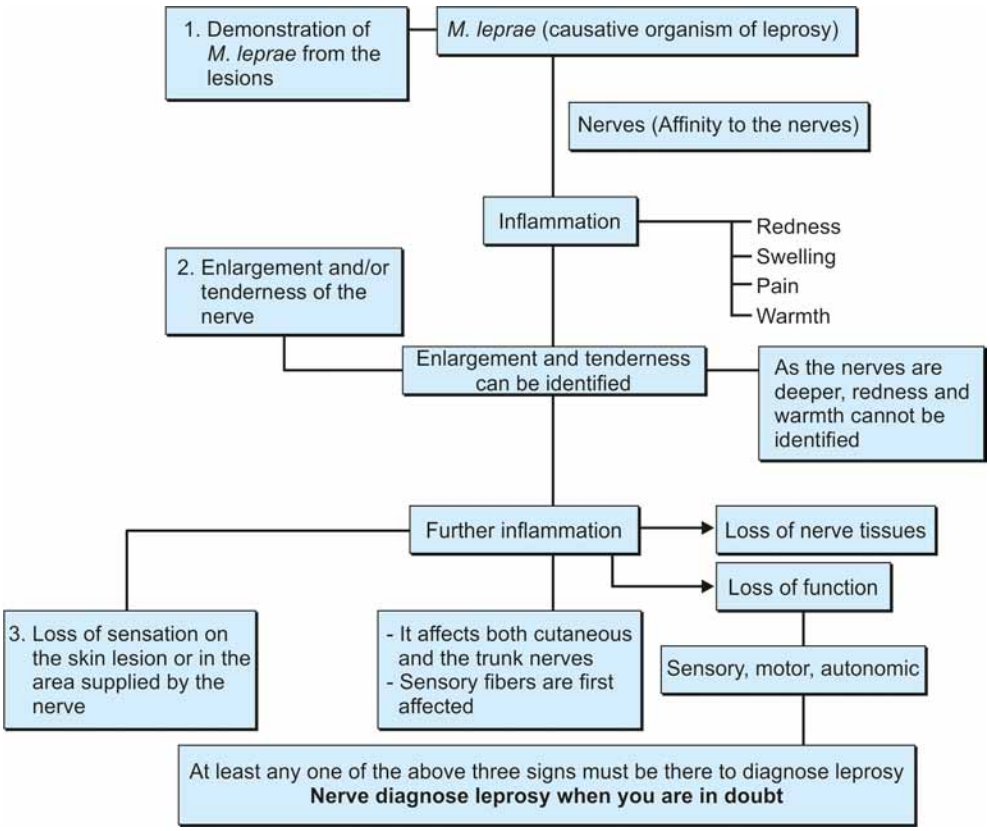
Diagnosis and Treatment Algorithm of Leprosy

This is shown in the **Flow chart 20.8**.

Key Points

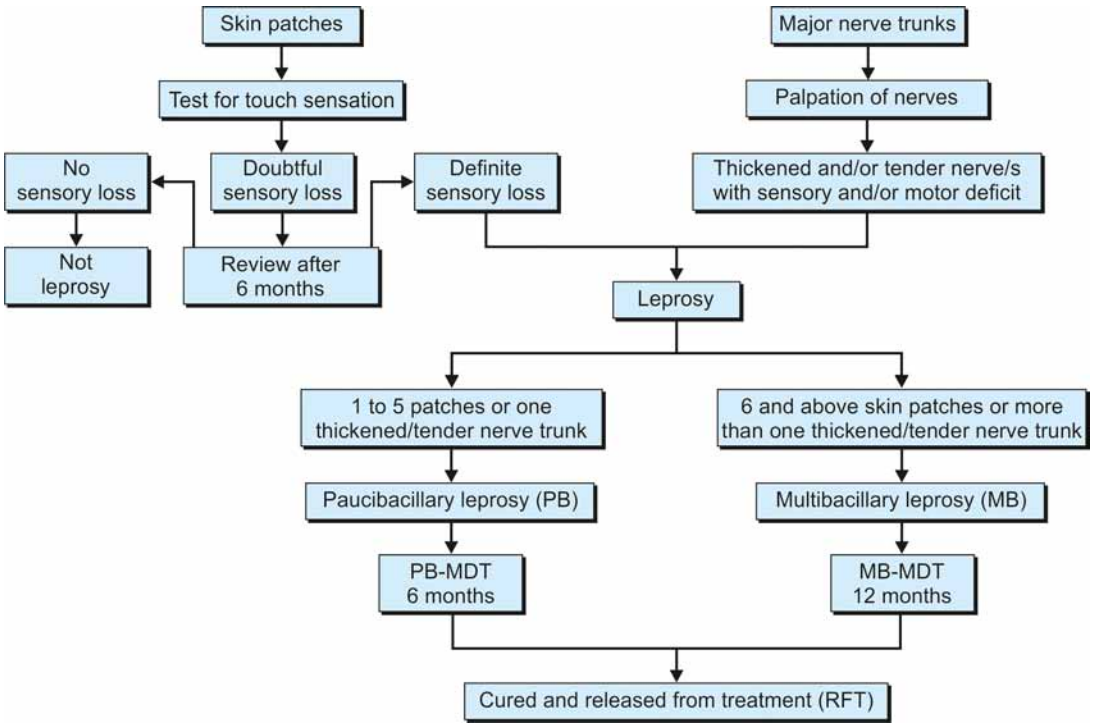
- Diagnosis to be confirmed by Medical Officer.
- *New case:* A patient with skin patches with definite sensory loss and/or definite thickened/tender nerve trunk(s) who never received any anti leprosy (MDT) treatment anywhere in the past.
- *Old case:* A leprosy patient who has taken MDT earlier (part or complete), anywhere.
- In some cases leprosy patches may not disappear even after complete treatment (MDT) and there is no need for further treatment.
- Reactions occurring before and during MDT are to be managed with steroids and MDT, whereas reactions after MDT are to be managed with steroids only.
- In case of 'Relapse', retreat with appropriate MDT regimen.

Flow chart 20.7 Cardinal signs of leprosy



Source: Karnataka State Leprosy Society. Manual of Prevention of Deformity. DHFWS, Bangalore.

Flow chart 20.8 Diagnosis and treatment algorithm of leprosy



Investigations

- Bacteriological examinations
- Lepromin test

} Already explained

- *Histamine test:* 0.1 mL of 1/1000 solution of histamine acid phosphate is injected intradermally in the hypopigmented patch/anesthetic patch. In case of leprosy, because of the involvement of nerves, the erythematous flare response is lost (Normally in healthy persons, there will be positive flare response). So negative test favors the diagnosis.
- *Histological examination (Biopsy of skin):* This is not recommended as a routine. It may be useful in some doubtful cases.
- *Foot-pad culture:* Inoculation of the test material into the foot-pad of mice and the demonstration of lepra bacilli is a confirmatory test. But not done as a routine.

Complications

There are three types—reactions, relapse and deformities.

Lepra Reactions

Reaction in leprosy is a process of development of sudden, acute, inflammatory response often producing painful symptoms. It can occur before, during or after chemotherapy. The reactions are observed due to certain adverse immunological changes taking place in the body, due to unknown reasons. However the precipitating factors are vaccination, pregnancy and delivery, intercurrent infections and mental and physical exhaustion.

There are two principal types of reactions: Type 1 and Type 2 **(Table 20.30)**.

Type 1—Lepra reaction (Reversal reaction): This is observed in unstable spectrum of leprosy (BT, BB, BL) and is ascribed to increase in cellular hypersensitivity, as a result of changes in CMI defence levels of the host. There will be exacerbation of existing lesions associated with acute inflammatory signs such as erythema, warmth, swelling and tenderness. In severe stages, there may be necrosis and ulcerations of the lesions. The nerves close to the skin lesions are also inflamed resulting in swelling and pain (tenderness) of the nerves, followed by nerve deficit in severe cases. The deficit may be sensory, motor or combined. This condition is associated with constitutional symptoms such as fever, headache, arthralgia, myalgia, etc. There may be edema of hands and feet. The severity of these symptoms will be directly proportional to the severity of the reaction.

Type 2—Lepra reaction [(Erythema Nodosum Leprosum–ENL)]: This is observed only in lepromatous leprosy. This is ascribed to immune complex mediated vasculitis. The reaction usually appears after a period of chemotherapy and is characterized by appearance of nodules over days and weeks.

The nodules are erythematous, tender and subcutaneous. They are better felt than seen, may be found anywhere on the body (usually extremities), not related to the existing lesions. In severe cases the nodules become necrotic and ulcerating. The nodules are episodic (i.e. appear in crops) and recurrent. Usually they are discrete but often they may coalesce.

The nerves, even farther away from the lesions, can also be affected. The inflammation of the nerves may be sudden and severe, resulting in nerve deficit. Rarely the neuritis can be silent without signs of inflammation like tenderness. In this case loss of function is the only clinical manifestation. This condition is known as 'Silent neuritis' or 'Quite nerve paralysis'.

In severe cases there will be involvement of other organs such as liver, kidneys, bones, joints, testes, eyes, muscles, lymph nodes, etc.

Associated constitutional signs and symptoms are also present.

Table 20.30 Differences between type 1 and type 2 reactions

Type 1	Type 2
Reversal reaction	Erythema nodosum leprosum
Seen in unstable types of leprosy (BT, BB, BL)	Seen in lepromatous type of leprosy only
Shift in immunological status during reaction	No shift in immunological status during reaction
Ascribed to delayed hypersensitivity reaction, type 4 of Coombs and Gell	Ascribed to immune complex mediated vasculitis (Arthus reaction), of type 3 Coombs and Gell
T-cells are mainly responsible	B-cells are mainly responsible
Generally occurs during chemotherapy	Generally occurs after chemotherapy
Sudden in onset	Insidious in onset
Existing lesions exacerbate, associated with swelling, pain, ulceration and necrosis. Nerves are enlarged and tender	Reactivation of the lesions seen in the margin associated with the appearance of subcutaneous nodules, which are tender and appear in crops
Involvement of other organs is not common	Other organs like viscera, bones, testes, eyes, etc. are commonly involved. Nerves may be affected
Clofazimine is not useful in the treatment	Clofazimine is useful
Thalidomide is not useful in the treatment	Thalidomide is very useful but not during pregnancy
Management is with steroids and MDT	Management is with steroids only

CONTROL OF LEPROSY

This can be discussed under the following headlines:

- Medical measures
- Social measures
- Managerial aspects
- Evaluation.

Medical Measures

This consists of the following measures:

General Measures

This starts with the estimation (size; magnitude) of the problem, by doing surveys. Survey by a random sample provides information about the prevalence of leprosy, age and sexwise distribution, various forms of leprosy and the health facilities available. Roughly the total prevalence of leprosy in an area would be about 4 times that of the cases found among school children. These estimates are essential to plan, implement and to evaluate the results of the control program.

Early Case Detection

The objective is to detect all the cases as early as possible and to register them. Since the disease is symptomless in the early stages, active case finding goes a long way in detecting large number of cases by the trained health workers.

Cases can be detected by the following types of surveys:

Contact survey: This consists of examination of all household contacts, particularly children, of known cases of leprosy in areas with prevalence less than 1 per 1000.

Group survey: This is an additional case finding method, employed in those areas where prevalence of leprosy is more than 1 in 1000 population. This consists of screening certain groups such as school children, slum dwellers, military recruits, industrial workers, etc. through 'Skin camps'.

Mass survey: This consists of examination of each and every individual by house-to-house visits in those areas where the prevalence of leprosy is 10 or more per 1000 population (hyperendemic areas).

The data of each case is entered in the standardized proforma developed by WHO.

Chemotherapy

Monotherapy practiced with Dapsone (Diamino Diphenyl Sulphone—DDS) alone till 1981 used to result in the development of resistance and relapse, jeopardizing the whole strategy of leprosy control.

Multidrug Therapy: Introduction of Multidrug Therapy (MDT) has opened a new avenue in the control of leprosy in the world. WHO recommended in 1982 that all leprosy patients should receive multidrug therapy.

Aim: Aim of MDT is to convert the infectious case into non-infectious as soon as possible, so as to reduce the reservoir of infection in the community.

Objectives: The main objectives of MDT are:
- To ensure early detection of the cases.
- To interrupt the transmission of infection in the community by rendering infectious cases non-infectious by using drugs.
- To prevent drug resistance, relapse and reaction.

The advantages of MDT over monotherapy are shorter duration of treatment, more patient compliance, high cure rate, cost-effectiveness and decreased work load on the health delivery system.

Definition of Terminologies (WHO) (Table 20.31)

- *Case of leprosy:* It is a one showing clinical signs of leprosy with or without bacteriological confirmation of the diagnosis.
- *Paucibacillary leprosy:* It is a one having 1 to 5 skin lesions and/or only one nerve involvement and smear negative for AFB. It is noninfectious and includes indeterminate, tuberculoid, borderline tuberculoid, and pure neural type of leprosy cases (According to Ridley's scale a bacteriological index of less than 2 is considered as paucibacillary).
- *Multibacillary leprosy:* It is a one having 6 or more skin lesions and/or more than one nerve involvement. It has smear positive for AFB and it includes borderline lepromatous and lepromatous lepromatous types (According to Ridley's scale a bacteriological index of 2 or more is considered as multibacillary).

  Thus, for purposes of chemotherapy, leprosy patients are grouped into paucibacillary and multibacillary categories. In most of the leprosy clinics, paucibacillary cases constitute more than 60 percent of the cases.
- *Adequate treatment:* A patient is said to have taken adequate treatment and completed MDT within a reasonably short period of time.
  - For paucibacillary cases, 6 monthly doses of combined therapy have been received within 9 months
  - For multibacillary cases, 12 monthly doses of combined therapy have been received within 16 months.
- *Regular treatment:* The patient is said to have taken regular treatment if he or she has taken for at least two-thirds of the duration of treatment.
- *Newly diagnosed case:* It is one who has not taken MDT in the past.
- *Defaulter case:* It is one, who has not collected treatment for 12 consecutive months or who has not completed the course. Such patients are deleted from the register. But if a defaulter returns for the treatment, should be given a new course of MDT if he/she has new lesions with nerve involvement.
- *Recycled one:* A case of leprosy who has taken MDT treatment partially or totally and has residual signs of leprosy and has now been re-registered as a newly diagnosed case and has restarted treatment with MDT.
- *Relapse case:* It is a one who has successfully completed the course of MDT and develops new signs and symptoms of the disease.

STANDARD CHILD TREATMENT REGIMEN (10–14 YEARS)

For MB Leprosy

- Rifampicin 450 mg once a month
- Clofazimine 150 mg once a month and 50 mg on every alternate day
- Dapsone 50 mg daily
- Duration 12 months.

Table 20.31 WHO Recommended MDT Regimen of Leprosy (Adults)

Type of leprosy	Drugs used	Dosage (adults)	Frequency of administration	Duration of treatment	Follow-up
Multibacillary (MB)	Dapsone Rifampicin Clofazimine	100 mg 600 mg 300 mg 50 mg	Daily Once monthly Once monthly Daily	12 months	Once a year for 5 years
Paucibacillary (PB)	Dapsone Rifampicin	100 mg 600 mg	Daily Once monthly	6 months	Once a year for 2 years
Single skin lesion paucibacillary *(SSLPB)	Rifampicin Ofloxacin Minocycline	600 mg 400 mg 100 mg	Single dose Single dose Single dose	Single dose treatment of ROM	–

For PB Leprosy

- Rifampicin 450 mg once a month
- Dapsone 50 mg daily
- Duration 6 months.

Epidemiological Points

- Dose is adjusted approximately for children below 10 years
- Doses recommended daily are self-administered by the patient
- Doses given once a month (pulse dose) are taken by the patient under supervision
- Patients with single lesion, not improving with single dose of ROM are treated as PB cases
- Single dose of ROM for single lesion are not recommended for pregnant women (or children below 5 years) and the treatment should be deferred until after delivery
- The drugs are supplied in blister pack, free of cost, under National Program **(Figs 20.82A and B)**. Each blister pack contains drugs required for one month, separately for children and adults.
- Leprosy is exacerbated during pregnancy. Therefore the MDT should be continued during pregnancy
- MDT-drugs are safe both for the mother and the child, except for the mild discoloration of the infant due to clofazimine
- If the leprosy patient has active tuberculosis also, it is necessary to treat both infections simultaneously
- If the leprosy patient has HIV infection also, the MDT does not require any modifications
- If the patient cannot take dapsone due to toxicity, dapsone must be immediately stopped. However clofazimine and rifampicin to be continued as usual in MB cases. In PB cases, rifampicin 600 mg once a month is continued alongwith clofazimine 50 mg daily and 300 mg once a month as in MB cases
- If the patient is severely anemic, Hb level should be improved before starting dapsone therapy
- In MB cases, if clofazimine is unacceptable because of adverse effects, it should be replaced by a self-administered, daily dose of 250 to 375 mg of ethionamide or protionamide

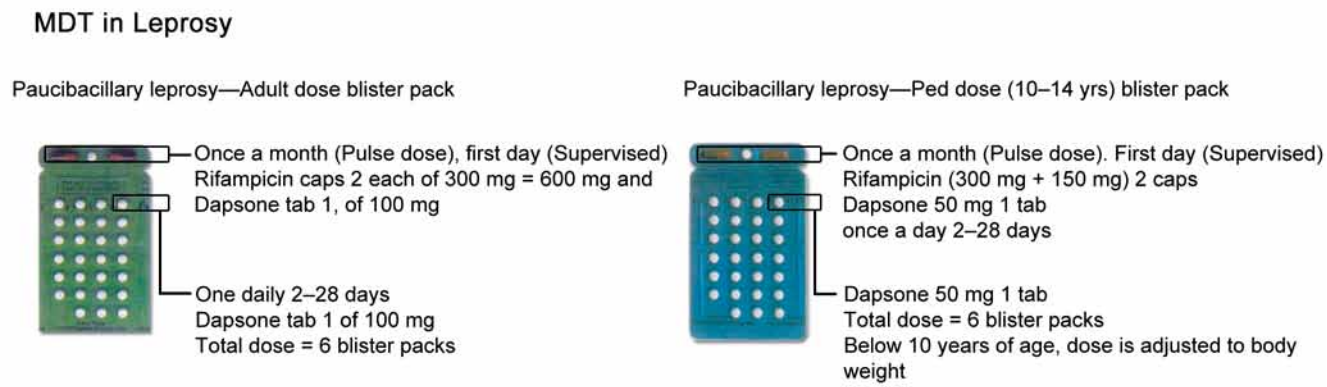


Fig. 20.82(A) WHO recommended MDT regimen for PB leprosy. Each blister pack contains drugs for one month.

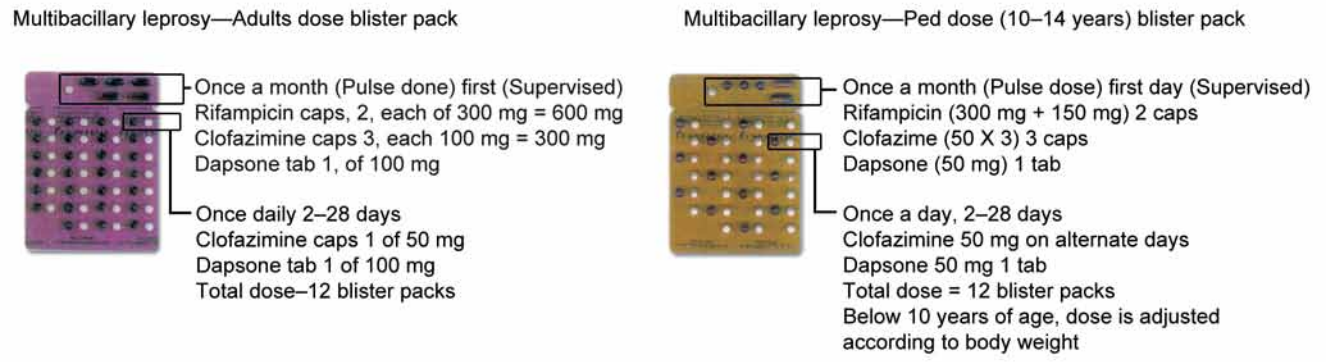


Fig. 20.82(B) WHO recommended MDT regimen for MB leprosy. Each blister pack contains drugs for one month

- If the patient cannot take rifampicin because of allergy or intercurrent disease like hepatitis, 500 mg of Clarithromycin can be substituted
- If the patient refuses to take clofazimine because of skin discoloration, it is replaced by ofloxacin 400 mg daily for 12 months or minocycline 100 mg daily for 12 months
- After completion of the treatment, patients may develop lepra reaction (Type 1 or Type 2) or may develop neuritis. Such patients are treated with oral prednisolone
- Since the corticosteroids are known to accelerate the multiplication of organisms resulting in reactivation, it is recommended to give clofazimine 50 mg daily as a prophylactic measure, as long as steroid is given
- A defaulter who returns to the health center for treatment should be given a new course of MDT when he/she shows one or more of the following signs:
  - Reddish and/or raised lesions
  - Appearance of new lesions
  - New nerve involvement
  - Nodules
  - Signs of reaction (Type 1 or 2).

The principle underlying the MDT regimen is to prevent the development of not only resistance but also the relapse and the reactions. The side effects are negligible and disabilities are prevented. Training the health workers and administration of drugs is also easy. Thus MDT is the most effective intervention.

Rifampicillin is exceptionally potent bactericidal against *M. leprae*. A single dose of 600 mg is capable of killing more than 99.9 percent of viable organisms. The rate of killing is not further increased by subsequent doses. Since Rifampicin exerts its effect for several days, during which the pathogens are incapable of multiplying, this is another reason why rifampicin is given once in a month. This makes the programme cost effective also.

Clofazimine is also given once in a month, in a loading dose because it is a repository drug, excreted slowly, thus ensuring maintenance of optimum concentration in the body even if the patient misses the daily dose.

Clofazimine is known to result in the discoloration of the skin. The discoloration (brownish) starts by third month, attains maximum intensity by one year, then starts diminishing after discontinuation and skin returns to normal within a year. Thus it is completely reversible.

Alternative anti-leprosy drugs are minocycline (Tetracycline) group, quinolone group, macrolide (clarithromycin) group and newer derivatives of rifampicin. However none of these is superior to the combinations used in MDT.

SUMMARY

- Leprosy can be easily diagnosed and classified on the basis of clinical findings alone
- There is no need to take skin smears for diagnosis, classification or for monitoring the progress of the treatment, because invariably it yields negative results
- MDT treatment regimens are standardized and usually do not require mid-course changes
- Cure of leprosy is based on completion of a full course of standard MDT regimen
- Unnecessary skin piercing procedures are not only unethical but also covers the risk of transmission of HIV and hepatitis B.

Management of Leprosy Reaction

Only severe reactions require hospitalization.

- General treatment consists of bed rest, analgesics and tranquilizers (sedatives)
- Specific treatment.

For type 1 reaction: Antileprosy treatment to be continued. Reactions require urgent treatment as they can lead to irreversible deformities. Along with MDT, corticosteroids (prednisolone) to be started and given in tapering doses, for 12 weeks, as follows:

- 40 mg daily for weeks 1 and 2
- 30 mg daily for weeks 3 and 4
- 20 mg daily for weeks 5 and 6
- 15 mg daily for weeks 7 and 8
- 10 mg daily for weeks 9 and 10
- 05 mg daily for weeks 11 and 12.

Patient is examined every week and dose is reduced every 2 weeks.

For type 2 reaction: Antileprosy treatment to be continued. If there is mild reaction, it is supplemented by non-steroidal anti inflammatory drugs like ibuprofen, nimesulide, diclofenac, etc.

If there is severe reaction, corticosteroids and clofazimine are given.

- *Corticosteroid* (Prednisolone)*:* It is given in the same dosage schedule as in **Table 20.27** reaction.
- *Clofazimine:* 100 mg three times a day for 3 months followed by 100 mg per day for about 9 months. Management with clofazimine alone is indicated when steroid is contraindicated.

Active physiotherapy is recommended after the acute phase. In case of recurrent neuritis, not responding to steroids, surgical decompression of the nerve is recommended to relieve the pain and to promote vascular supply to the nerve.

Follow-up: After completion of MDT therapy, follow-up of the patients is necessary to ensure that the therapy has been successful and the disease has not relapsed. In paucibacillary leprosy clinical examination is necessary at least once in a year for a minimum of 2 years and in multibacillary leprosy clinical and bacteriological examination is required once a year for 5 years.

Leprosy vaccine (Immunoprophylaxis): BCG vaccine has shown to have a variable protective effect against leprosy. Other vaccines are grouped under 'Candidate vaccines', which are categorized as follows:

'Candidate Vaccines' against Leprosy

Category I (Based on *M leprae*)

- Killed *M leprae*
- Killed *M leprae* + BCG
- Acetoacetylated *M leprae*

Category II (Based on cultivable mycobacteriae)

- BCG
- BCG + *M vaccae*
- Killed *M vaccae*
- Killed ICRC bacilli
- *M phlei*
- *M gordanae*
- *M habana*
- ICRC + BCG

Three leprosy vaccines are currently undergoing large scale human trials. First is the WHO vaccine developed by Dr J Convict in Venezuela. It is a combined vaccine containing BCG and heat killed *M. leprae*, harvested in armadillo. The rationale for incorporating BCG is that it has some protective effect against leprosy. The other two are Indian vaccines - ICRC vaccine and *M. vaccae* vaccine, respectively developed by MG Deo and GP Talwar. ICRC bacilli was cultivated by Khanolkar, in 1958.

ICRC vaccine

ICRC bacillus antigenically same as mycobacterium leprae and so cross reacts with it to produce cross immunity. It was cultivated in 1958 by Dr Khanolkar and developed by Dr MG Deo at Cancer Research Institute, Mumbai. ICRC vaccine was prepared in 1979 and since then many trails have been conducted. It is not only immunoprophylactic but also immunotherapeutic in some patients of lepromatous leprosy. The ICRC bacilli are attenuated by X-irradiation.

M vaccae Vaccine

This was developed by Dr GP Talwar at National Institute of Immunology, New Delhi. It is a nonpathological atypical mycobacteriae sharing antigens with *M. leprae*. It is also similar to ICRC vaccine.

All the three vaccines have shown similar degree of lepromin conversions in lepromatous leprosy patients. However all are under trial.

Chemoprophylaxis

Practicing chemoprophylaxis among contacts has been a controversial topic. However studies have shown that administration of dapsone for 3 years with a dose of 1 to 4 mg per kg wt, among young child contacts, providing protection varying from 35 to 53 percent.

Acedapsone, a long acting repository sulphone, has also been found to be equally effective. One injection is given every 10 weeks to cover 30 weeks. Protective rate is about 78 percent.

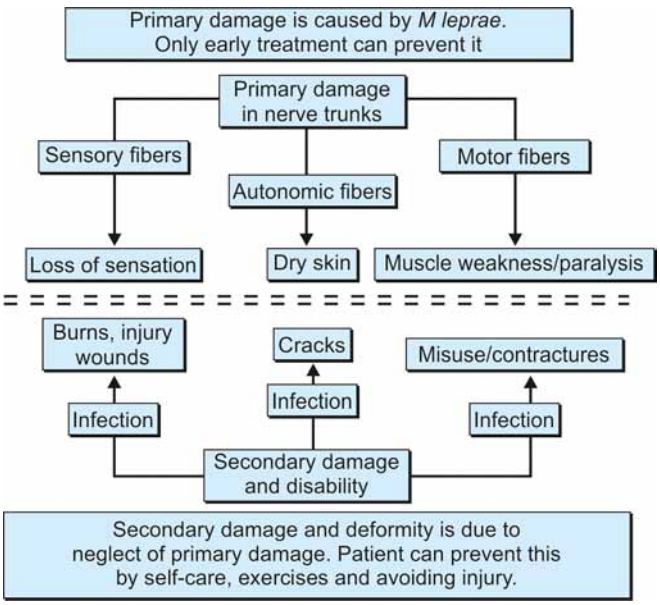
However, a recent study has shown that a single dose of Rifampicin given to contacts of the newly diagnosed leprosy patients is 57 percent effective in preventing the development of clinical leprosy at two years.

In case of a child who is in contact with a lepromatous mother, who is under regular DDS therapy, there is no need for prophylaxis till the child is weaned, because the breastfed child gets an adequate amount of DDS from the breast milk.

Deformities in Leprosy (Flow chart 20.9)

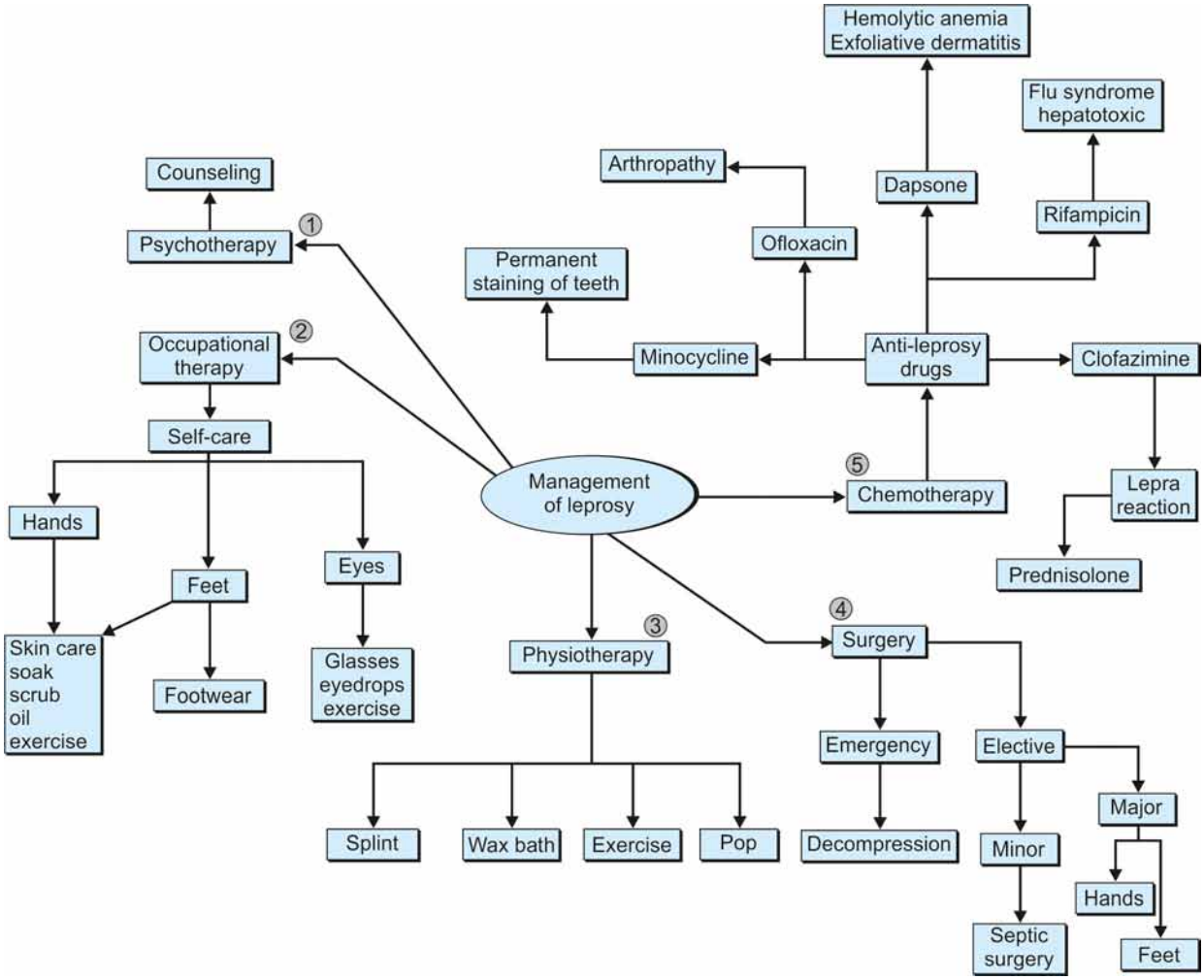
- Primary damage is caused by *M. leprae* and results from these failures:
  - Failure to come early for the treatment and continue it regularly.
  - Failure of field workers to send patients quickly to hospital.
  - Inadequate medical treatment.
- Secondary damage and deformity could be due to:
  - Failure by leprosy workers to provide health education to patients.
  - Failure by the patients to carry out the necessary instructions given.

Flow chart 20.9 Deformities in leprosy



Source: Karnataka State Leprosy Society. Manual of Prevention of Deformity. DHFWS, Bangalore.

Flow chart 20.10 Concept map



Source: Karnataka State Leprosy Society. Manual of Prevention of Deformity. DHFWS, Bangalore.

Rehabilitation

Preventive rehabilitation consists of prevention of development of disabilities in a leprosy patient by early diagnosis and prompt treatment.

But once the patient becomes handicapped and suffers from the damage caused, should be trained and retrained to the maximum functional ability so that the patient becomes useful to self, to the family and to community at large by various measures such as medical (physical), surgical, psychological, vocational and social (**Flow chart 20.10**).

Health Education

Health education is given to the patient, to the family and to the community at large about leprosy covering the following key messages, aiming at helping people to change their attitude and behavior by removing the misunderstandings and misconceptions among the people and also by eradicating social stigma, social ostracism and social prejudice associated with leprosy.

Key Messages

- Hypopigmented patch with loss of sensation could be leprosy.
- Leprosy like any other disease, is caused by germs.
- Leprosy is neither hereditary nor a curse.
- Eighty percent of the cases do not spread to others.
- Leprosy is completely curable.
- All it needs is early detection and sustained treatment.
- Deformities are due to negligence.
- Leprosy patients need sympathy and kindness.
- Treatment of leprosy is absolutely free.

- Leprosy is not a poor man's disease. It can occur even among the affluent.
- Leprosy patients can stay at home without any risk and continue to work.
- Once the treatment is started very soon they become noninfectious.
- Community support to leprosy patients is as important as medical help.

Social Measures

These are the measures taken to see that the leprosy patients are accepted by the society, because of the social stigma. Social assistance should be promoted through voluntary agencies and department of social welfare. Thus social measures consist of social rehabilitation and health education of the public. Social support consists of mainly acceptance of the patient by the family members, job placement and abolishing the social evil of beggary.

Managerial Aspects

Managerial and administrative support are essential ingredients for effective implementation of any health program and leprosy control is no exception. Availability of adequate infrastructure, trained personnel, medicines, equipment, transport and finances must be ensured. Further discussed under National Leprosy Eradication Program.

Evaluation

Proper evaluation of any health program is necessary to check whether the desired results are achieved or not and if not, what modifications are needed.

The indicator for evaluation of leprosy control program are of two types–Operational and Epidemiological.

Operational Indicators

- *Relapse rate:* This is a very good indicator of the efficacy of the drug regimen.
- *Case detection ratio:* It is the ratio of number of cases registered to the estimated number of cases.
- Proportion of children below 14 years among the total number of newly detected cases.
- Proportion of multibacillary cases on regular treatment during one year.

Epidemiological Indicators

These are employed to assess the effectiveness of the programme. These are:

- Incidence rates with reference to age, sex and area-wise are estimated. It is the most sensitive index of transmission of the disease (This measures the reduction of transmission).
- Prevalence rates with reference to age, sex and areawise provides the measure of 'case load' (magnitude of the problem) and is useful in planning the implementation of control program.

The following epidemiological parameters are to be kept in mind while doing evaluation of the program:

- 17 states have achieved the level of leprosy elimination
- 07 states are near the goal of elimination. Karnataka is one of them (i.e. Prevalence rate of leprosy is < 1 per 10,000 population)
- Female proportion is 34.77 percent of the total new cases in 2003-04
- Child proportion is 13.77 percent of the total new cases in 2002-03
- Multibacillary proportion is 39.30 percent
- Percentage of visible deformities are 1.44 percent as on 1.4.2004.

Leprosy Organizations in India

There are many voluntary organizations working in the field of leprosy in India. These are:

- *Leprosy mission:* This was the first organization for leprosy work founded by Baily in 1874, in Chamba, Himachal Pradesh. Presently its headquarter is in Purulia, West Bengal.
- *Hind Kusth Nivaran Sangh:* This was established in Delhi, about 100 year later, i.e. during 1974, as a branch of the Association in London.
- Gandhi Memorial Leprosy Foundation, Sevagram, Wardha.
- Belgium Leprosy Centre (Polambakkam, Chennai).
- Danish Save the Children Fund.
- Bharath Sewashram Sangh (Jamshedpur, Jharkhand).
- Kashi Kusth Seva Sangh (Varanasi, UP)
- Japovan (Amarvathi, Maharashtra).
- German Leprosy Relief Association.
- Damien Foundation.

Two other important organizations active in the field of leprosy are JALMA Central Institute of Leprosy, Agra, which is taken over by ICMR in 1975 and Central Leprosy Teaching and Research Institute, Chingleput.

National Leprosy Eradication Program

Except for samllpox and guinea worm disease, no other diseases are eradicated in India. Government of India committed to 'eradicate' leprosy by the year 2000 AD, by becoming signatory to Alma Ata declaration of Health for All, 2000 AD.

But leprosy falls short of almost all the requirements of eradication of a disease and therefore not suitable for eradication. The real hurdles are long and variable incubation period, disputed modes of transmission, presence of sub-clinical cases in the community, the complicated spectrum of the disease features, failure of the cell mediated immunity in lepromatous cases of leprosy, bacterial resistance and persistence in the body, absence of an effective vaccine, social and cultural taboos, presence of extra-human reservoirs, etc.

National leprosy eradication program (NLEP) has been compared to 'Garibi Hatao Program'. Both are related.

More than the eradication, if leprosy ceases to be a public health problem, that-itself is an achievement. NLEP-Discussed under National Programs.

National Leprosy Elimination Campaign

With the introduction of MDT since 1981, the prevalence of leprosy has been remarkably reduced from 57.6 per 10,000 population during 1981, to hardly 2.3 per 10,000 by 2004. During 1997, National Leprosy Elimination Campaign was taken up with a goal to eliminate by the year 2005. During 2005, the prevalence rate was 1.3 per 10,000 population, it became 0.84 during 2006 and by 2011, it came to 0.69 per 10,000 population. So leprosy is now said to be eliminated.

Myths and Realities of Leprosy Elimination

It is a myth that some aspects of this disease like exact mode of spread, its selection of the people are ill defined but it is a reality that the disease has been largely controlled and is in the verge of elimination.

It is a myth that suitable leprosy is yet eluded the scientists and doctors but it is a reality that the potent Multi-drug treatment is available to every leprosy patient. It is a myth what was thought to be a lifelong treatment with the then Dapsone monotherapy, it is a reality that the duration of treatment is hardly reduced to 6 to 12 months depending upon the type. It is a myth that the classification adapted earlier was creating confusion has in reality been reduced to a practical field level approach as paucibacillary and multibacillary.

It is a myth that the earlier concept of active case detection by house to house visit by leprosy workers is no more necessary. It is also a myth that the treatment given in intensive and maintenance phases has in reality been reduced to single phase.

It is a myth that leprosy which was synonymous with poverty and social ostracization has now improved the status of a beggar to that of a patient.

What once leprosy meant deformity and disability is in reality now disappearing from the minds of the people. What was once a myth that cell mediated immunity is one of the important determining factor, now, it is a reality that there is hardly any association with HIV/AIDS, which is also based on immunity.

It was a myth that leprosy which affected more than 130 countries in the world few years back, in reality is greatly reduced to 6 countries as a main public health problem.

It is a myth that leprosy cannot be eradicated from the mankind but in reality it can be eliminated from the world.

Leprosy Day

Fourth Sunday of January of every year is being celebrated as 'World Leprosy Day', since 1954.

Let us join hands and work towards a world without leprosy.

YAWS

Yaws is a contagious, nonvenereal, infectious disease, caused by *Treponema pertenue*, common among children. Clinically characterized by a primary, papillomatous, skin lesion, called 'mother yaw', seen on exposed part of the body like face or trunk, followed by a generalized lesions and a late stage of destruction of skin and bone, in an untreated case. The disease is closely linked with standard of living and social customs.

Magnitude

Yaws is a public health problem in Africa, South-East Asia and central part of South America. In Africa, it is reported from Benin, Ghana, Ivory-coast. In South-East Asia, it is reported from India, Indonesia, Papua New Guinea and South Pacific. In South America, it is reported from Brazil, Columbia, Ecuador, Guyana and Suriname.

During 1950s, WHO and UNICEF launched a concerted programme to curb the disease by giving a mass treatment for about 50 million individuals from 46 countries, covering a population of about 400 million people living in the affected areas, resulting in a great reduction in the prevalence of yaws. However, there has been an increasing trend of the disease.

In India, it is mainly a disease of tribal people in Maharashtra, Odisha, Madhya Pradesh, Assam and Andhra Pradesh. The problem of yaws now is one of either 'residual yaws' or 'recrudescence' of yaws, due to continued low levels of transmission.

Agent

The causative agent is *Treponema pertenue*, which is morphologically similar to *T. pallidum*. It has 10 to 12 spirals and 20 μ in length. It is highly host specific. It occurs in the epidemis of the lesions, lymph glands, spleen and bone marrow. It cannot survive outside the human body.

Reservoir of Infection

There is only human reservoir. Source of infection is the discharges of the cutaneous lesions of yaws. The lesions relapse several times and serve as source for new infections.

Age Incidence

It is primarily a disease of children, below 15 years of age, peak incidence is between 5 and 10 years of age. However it can occur in any age group.

Sex Incidence

Preponderance is more among males than females.

Immunity

There is no natural immunity. Immunity is acquired slowly over several years. It is suppressed by treatment. However it offers cross immunity partially against venereal syphilis. The prevalence of yaws is inversely proportional to the prevalence of venereal syphilis. That means if the prevalence of venereal syphilis is more, that of yaws is less and vice-versa.

Social Factors

The disease is endemic among tribal people because of scanty clothing, poor personal hygiene, frequent trauma and wounds, over crowding, low standard of living, lack of availability of soap and water are responsible for the prevalence of yaws.

Environmental Factors

Warm and humid climate favors the transmission of yaws, because it keeps the organisms viable in the discharges from the wound, on the ground. Thus the prevalence is high among tribals living on the top of the hills than among those living in foot hills.

Modes of Transmission

The disease is mainly transmitted by direct contact with the discharges of cutaneous lesions, during holding each other, embracing, sharing bed, mother carrying the child while feeding, etc., i.e. by close physical contact.

- *Indirect contact:* The disease is also transmitted indirectly through discharges on ground and the pathogens enter the body through injuries on feet.
- *Vectors:* House flies and other small insects have been incriminated as mechanical vectors in the transmission of the disease.

Period of Communicability

It may extend for several years, continuously or intermittently. The lesions are infectious as long as they are moist and exudative. The pathogens are usually not found in late, ulcerative lesions.

Incubation Period

Varies from 3 to 6 weeks.

Clinical Features

- *Early yaws:* The primary lesion, seen on the exposed part of the body like face or limb, is called 'mother yaws', indicates the route of entry of the pathogen. It is a papillomatous lesion. It is called mother lesion because it is from here, further spread takes place resulting in generalized eruptions, while the mother lesion continues to remain, becomes proliferative, exudative, papillomatous, large, yellow, crusted, granulomatous lesion resembling condylomata lata of secondary syphilis. It goes on spreading. During the next 5 years, waxing and waning or spontaneous healing is a common feature. The early lesions are highly infectious. Local lymph glands are enlarged and the blood becomes positive for serological test for syphilis (STS).
- *Late yaws:* This occurs after about 5 years, characterized by destructive, deforming and disabling lesions affecting skin and bone. The lesions on the palms and soles are called 'Crab yaws', those on the palate (hard and soft) and nose are called 'Gangosa', the swelling by the side of the nose due to osteoperiostitis of the maxillary bone is called 'Goundu'.

  These late features occurs in about 10 percent of untreated cases.

  The late ulcerative lesions are not infectious.

Laboratory Investigation

Dark field microscopy of early exudative lesions for treponemal identification.

Treatment

The drug of choice is benzathine penicillin, a long acting penicillin. Dose is 6 lakh units and 12 lakh units for children below 10 years and those above 10 years respectively. It is given deep intramuscularly. Single dose will cure the infection.

Those who are sensitive to penicillin are given tetracycline or erythromycin 500 mg four times a day for 2 weeks.

Prevention and control: It involves the following steps:

- Survey
- Treatment
- Resurvey
- Surveillance
- Improvement of sanitation
- Evaluation.
- *Survey:* A clinical survey is done in the endemic area, covering almost 95 percent of the total population, to know

the magnitude of the problem in terms of prevalence rate of yaws. During the survey, the cases and their contacts are listed.

- *Treatment:* WHO has recommended three treatment policies, depending upon the prevalence rate as follows:
  - *Selective mass treatment:* This is for the area, where the prevalence rate is less than 5 percent (hypoendemic area). In these areas, treatment is given to the cases, family contacts and close extra familial contacts.
  - *Juvenile mass treatment:* This is for the area, where the prevalence rate is between 5 and 10 percent (mesoendemic area). Treatment is given to all cases and to all children below 15 years of age and other extrafamilial close contacts.
  - *Total mass treatment:* This is for the area, where the prevalence rate is more than 10 percent. Treatment is given to the entire population including the cases, because the whole population is at risk.
- *Resurvey:* Since it is not possible to cover the entire population in a single round of survey, resurvey is undertaken once in 6 to 12 months to find out and treat all missed cases and new cases.
- *Surveillance:* This is a technique recommended to detect any new case of yaws (i.e. case detection). Any case detected, is investigated epidemiologically to identify the probable source of infection and contacts so as to prevent new cases. The case is given therapeutic treatment and contacts are given prophylactic treatment. Monthly follow-up the family contacts is done for 3 to 4 months. All these measures help in interruption of transmission.
- *Improvement of environmental sanitation:* Since socio-environmental factors play a key role in the prevalence of the disease in the community, emphasis has been laid in the improvement of sanitation, such as provision of ample water supply, improvement of housing conditions, control of vectors, disposal of the discharges of the lesions, health education of the people to maintain high standard of personal hygiene by using soap and water liberally, avoiding unnecessary close physical contact with others and cleanliness in and around the houses, thus improving the quality of life.
- *Evaluation:* Resurvey is done after implementing the control campaign to find out the prevalence rate. More than the clinical survey, serological studies are done among children borne after the completion of the control campaign. If no antibodies are found among those children, that means the disease is under control.

Eradication of Yaws

Even though there is treatment for yaws and the preventive measures are simple, yaws is not amenable for eradication because:

- The cases are infectious for months and years
- The pathogens remain latent in lymph nodes
- The immunity acquired does not last longer
- There is no vaccine against yaws.

BIBLIOGRAPHY

1. Bikash Ranjan Kar. Emerging and Remerging Infections with Special Reference to Eastern Zone. NAMSCoN; 2001.
2. DHFWS. Leprosy Division, Bengaluru. Karnataka.
3. file: //I:/art_53805.html;file://I:art_53806.html
4. Ind J Int Med. Rabies. Special Issue. Vol 3. Aug 1993.
5. Ind J Lep. Strategic Issues. The Elimination of Leprosy as a Public Health Problem. 2003 Oct – Dec;75(4).
6. Karnataka State Leprosy Society. Manual of Prevention of Deformity. DHFWS, Bangalore.
7. Kishore J. National Health Programmes of India. 5th Edn. 2005.
8. Sudarshan MK, et al. JIMA. 1995;93:14-6.
9. Sudarshan MK. Rabies—A Manual for Doctors. 2nd edn. 2002.
10. Tapan K Ghosh. Various protocols of cell culture Anti Rabies Vaccine. JIMA. 1993 May;91(5).
11. WHO. Tech Rep Ser. No. 675, 1982.
12. WHO. Tech Rep Ser No. 824, 1992.

CHAPTER 21

Epidemiology of Noncommunicable Diseases

NONCOMMUNICABLE DISEASES

Burden, Socioeconomic Implications, Policies and Program for Prevention and Control of Noncommunicable Diseases in India—A Report on National Summit on NCDs

Noncommunicable diseases (NCDs) and injuries are replacing communicable diseases as the most common causes of disability, morbidity and premature mortality, thus showing an epidemiological transition in low and middle income countries including India. The leading causes are cancer, diabetes, hypertension, cardiovascular disease, stroke, chronic obstructive pulmonary disease, chronic kidney disease, mental disorders and trauma. Besides presenting a serious threat to public health, NCDs hamper socioeconomic development of the country. They account for 52 percent of deaths, 43 percent of disability adjusted life years (DALYs) and 62 percent of total disease burden in India. This burden is likely to increase in the years to come. Cardiovascular diseases (CVDs) figure at the top among the ten leading causes of adult (25–69 years) deaths in India. WHO has projected that by the year 2030, CVDs will emerge as the main cause of death (36%) in India and majority of these deaths are premature. The expenditure associated with the long-term effects of NCDs is high and about 10 to 25 percent of families with CVDs or Cancer respectively are driven to poverty. The economic burden would be in the range of 5 to 10 percent of GDP, which is significant and this slowing down of GDP hampers the development of the country.

Associated with this, the demographic transition (i.e. raise in aged population), the epidemiological transition (i.e. increase in the incidence of NCDs compared to communicable diseases) and social transition (like eating habits, smoking and alcoholism) pose serious challenge to the health system for providing treatment, care and support. Besides, the industrialization, urbanization and globalization are also contributing to the epidemic of NCDs by increasing the risk factor levels. As a result of this multidimensional effect at individual household, health system and macroeconomic level, NCDs are being labeled as global 'Chronic Emergency.' Since health sector alone cannot deal with the chronic emergency of NCDs a multisectoral action is required with a high political commitment.

The estimated burden and trends of NCDs in India is shown in the **Table 21.1**.

National Response to Noncommunicable Diseases

Government of India had supported the States in the prevention and control of NCDs through several vertical programs. National Health Programs for Cancer and Blindness were started as early as 1975 and 1976 respectively, followed by program on Mental Health in 1982. However there was considerable upsurge to prevent and control NCDs. New programs were started on a low scale in limited number of districts. Convergence with public sector health system was a feature of these programs. National Health Programs

Table 21.1 Estimated burden and trends of noncommunicable diseases in India

Diseases	Existing burden and trends
Cancer	28 lakh (2010); incidence of 10 lakh in a year; 20–25 percent increase in 5 years
CVD	2.9 crore (2000); expected to rise to 6.4 crore by 2015
Stroke	20 lakh
Diabetes	5.1 crore (2010); expected to rise to 8 crore by 2030
COPD	Burden: 3.9 crore; Prevalence 405/lakh; projected 596/lakh by 2015
Mental disorders	6–7 percent of population. 1–2 percent have severe mental disorders
Blindness	Estimated blind persons: 1.21 crore; prevalence reduced from 1.49 percent (1976) to 1 percent (2006–07)
Deafness	Estimate prevalence 6.3 percent of population; 2.91 crore with profound hearing loss. There is increasing frend
Iodine deficiency	More than 7.1 crore persons with IDD; 263 districts with prevalence >10 percent
Fluorosis	Nearly 6.6 crore persons affected with fluorosis; endemic in 230 districts
Bone and joint disorders	Rheumatoid arthritis: 16.4–17.8 percent in females aged 30–59, osteoarthritis of knee 15. 4 percent males and 14.4 percent in females aged 60–69 years
Burn injury	Annual incidence 70 lakh (10 percent require hospitalization) deaths 1.40 lakh per year; disability 2.5 lakh per year
Road traffic accidents	Annual deaths 1,18,239; injured 4,69,100. 50 percent injured aged 25–65 years
Disabilities	2.19 crore (2.13 percent of population) suffering from various disabilities
Oral diseases	50–60% children have dental caries. Periodontal diseases in 40–45% population

implemented during the 11th plan and their status is given in the **Table 21.2**.

FUTURE PLAN TO PREVENT AND CONTROL NONCOMMUNICABLE DISEASES

There is adequate evidence that NCDs are the major contributors to high morbidity and mortality in the country. Risk factors like tobacco and alcohol use, lack of physical activity, unhealthy diet, obesity, stress and environmental factors contribute to high disease burden of NCDs, which are modifiable factors and can be controlled to reduce the incidence of NCDs and better outcomes for those having NCDs. Costs borne by the affected individuals and families may be catastrophic as treatment is longterm and expensive.

The efforts made by the Government of India and the States have not been able to check the rising burden of NCDs. Investments during the 11th plan and earlier plans have been more on provisions of medical services, which have not been adequate in the public sector. Private sector has grown particularly in urban settings but is beyond the reach of the poor and middle sections of the society. There is urgent need for a comprehensive scheme that should focus on health promotion and prevention of NCDs and their risk factors and comprehensive management of NCDs at various levels across the country. Lessons learnt during the 11th Plan should be addressed and the programs for various NCDs and their risk factors should be integrated and converged with public sector health system.

Approach

A comprehensive approach would be required through the following key strategies:

- Health promotion for healthy life styles
- Strategies to reduce exposure to risk factors
- Early diagnosis through periodic screening of the population
- Development of infrastructures for the management of NCDs including rehabilitation
- Capacity building of human resources
- Establishment of emergency medical services including referral services
- Health legislation
- Surveillance, monitoring and research in these areas.

Programs

The recommended integrated and comprehensive intervention programs are grouped under three headings.

Table 21.2 Status of National Health Programs on NCDs in India

Year of launch	National Health Programs	Current status
1975	National Cancer Control Programs	Integrated with NPCDCS in 2010–11
1976	National Blindness Control Programs	Ongoing in all districts
1982	National Mental Health Programs	Revised programs (2003) being implemented in 123 districts
1986	National Iodine Deficiency Disorders Control Programs	Availability of iodated salt 100 percent. At present, 71 percent population using iodated salt
2007	National Tobacco Control Programs	Being implemented in 42 districts in 21 states
9th Plan	Trauma Care Facility on National Highways	140 trauma care centers set up along golden quadrilateral highways and NE and SW highways
2006–07	National Deafness Control Programs	Initiated in 25 districts. Expanded to cover 203 districts by March 2012
2007–08	National Programs for Prevention and Control of Fluorosis	Initiated to cover 100 districts
2010–11	National Programs for Prevention and Control of Cancer, Diabetes, CVD, Stroke	Initiated to cover 100 districts by March 2012
2010–11	National Programs for Health Care of the Elderly	Initiated to cover 100 districts by March 2012
2010–11	Pilot Programs for Prevention of Burn Injuries	Piloted in Assam, Haryana and Himachal Pradesh
2010–11	Up-gradation of department of PMH in medical colleges	In 28 medical colleges
2010–11	Disaster management/Mobile hospitals/CBRN	Technical specifications and operational details finalized
2010–11	Organ and tissue transplant	Model network for organ procurement and distribution in progress. Biomaterial center for tissue being established

1. *Programs for lifestyle chronic diseases*
   - Cancer
   - Diabetes, cardiovascular diseases (CVDs) and stroke
   - Chronic obstructive pulmonary diseases (COPDs)
   - Chronic kidney diseases
   - Organ and tissue transplant
   - Mental disorders
   - Iodine deficiency disorders
   - Fluorosis
   - Oral dental disorders.
2. *Programs for disability prevention and rehabilitation*
   - Trauma (including road traffic accidents)
   - Burn injuries
   - Disaster response
   - Emergency medical services
   - Musculoskeletal disorders (bone and joint)
   - Physical medicine and rehabilitation
   - Blindness
   - Deafness
   - Health care of the elderly (geriatric disorders)
   - Neurological disorders (epilepsy, autism)
   - Congenital diseases
   - Hereditary blood disorders (Sickle cell anemia, thalassemia and hemophilia).
3. *Health promotion and prevention of NCDs*
   - Tobacco control
   - Prevention of nutritional disorders and obesity
   - National Institute for Health Promotion and Control of Chronic Diseases
   - Patient safety program
   - Establishment of air port/port health offices.

To ensure long-term sustainability of interventions, the programs should be built within existing public sector health system and feasible public private partnership models in all the 640 districts of the country.

The 'Best buys' for NCD prevention and control are shown in **Table 21.3**.

For the cost effective and high impact interventions for the prevention and control of NCDs, integrated approach is necessary. This consists of engaging multiple government ministries to influence public health policy with clear intersections to work on NCDs control and the Prime Minister at the core of this mechanism to ensure smooth coordination is required **(Fig. 21.1)**.

Monitoring and evaluation is essential to improve the services further.

The proposed long-term targets for key indicators for the prevention and control of NCDs **(Table 21.4)**.

Table 21.3 'Best buys' for NCD prevention and control

Risk factor/Disease	Intervention
Tobacco	Tax increase Smoke-free indoor home, workplace and public place Adequate health information and warnings Ban on tobacco advertising, promotion and sponsorship
Harmful alcohol use	Tax increase Restricted access to retailed alcohol Ban on alcohol advertising
Unhealthy diet and physical inactivity	Enforcement of norms for reduced salt intake in food Replacement of trans fat with polyunsaturated fat Public awareness through mass media on diet and physical activity
Cardiovascular disease and diabetes	Counseling and multidrug therapy for people with high risk of developing heart attacks and stroke (including those with established CVD) Treatment of heart attacks with aspirin
Cancer	Hepatitis B immunization to prevent liver cancer Screening and treatment of precancerous lesions to prevent cervical cancer

Source: Global status report of NCDs, 2010

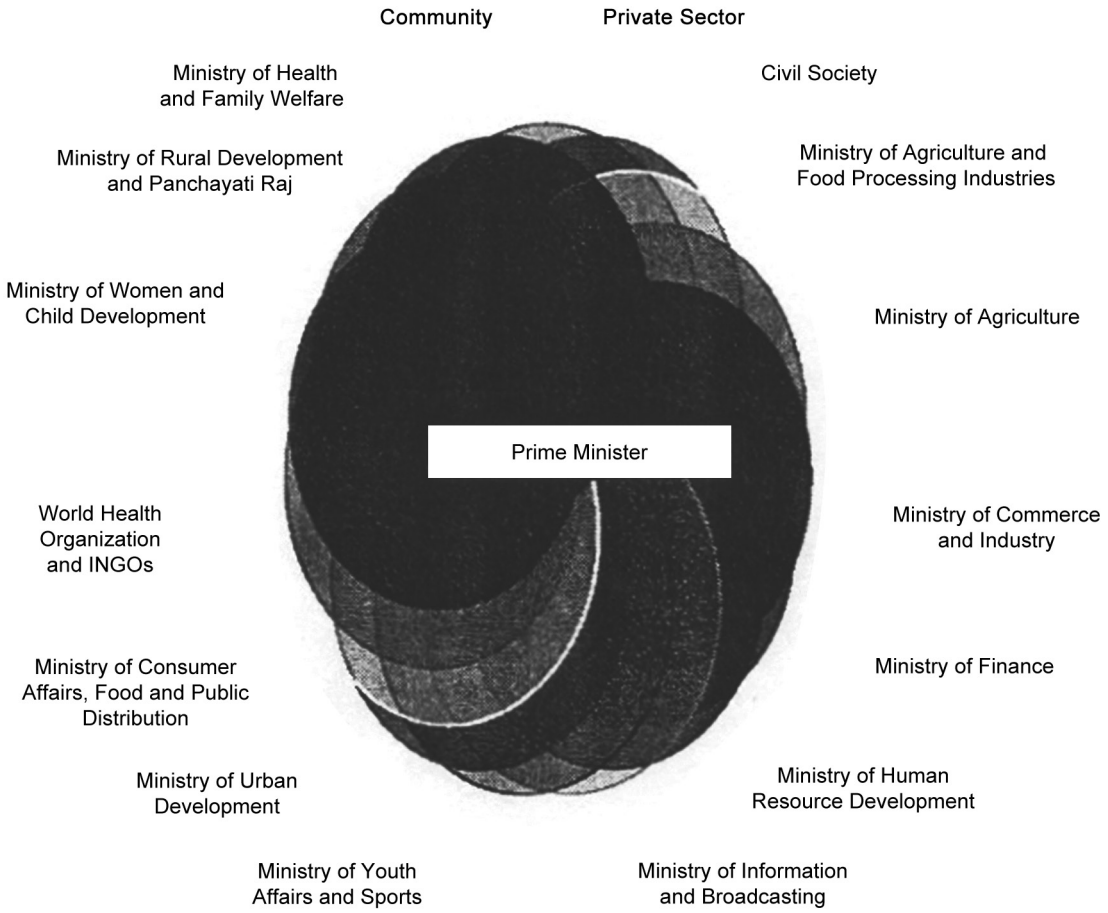


Fig. 21.1 Model for a multisectoral partnership with political commitment

Table 21.4 Proposed long-term targets for prevention and control of NCDs

Indicator	Target 2025
Premature mortality from cardiovascular diseases, cancer, diabetes, and chronic respiratory diseases from age 30 to 70	15 percent relative decline
Prevalence of diabetes mellitus among persons aged 25+	10 percent relative reduction
Prevalence of raised blood pressure among persons aged 25+	20 percent absolute reduction
Prevalence of current daily tobacco smoking among persons aged 15+	25 percent relative reduction and below 20 percent prevalence
Prevalence of obesity	No increase compared to 2010 levels
Prevalence of physical inactivity	10 percent relative reduction
Prevalence of raised total cholesterol among 25+ persons	20 percent relative reduction
Primary care management of cardiovascular risks	50 percent reduction in coverage gap
Coverage of cervical cancer screening	50 percent reduction in coverage gap
Comprehensive tobacco control measures	Cover all States/UTs
Regulations and controls on the reduction of salt and replacement of trans fatty acids with PUFA in manufactured food	Cover all States/UTs
Comprehensive alcohol control measures	Cover all States/UTs

CARDIOVASCULAR DISEASES

CORONARY ARTERY DISEASE ISCHEMIC HEART DISEASE

It is the impairment of the function of the heart due to inadequate blood flow to the myocardium, as a result of obstruction in the coronary circulation.

Coronary artery disease (CAD) is manifested in any of the following forms:

- Angina pectoris of effort
- Myocardial infarction
- Irregularities of the heart
- Cardiac failure
- Cardiac arrest

Coronary artery disease (CAD) is the leading cause of death in all the developed countries, accounting for 25 to 30 percent of total deaths. In the developing countries like India, there has been an increasing trend in the incidence of CAD because of changes in the lifestyle and behavior pattern of the people, so much so CAD accounts for nearly 15 percent of all deaths. Therefore, CAD is considered as 'modern epidemic.' This trend is increasing in India.

The incidence is 2 to 3 times greater in urban areas than rural areas. It is one and a half times more among men than among women. Incidence is maximum in the age group of 50 to 60 years.

Coronary artery disease is a local manifestation of progressive and generalized disorder of the arteries, namely atherosclerosis. The disease is produced from the blockage of the lumen of the coronary arteries. A plaque is formed inside the arteries, which gradually grows to form a thrombus that fills up the lumen and causes obstruction to the flow of blood.

Predisposing Factors

These are grouped into nonmodifiable and modifiable risk factors.

Nonmodifiable Risk Factors

- *Age:* Incidence of CAD is high above 50 years and maximum between 50 and 60 years of age.
- *Sex:* It is more among men than among women.
- *Family history:* Coronary artery disease has been seen to run in families.
- *Genetic factors:* Play a role indirectly by determining the total cholesterol and low density lipoprotein levels.

Modifiable Risk Factors

- *Cigarette smoking:* This has been considered as a major risk factor, because of the following mechanisms involved.
  - Carbon monoxide, induces atherogenesis
  - Nicotine stimulates the release of adrenaline resulting in hypertension
  - Nicotine also increases myocardial oxygen demand and decreases high density lipoprotein (HDL) level.

The risk of developing CAD is directly proportional to the number of cigarettes smoking per day and the duration of exposure (i.e. earlier the smoking is started, greater is the risk). Smoking acts not only independently but also synergistically with other factors like hypertension and elevated serum

cholesterol. The risk however comes down once smoking is given up, but after a few years.

- *Hypertension (HTN):* It increases the risk of CAD by accelerating the atherosclerotic process.
- *Serum cholesterol:* It is proved beyond doubt that increase in serum cholesterol level increases the risk of CAD. The threshold level is 220 mg/dl, beyond which the risk increases. The risk increases progressively with higher levels of low density lipoprotein (LDL) cholesterol, because LDL is atherogenic. [On the other-hand, very low density lipoprotein (VLDL) cholesterol is associated with the atherosclerosis of peripheral vessels resulting in intermittent claudication rather than CAD]. However the risk of CAD decreases with higher levels of high density lipoprotein (HDL) cholesterol because HDL transports cholesterol from the tissues to liver, thus prevents atherosclerosis. The ratio of LDL to HDL more than 5 indicates the risk.

Recent studies indicate that the level of plasma apolipoprotein-A 1 (a fraction of HDL protein) and apolipoprotein-B (a fraction of LDL protein) are better predictors of CAD than HDL and LDL cholesterol respectively.

Thus apolipoproteins are replacing lipoproteins.

- *Serum homocystine:* High serum levels of this amino-acid more than 15.5 mol/liter, damages the intima of the arteries, thus correlating positively with the presence of coronary artery disease. Such levels are related to a diet low in pyridoxine and folates.
- *Diabetes mellitus:* The risk of CAD is 2 to 3 times higher among diabetics than among nondiabetics.
- *Obesity:* Obesity increases the risk of CAD because of its association with LDL cholesterol level, HTN and diabetes.
- *Exercise:* Regular physical exercise increases the concentration of HDL, a protective factor, and decreases both body-weight (obesity) and blood pressure, which are beneficial to cardiovascular health.
- *Hormones:* Hyperestrogenemia favors the development of CAD. Women on oral contraceptives are more to develop CAD than those not using them.
- *Type A personality:* Such people with type A behavior are characterized by competitive drive, restlessness, impatience, irritability, short-temper, sense of urgency, overthinking, etc. are at a higher risk of CAD than the calmer type B personality people.
- *Alcohol:* CAD is common in heavy drinkers.
- *Soft water:* Incidence of CAD has been found to be higher among those consuming soft water than those consuming hard-water. The salts in the latter are protective to the cardiac muscle.
- *Noise:* Chronic exposure to noise over 110 db increases serum cholesterol level and thus the risk of CAD.
- *Drugs:* Misuse of fenfluramine and phentermine used for reduction of weight can be damaging to the heart.

Prevention of Coronary Artery Disease

- Primary prevention
- Primordial prevention
- Secondary prevention.

Primary Prevention

This consists of elimination or modification of 'Risk factors' of disease, with the following approaches.

- Population strategy
- High-risk strategy

Population strategy (mass primary prevention): This is directed towards the whole population focusing mainly on the control of underlying risk factors, irrespective of individual risk levels. This is based on the principle that a small reduction in the blood pressure or serum cholesterol level in a population, would go a longway in reducing the incidence of CAD. This requires a large community-wide efforts, to alter the lifestyle practices, as follows.

Dietary Changes

- Consumption of saturated fats should be less than 10 percent of total energy intake.
- The average intake of cholesterol should be less than 300 mg/day/adult.
- The serum cholesterol level should be less than 200 mg/dl.
- The consumption of carbohydrates must be proportionately increased.

Smoking changes: The goal is to achieve 'Smoke-free' society and many countries are at it. To achieve this, it requires educational activities, legislative measures and other programs.

Blood pressure: Studies have shown that a small reduction in the blood pressure in the population would produce a large reduction in the incidence of CAD. This involves a multifactorial approach based on prudent diet (reduced salt intake and avoidance of high alcohol intake), regular physical activity and control of weight.

Physical activity: Regular physical exercise will go a longway in preventing obesity, hypertension and thus indirectly coronary artery disease.

High-risk strategy: This consists of identifying the 'at-risk' group of persons for CAD and providing preventive care. The 'at-risk' or high-risk group of individuals can be identified by simple screening tests such as recording BP, estimation of serum cholesterol, history of smoking, strong family history of CAD and history of taking oral pills among women and estimation of fasting blood sugar to detect diabetics.

Having identified such high-risk persons, preventive care is taken by motivating them to take action against the

risk factors. Individuals with HTN are given treatment, smokers to give-up smoking, persons with hyperlipidemia are treated.

Sometimes this strategy will not help, for instance the treatment of hypertension does not reduce the risk of CAD.

Primordial Prevention

This consists of prevention of the emergence or development of risk factors among the population groups, in whom they have not yet appeared. Since many adult health problems like HTN, Obesity, have their early origins in childhood, efforts are directed towards discouraging the children from adapting harmful lifestyle such as smoking, eating pattern, physical exercise, alcoholism, etc. The main intervention is through mass education.

Secondary Prevention

This is the action which stops the progress of the disease in its early stage and prevents complications. With ref. to CAD, this consists of prevention of recurrence of CAD by cessation of exposure to risk factors as mentioned in high-risk strategy, e.g. giving up smoking after an attack of myocardial infarction, followed by bypass surgery, prompt treatment with antihypertensives after detecting hypertension, similarly starting antidiabetic drugs after detection of diabetes mellitus, etc.

CONGENITAL HEART DISEASES

A congenital heart disease (CHD) is a defect in the structure and function of the heart, developed during fetal growth, present at birth, often detected during later life. These malformations occur as a result of a complex interaction between genetic and environmental system.

It constitute an important cause of infant morbidity and mortality.

The prevalence of CHD is estimated to be about 5-9/1000 children below 10 years.

Congenital heart diseases are grouped into acyanotic and cyanotic heart diseases.

Acyanotic Heart Diseases (Left-to-Right Shunt)

- Atrial septal defect (ASD)
- Ventricular septal defect (VSD)
- Patent ductus arteriosus (PDA)
- Persistent trunkus arteriosus

Acyanotic Heart Diseases without a Shunt

- Congenital aortic stenosis
- Coarctation of aorta
- Congenital aortic incompetence; mitral incompetence.

Cyanotic Heart Diseases (Right-to-Left Shunt)

- Tetralogy of Fallot
- Complete transposition of great arteries
- Tricuspid atresia
- Coarctation of aorta
- VSD with reversed shunt (Eisenmenger's complex)
- PDA with reversed shunt
- ASD with reversed shunt.

A child with CHD is suspected if there is history of apnea, growth failure and repeated attacks of respiratory infections. The child is physically retarded and often cyanotic. Cardiac murmurs are common. Anomalies of other organs in the body may coexist.

The etiology of CHD is multifactorial. The intrinsic agents are chromosomal aberration, defects of T lymphocytes, systemic lupus erythematosus. The external agents are rubellavirus, X-rays, alcohol, drugs acting on women during pregnancy. Often they (CHD) occur themselves or be a part of syndrome like Down's syndrome, Trisomy 13 syndrome, Turner's syndrome, Marfan syndrome, etc.

Other determinants (influencing factors) are altitude at birth, prematurity, maternal age, sex of the child, consanquinous marriage, etc.

Altitude at Birth

Persistence of the ductus arteriosus is six times more frequent among the children born at high altitudes than those born at sea level.

Prematurity

Ventricular septal defect and PDA are relatively common among premature infants.

Maternal Age

Late maternal age seems to increase the risk of Fallot's tetralogy.

Sex of the Child

The bicuspid aortic valve is predominantly a male disease. Aortic atresia is almost exclusively a disease of male infants.

PDA and ostium secondum atrial septal defect are higher among females. Congenital aneurysms of sinuses of Valsalva carry a male to female ratio of 4:1.

Prevention

In about 90 percent of CHD, the cause is not known clearly. Therefore prevention is possible only in about 10 percent of cases by the following measures.

- *Health education:* People are educated to avoid consanguineous marriages. Women are advised not to postpone marriages and first pregnancy beyond 30 years. Pregnant women are advised to avoid infections, alcohol, smoking, X-rays, drugs and chemicals. They should consume only iodized salt. Diabetic women should keep the disease under control during pregnancy.
- Rubella vaccine to be given to all potential mothers before becoming pregnant.
- Genetic counseling is offered to the parents who have given birth to a child suffering from CHD.
- Detected cases of CHD are referred to pediatric surgeons for the corrections by surgery if any.
- Efficient antenatal care to be taken to prevent prematurity.
- Deliveries at high altitudes are avoided.

RHEUMATIC HEART DISEASE

Rheumatic heart disease (RHD) is the ultimate, sequelae and crippling stage of rheumatic (Rh) fever, which in turn is the result of streptococcal pharyngitis.

Rheumatic fever is an acute febrile disease, affecting the connective tissues particularly in the heart and joints, which occurs following the infection of throat (pharynx) group A beta-hemolytic streptococci. Thus although Rh fever is a noncommunicable disease, it results from communicable pharyngitis.

Rheumatic heart disease is a major public health problem in India. About 20 percent of all sore throats among children are due to streptococcal infection and of these about 2 percent result in rheumatic fever. Almost 80 percent of those who get Rh fever, end up with Rh heart disease. Thus RHD is the most common and most widely prevalent heart disease (30–50 percent of all cardiac cases) among children in India. Its prevalence is about 6/1000 children in the age group of 5 to 15 years. In absolute numbers, about 6 million children in India are suffering from RHD and RHD is responsible for about 30 percent of all cardiovascular deaths.

It is estimated that about 2 to 3/1000 of the overall population in the country, including people of all the age group and both the sexes, are suffering from RHD.

In the last two decades, the incidence of Rh fever and the prevalence of RHD have fallen remarkably as the living conditions improved, indicating relation between the prevalence of the disease and the socioeconomic factors. Thus it indicates that RHD is one of the most readily preventable chronic disease.

Agent Factor

Agent: RHD is the late sequel of Rh fever, which in turn is the result of the infection of tonsils, pharynx, adenoids, etc. caused by Group A, β-hemolytic streptococci (also called *S. pyogenes*). Particularly of the serotype 'M-type 5' has been incriminated as the causative agent, because of its rheumatogenic potential. They are gram-positive, nonmotile, nonspore forming, spherical bacilli, 0.5 to 1.0 μ in diameter, arranged in the form of chains.

They are called hemolytic streptococci because they cause lysis of RBCs due to the presence of a heat stable toxin called 'Streptolysin-O.' They also have a heat labile, mildly antigenic toxin, called 'Streptolysin-S.'

Because of the presence of many strains of the streptococci, it has not been possible to prepare an effective vaccine.

Reservoir of infection: All the cases and the carriers of streptococcal pharyngitis are the reservoirs. Among the carriers, both temporary and chronic carrier state occurs. Cases of strep. pharyngitis are at a greater risk of developing Rh. fever than the carriers.

Age incidence: Incidence is maximum among school children, in the age group of 5 to 15.

Sex incidence: It is equal in both the sexes.

Immunity: There has been an immunological basis for the development of Rh fever and RHD. According to toxic immunological hypothesis, the streptococci have certain toxic products leading to immunological process, resulting in Rh fever.

Another concept is that it requires repeated exposure to precipitate the illness.

Another belief is that RHD is an autoimmune disease.

Predisposing factors: Rh fever and RHD is considered as 'Social disease', because many social factors are responsible for the prevalence of this disease such as poverty, poor housing, undernutrition, illiteracy, ignorance, large families, over crowding, etc. This disease is therefore common among slum dwellers and inmates of barracks. Prevalence declines sharply as the standard of living improves.

Pathogenesis: Aschoff's nodule is the pathognomonic sign of Rh fever. The nodule is a perivascular aggregate of lymphocytes and plasma cells surrounding a fibrinoid core. So the basic disease process is that of an inflammatory vasculitis. In the heart, mitral valvulitis is the most common lesion. Later, as the fibrosis of valve takes place results in mitral stenosis and incompetence.

Clinical Features

- *Fever:* Usually low grade fever, lasts for about 3 months.
- *Polyarthritis:* This occurs in 80 to 90 percent of the cases. The arthritis is asymmetrical, migratory and non-deforming type. Large joints like knees, ankles and elbows and wrists are affected. Rarely smaller joints of hands and feet are affected. There will be painful swelling of these joints which later subside spontaneously after about one week. There is no residual damage to the joints. The movements of the affected joints is limited because of the pain. As it subsides, it appears in another joint (migratory).
- *Carditis:* Heart is affected in 60 to 70 percent of the cases of Rh fever. All layers of the heart—pericardium, myocardium and valves are affected. The damage is permanent. The manifestations are tachycardia, cardiomegaly, pericarditis, and heart failure. The common cardiac murmur indicating the involvement of mitral valve is soft, mid-diastolic murmur called 'Carey-Coombs murmur.' The most common ECG finding is prolonged P-R interval and first degree AV block.

Thus in Rh fever, the organisms 'lick the joints and bite the heart.' Involvement of the heart is the last stage of Rh fever.

- *Subcutaneous nodules:* These are round, firm and painless nodules appearing below the skin, over the bony prominences such as occiput, elbow, ankle or wrist joints, about four weeks after the onset of Rh fever. The skin over the nodules move freely and is not inflamed. The nodules last for a variable period of time and then disappear, leaving no residual damage. This is also called as 'erythema nodosum.'
- *Chorea:* This is a late manifestation occurring due to involvement of brain, which can occur alone or with carditis, characterized by purposeless, abnormal, jerky movements of arms, often associated with muscular weakness and/or behavioral abnormalities. It is seen in about 10 percent of cases. It disappears gradually leaving no residual damage.
- *Erythema marginatum:* It is a nonpruritic, pink colored, skin rashes, appearing in about 5 percent of the cases of Rh fever. They appear for a transient period of time over the trunk and extremities but never on the face, the center being pale and margin being serpiginous and they blanch on pressure. They disappear later without any damage.

Thus except carditis, all other manifestations of Rh fever do not cause permanent damage.

According to J Duckett Jones, the clinical feature of Rh fever are grouped into major and minor manifestations **(Table 21.5)**.

Major Manifestations

Carditis, polyarthritis, chorea, erythema nodosum (nodules) and erythema marginatum.

Minor Manifestations

Fever, polyarthralgia, past history of Rh fever, raised ESR, leukocytosis, raised C-reactive protein.

WHO criteria (2002-03) for the diagnosis of Rh fever and RHD based on revised Jones criteria is shown in **Table 21.5**.

Table 21.5 WHO criteria (2002–03) for the diagnosis of Rh fever and RHD based on revised Jones criteria

Category	Criteria
• Primary episode of Rh fever	One or two major and two minor manifestations plus evidence of preceding group A streptococcal infection (such as prolonged P-R interval in ECG, rise in anti-streptolysin –'O'– titer, a positive throat culture)
• Recurrent attack of Rh fever in a patient without established RHD	One or two major and two minor manifestations plus evidence of preceding Gr A streptococcal infection
• Recurrent attack of Rh fever in a patient with established RHD	Two minor manifestations plus evidence of preceding Gr A streptococcal infection

Prevention of Rheumatic Fever and Rheumatic Heart Disease

Health Promotion

Measures necessary for primordial prevention are:

- Improvement in the living conditions
- Improvement of sanitation in and around the house
- Prevention of overcrowding
- Prevention of malnutrition among children
- Improvement in the socioeconomic condition
- Health education of the people regarding dangers of sore throat
- 'Health-Fair' should be conducted in the schools to make the children health conscious.

Specific Protection

- No vaccine is available
- Chemoprophylaxis of the contacts of a case of pharyngitis or scarlet fever with Benzathine penicillin.
- 'Secondary prophylaxis' is given for all cases of Rh fever to prevent RHD with 1.2 million units of Benzathine Penicillin, once in 3 weeks, regularly for 5 years or until the age of 18 years, whichever is later. If they have developed RHD, prophylaxis is continued for life.

Early Diagnosis and Treatment

- By conducting periodical 'School health survey', to detect the cases of sore throat.

- By surveillance of 'high-risk' groups such as slum dwellers.
- Detected cases of sore throat (or acute pharyngitis) are treated by 1 dose of 1.2 million units of Benzathine penicillin, a long acting one. This essentially prevents the subsequent development of Rh fever and RHD.

Disability Limitation

This consists of limiting the development of disability in an individual who has already developed RHD. This consists of giving intensive treatment with Aspirin for joint pains and prednisolone for carditis, life long Benzathine Penicillin, 1.2 million units, once in 3 weeks and Balloon valvotomy or valve replacement.

Rehabilitation

By social, vocational and psychological measures of those who are suffering from RHD.

HYPERTENSION

It is a condition characterized by an increase in the arterial pressure of the individual. It is the most common cardiovascular disease all over the world and constitutes an important risk factor for the cardiovascular deaths. Higher the blood pressure, higher is the risk of complications like stroke, myocardial infarction and renal failure.

Classification of blood pressure according to WHO is shown in **Table 21.6**.

Table 21.6 Classification of blood pressure (WHO)

Category	Systolic (mm Hg)	Diastolic (mm Hg)
Normal	<130	<85
High normal	130–140	85–90
Hypertension		
Mild (stage1)	140–159	90–99
Moderate (stage 2)	160–179	100–109
Severe (stage 3)	>180	>110

'Isolated systolic hypertension' is defined as a systolic pressure of 140 mm Hg or more and a diastolic blood pressure of less than 90 mm Hg.

WHO Expert committee has also recommended that:

- Blood pressure should be recorded in the sitting position of the patient.
- Only one arm (either right or left) to be used consistently.
- The reading at which 'Korotkoff sound' is first heard is considered as systolic pressure and at which the K-sound disappears, as diastolic pressure.
- At least 3 readings should be taken over a period of 3 minutes and the lowest reading is recorded.

Classification

Hypertension is classified into two types, primary and secondary. It is 'primary' (or essential) when the causes are generally unknown. This accounts for nearly 90 percent of cases.

It is called as 'secondary', when the cause is known, such as diseases of the kidney, tumors of adrenal gland, consumption of drugs like steroids, oral pills, congenital narrowing of the aorta, etc. This accounts for about 10 percent of all cases.

Magnitude

Hypertension (HTN) is a global problem. In India, it is estimated to range from 4 to 8 percent and the trend is increasing due to changes in lifestyle. A recent report indicates that nearly 1 billion adults globally had HTN in 2000 and this is predicted to increase to 1.56 billion by 2025.

Rule of Halves

Hypertension is an 'Iceberg disease' and constitutes the tip of the iceberg. The submerged portion corresponds to undiagnosed cases, asymptomatic cases, inadequately treated cases etc. which are all represented diagrammatically as 'Rule of Halves' **(Fig. 21.2)**.

1. The whole community.
2. Normotensive subjects.
3. Hypertensive subjects.
4. Undiagnosed HTN subjects.

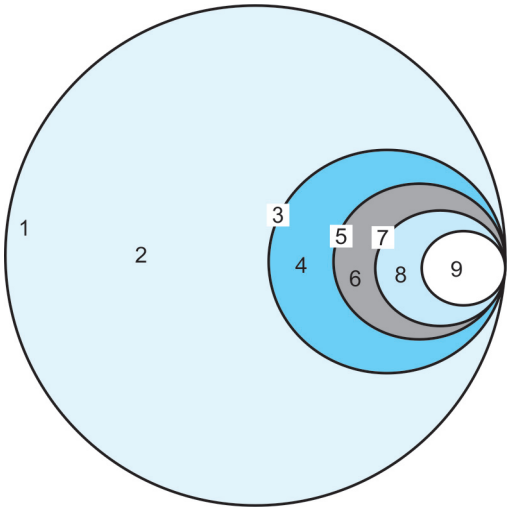


Fig. 21.2 Hypertension in the community

Source: Park K. Park's Textbook of Preventive and Social Medicine, 18 edn. 2005.

5. Diagnosed HTN subjects.
6. Diagnosed but untreated.
7. Diagnosed and treated.
8. Inadequately treated.
9. Adequately treated.

First rule: About half of the cases of HTN are aware of their condition.

Second rule: About half of those who are aware are under treatment.

Third rule: About half of those who are under treatment are receiving adequate treatment.

Tracking of Blood Pressure

Suppose the BP recordings in a group of children are followed up over a period of several years, it will be observed that those individuals, whose BP was initially high would probably continue in the same 'track' as they grow older and those with low BP would continue in the same track as they grow older. This phenomenon of persistence of the rank order of BP has been described as 'Tracking' of BP. This knowledge helps to identify the 'at-risk' group of children and adolescents, who can develop hypertension in the future period, so that preventive care can be provided for them.

Risk Factors

Hypertension itself is a risk-factor for cardiovascular diseases, stroke and renal failure. But still, it has its own risk factors, which are grouped into two groups—Nonmodifiable and modifiable.

Nonmodifiable Risk Factors

- *Age:* The prevalence of HTN rises with age and the rise is greater in those, who had higher initial BP. Usually as the age advances, there will be cumulative effect of environmental factors. Thus usually the prevalence is high above 40 years of age.
- *Sex:* During young age, there is no difference in BP in both the genders. But in the middle age, there is male preponderance. However, in later life, the pattern is reversed and it is more among women, may be because of postmenopausal changes.
- *Genetic factors:* A polygenic type of inheritance has been postulated based on twin and family studies. However, no genetic markers have been identified. If both the parents are hypertensives, offsprings have 45 percent possibility of developing HTN and if parents are normotensives, the possibility is only 3 percent.
- *Ethnicity:* Studies have shown higher BP levels among black people than among whites.

Modifiable Risk Factors

- *Occupation:* Occupation involving stress and strain including tension predisposes for the development of HTN, as in professional group of people like Doctors, Lawyers, Engineers, Business executives, etc. The stress and strain, which is made up of psychosocial factors operate through mental processes, consciously or unconsciously, to result in HTN, through sympathetic nervous system and noradrenaline.
- *Socioeconomic status:* Prevalence of HTN is usually higher among people of higher socioeconomic status than the people of lower status. However, in the fast developing countries, it has been observed to be higher among lower class also, because of the changes in the lifestyle, as it is seen in India nowadays.
- *Physical activity:* Physically inactive and those leading a sedentary way of life are more susceptible for HTN.
- *Obesity:* Greater the weight gain, higher the risk of acquiring HTN. Specially central obesity (increased waste to hip ratio) has been positively correlated with HTN. Thus obesity has been identified as a risk factor.
- *Diet:*
  - Higher the salt intake in the daily diet, greater the risk. However, potassium antagonizes the biological effects of sodium, thereby reduces BP. Other cations such as calcium, cadmium and magnesium have also been suggested as of importance in reducing BP levels.
  - Foods rich in saturated fats is a risk factor for HTN and serum cholesterol.
  - Foods rich in fats and sweets predispose for obesity, which in turn predisposes for HTN.
  - Consumption of dietary fibers is associated with reduced risk of HTN, because it reduces LDL cholesterol level.
- *Diseases:* Like diabetes mellitus predisposes for HTN.
- *Lifestyle (Habits):* High alcohol intake raises systolic pressure more than diastolic pressure. However it returns to normal level on stopping the consumption of alcohol. This indicates that alcohol induced elevation is not fixed.
- *Other factors:* Consumption of oral contraceptive pills over a long period of several years, constitutes the risk of HTN because of sestrogen component. However the role of other factors like noise, vibration, humidity, etc. require further investigations.

Clinical Manifestations

The most consistent symptom is headache. It is early morning, suboccipital pulsating headache. It is often associated with the stiffness of the neck, awakening the patient from sleep and gives relief after vomiting. Other features are dizziness, palpitation, easy fatigability, epistaxis, blurring of vision, breathlessness and personality changes. Complications are angina pectoris, myocardial infarction, stroke (cerebral thrombosis and hemiplegia, cerebral hemorrhage) and renal failure. Ocular manifestations are blurring vision, scotoma, (unilateral or bilateral,) papilledema and exudates on the retina.

Hypertensive patients are grouped into three groups:

1. Those who do not have any symptoms, but are detected during the routine check-up
2. Those who come with specific complaints as explained above
3. Those who come with complications.

Prevention of Hypertension

Primary Prevention (Primordial Prevention)

This consists of modification or elimination of the risk-factors by two approaches—Population strategy and high-risk strategy.

Population strategy: This is directed at the whole population based on the fact that even a small reduction in the average blood pressure of a population would produce a large reduction in the incidence of HTN and its complications. This involves 'health-promotive' measures as follows:

On nutrition: The dietary changes should be:

- Average consumption of the salt to be reduced to less than 5 g per day per caput (To avoid pickles, salted nuts, etc.).
- Moderate fat intake (avoiding fats of animal origin, except fish as well as coconut oil and vanaspathi).
- Prudent diet (rich in fruits and vegetables) to be encouraged.
- Consumption of alcohol to be discouraged.
- Energy intake to be restricted to body needs.
- The DASH diet.

The DASH diet: It is a dietary approach to stop hypertension (DASH), now recommended as an important step in controlling blood pressure. This diet is not only rich in important nutrients and fiber but also includes foods that contain two and half times the amounts of electrolytes, potassium, calcium and magnesium. It makes the following recommendations.

- To avoid saturated fats.
- To include monounsaturated fatty acids (MUFA, e.g. Omega 9 MUFA) such as olive or canola oils.
- To include polyunsaturated fatty acids (PUFA) also (e.g. Omega 3 and 6 PUFA) present in safflower, sunflower, cottonseed and fish oils, which have anti-inflammatory and antiblood clotting effects and is significantly beneficial to heart. Omega 3 is further categorized as alpha linoleic acid and docosahexaenoic acid (DHA). DHA appears to have specific benefits on blood pressure.
- To choose whole grains over white flour.
- To include fresh fruits and vegetables daily, specially potassium rich fruits like bananas, oranges, and vegetables like carrot, spinach, mushrooms, beans and potatoes (Grape fruits boosts the effect of calcium channel blocking drugs used for hypertension).
- To include nuts, seeds or legumes (dried beans or peas daily).
- To choose moderate amount of protein preferably fish or poultry. Oily fish may be particularly beneficial.

  A combination of DASH diet and salt restriction is very effective in reducing blood pressure.
- *On weight:* Weight reduction is done by diet control and promotion of physical activities, specially by the obese people. Regular physical activity leads to fall in body weight, blood lipid and blood pressure. Maintain normal body weight.
- *On behavioral changes:* Modification in the personal lifestyle, reduction in the stress, practicing yoga and meditation goes a longway in controlling BP. Abstain from alcohol and smoking.
- *Health education:* People are made health conscious about HTN and its consequences and encouraged to practice health promotive measures, as explained above.
- *Self care:* All hypertensive patients are educated to take self care by maintaining a log-book of the BP readings, which will be helpful for follow-up.
- *Recreation:* The establishment of recreation clubs, involving in hobbies like gardening, music, periodic excursions, cultural shows and the like will help to relieve the stress.

High-risk strategy: This consists of screening of all 'high-risk' cases (such as obese people, individuals above 50 years of age, alcoholics, diabetics, sedentary workers, pregnant mothers, individuals having family history, etc.) by recording BP. The aim is to prevent the attainment of levels of blood pressure at which treatment has to be started. This constitutes 'specific protection' of primary prevention.

Secondary Prevention

This consists of the following measures:

- Identification of hypertensive individuals (Early diagnosis)
- Instituting nonpharmocological management of HTN in all
- Use of appropriate drugs to control the blood pressure

- Regular follow up to ensure control of BP and compliance of management, because the drugs have to be taken life-long.

Tertiary Prevention

- *Disability limitation:* If the patient comes with very high BP, treatment is given intensively to limit the development of disability.
- *Rehabilitation:* This is given for those who have become handicapped due to complications of HTN such as hemiplegia (following stroke), blindness (due to retinopathy), etc.

STROKE

Stroke (or apoplexy) is a syndrome of rapidly developing signs and symptoms of focal loss of cerebral function due to sudden death of brain cells caused by disturbance in the blood supply to the brain. This vascular disturbance can be due to ischemia caused by blockage (thrombosis or embolism) or by hemorrhage, resulting in infarction of the brain. Therefore stroke is also called as "cerebrovascular accident".

Clinically stroke is characterized by sudden onset of unilateral paralysis, loss of vision, impairment of speech, loss of memory, impaired reasoning ability, convulsions, coma or death. The effects of stroke are determined by the extent and site of brain injury. If the symptoms resolve within 24 hours, it is called 'transient ischemic attack' (TIA). A stroke is a medical emergency and can cause permanent neurological damage or death.

World Health Organization (WHO) clinically defines stroke as the rapid development of clinical signs and symptoms of focal neurological disturbance lasting more than 24 hours and leading to death with no apparent cause other than vascular origin (WHO 2005).

History

Hippocrates (460-370 BC) was first to describe the phenomenon of sudden paralysis that is often associated with ischemia of brain.

In 1658, John Jacob Wepfer, identified the cause of stroke as hemorrhage and ischemia of brain.

Rudolf Virchow was the first person to describe the mechanism of thromboembolism, as a major factor in stroke.

Classification

There are two major categories—ischemic and hemorrhagic.

Ischemic Stroke

This the most common cause of stroke, accounting for about 87 percent. In this type, the blood supply to the brain is interrupted either by arterial thrombosis, embolism, systemic hypoperfusion (as in shock) or cerebral venous sinus thrombosis, leading to cerebral infarction and dysfunction of the brain. Stroke without an obvious explanation is termed "Cryptogenic Stroke" (of unknown origin). This constitutes 30 to 40 percent of all ischemic strokes.

Hemorrhagic Stroke

This results from rupture of a blood vessel or an abnormal vascular structure (like aneurysm). Hemorrhage may be intra-axial/intra-cerebral or extra-axial/extra-cerebral (outside the brain but inside the skull). The main types of extra-axial hemorrhage are epidural hematoma, subdural hematoma and subarachnoid hemorrhage.

Magnitude of the Problem

Stroke is one of the leading causes of disability, morbidity and mortality worldwide.

Global burden

- Nearly 20 million people suffer from acute strokes every year.
- About 5 million die each year.
- About 15 to 30 percent of survivors are permanently disabled.

Burden in India

- Nearly 1.5 million people suffer from acute strokes every year.
- About 0.63 million die each year.
- Prevalence rate is about 2 to 5 percent of the population.
- About 12 percent of strokes occur among people below 40 years of age.
- India will report 1.6 million stroke cases during 2015, at least one-third of whom will be disabled.

However this data has limitations due to incomplete death certification and incorrect death certification and uncertainty of etiology in cases of sudden death.

WHO estimates suggest that by 2050, 80 percent stroke cases in the world would occur in low and middle income countries mainly India and China.

Epidemiology

Age incidence: Incidence rate rises steeply as the age advances, specially after 40 years of age.

Sex incidence: Incidence of stroke is more among men than among women in the rate of 7:1. This could be due to differences in risk factors like smoking and alcoholism.

Risk Factors

These are multiple and often combined.

- *Non-modifiable risk factors:* These are age, sex and genetic factors (family history).
- *Modifiable risk factors*:
  - *Hypertension:* This is considered as the main risk factor of stroke. It accounts for 30 to 50 percent of the stroke cases.
  - *Obesity and smoking:* These constitute the next important risk factors.
  - Atrial fibrillation, hypercholesterolemia, disorders of blood coagulation, carotid bruits, patent foramen ovale, aortic arch atheroma, arteriosclerosis are the cardiovascular conditions associated with an increased risk of stroke.
  - Other risk factors are diabetes mellitus, heavy alcohol consumption, use of oral contraceptive pills, lack of physical activity and food habits of processed red meat consumption.
  - Drugs like cocaine, amphetamines and sympathomimetics predispose for the risk of stroke.
  - Recurrence of transient ischemic attack constitutes a warning sign of stroke.
  - Transitions like demographic shift (as shown by increased life expectancy), life style of food consumption and less physical activity and socioeconomic condition have contributed to the emergence of stroke epidemic in India.

Signs and Symptoms

Symptoms typically start suddenly, over seconds to minutes and in most cases do not progress further. It depends upon the area of the brain affected. More the area of brain affected, more the functions lost.

Sudden onset of face weakness, arm drift (means involuntary fall of arm when lifted) and speech abnormal. Time is critical and it is time to act. Any one feature or all three features goes in favor of stroke. This is abbreviated as FAST (Facial weakness, arm drift, speech abnormal and time to act).

Depending upon the involvement of spinothalamic, corticospinal and medial leminiscus, there will be hemiplegia, numbness, reduction in sensation, initial flaccidity followed by spasticity and hyper-reflexia.

If brainstem is affected, symptoms of deficit due to involvement of cranial nerves occur.

If cerebellum is affected, there will be altered walking gait, vertigo and disequilibrium.

Loss of consciousness, headache and vomiting usually occur in hemorrhagic stroke because of increased intracranial pressure from leaking blood compressing the brain. If symptoms are maximum at onset, the most likely cause is subarachnoid hemorrhage or an embolic stroke.

Silent stroke is a stroke that does not have any outward symptoms and the patients are typically unaware they have suffered a stroke. A silent stroke also causes damage to the brain and places the patient at increased risk for both transient ischemic attack and major stroke in future. Conversely those who have suffered a major stroke are also at risk of having silent stroke. Silent stroke are estimated to occur at five times the rate of symptomatic strokes. The risk of silent stroke increases with age but may also affect younger adults and children especially those with acute anemia.

Diagnosis

- Neurological examination (adopting National Institute of Health Stroke Scale; NIHSS).
- CT scan
- MRI scan
- Doppler/Ultrasound study of carotid artery
- Arteriography
- Blood test for cholesterol level and bleeding diathesis.

Management

Patients are admitted in "Stroke Unit" and managed.

- *Ischemic stroke:* These patients are managed by thrombolysis with recombinant tissue plasminogen activator or by thrombectomy (mechanical removal). Earlier the treatment started, lesser the brain cells dying. Larger territory stroke as in that of middle cerebral artery territory, also called as "malignant cerebral infarction" requires hemicraniectomy (tempory removal of skull on one side). Angioplasty and stenting are viable options in the treatment of acute ischemic stroke.
- *Hemorrhagic stroke:* In this type, anticoagulants and antithrombotics can make bleeding worse.

Rehabilitation of stroke should be started as early as possible physically, psychologically, socially and vocationally. Newer methods of rehabilitation are transcranial magnetic stimulation, transcranial direct current stimulation and robotic therapies.

Prevention and Control

- *Primordial prevention:* This is by interventions targeting modifications of behaviors such as reduced smoking, alcohol and salt consumption and increased consumption of fruits and vegetables. Mediterranean style of diet consisting of high consumption of olive oil, legumes, unrefined cereals, fruits, vegetables, moderate consumption of diary products like cheese and yogurt, wine, fish and low consumption of meat, prevents stroke in 50 percent of the cases.

All these aim at prevention of obesity, diabetes and hypertension. Other health promotive measures are exercise, avoidance of smoking and alcohol.

- *Secondary prevention:* Strategies include pharmacotherapy with aspirin, dipyridamole, clopidogrel to prevent platelets from aggregating. Warfarin prevents thromboembolic stroke in patients with nonvulvular atrial fibrillation.

  Other measures consist of effective management of comorbidities such as hypertension, atrial fibrillation and hypercholesterolemia.

  Carotid endarterectomy or carotid angioplasty can be used to remove atherosclerotic narrowing (stenosis) of carotid artery.

OBESITY

It is a type of nutritional disorder, due to imbalance between energy intake and energy expenditure resulting in positive in positive energy balance, characterized by the abnormal growth of the adipose tissue, resulting in an increase in the body weight to the extent of 20 percent or more of the standard weight for the person's age, sex and height.

Obesity is expressed by four indicators—namely Corpulence index, Body Mass Index, Waist circumference and Waist-Hip ratio.

- *Corpulence index:* This is based on only weight of the individual.

$$\text{Corpulence index} = \frac{\text{Actual body weight (ABW) of the individual}}{\text{Expected body weight (EBW)}}$$

Corpulence index of 1.2 or more is considered as obesity.

Expected body wt can be calculated by two methods.

- Broca's method

  EBW = Height in cm – 100

  Example: A person who is 160 cm tall, his ideal weight is 160–100 = 60 Kg.
- Lorentz's method

$$\text{EBW (males)} = \text{Height in cm} - 100 - \left(\frac{\text{Height in cm} - 150}{4}\right)$$

$$\text{EBW (females)} = \text{Height in cm} - 100 - \left(\frac{\text{Height in cm} - 100}{2}\right)$$

Body Mass Index

Body mass index (BMI) is based on weight and height of the individual.

$$\text{BMI} = \frac{\text{Weight in Kg}}{(\text{Height in mtr})^2}$$

This is also called as 'Quetelet's index', named after Lambert Adolphe Jacques Quetelet, a Belgium Scientist.

For example, an adult who is 80 Kg in weight and 1.7 mtr in height will have a BMI of 27.7.

$$\text{BMI} = \frac{80}{(1.7)^2} = 27.7$$

Classification of the obesity according to BMI **(Table 21.7)** helps in comparison of weight status within and between population, helps in identification of at-risk groups, for implementation of intervention programs and also for evaluation of the program.

Table 21.7 Classification of obesity according to body mass index

Classification	Body mass index (kg/m^2)
Under weight	< 18.5
Normal range	18.5–24.9
Overweight	> 25
Preobese	25–29.9
Obese class I	30–34.9
Obese class II	35–39.9
Obese class III	> 40

Body mass index values are age-independent and it is same for both the genders. Higher the BMI above 25, greater is the risk of morbidity according to grades.

Limitations

Body mass index does not distinguish between the weight associated with muscle and weight associated with fat. As a result the relationship between BMI and body fat content may vary according to body build and proportion. Therefore a given BMI may not correspond to the same degree of fatness across the populations. For example, Polynesians tend to have a lower fat percentage than Caucasian Australians at an identical BMI. In addition the percentage of body fat mass increases with age up to 60 to 65 years in both sexes and is higher in women than in men of equivalent BMI.

Inspite of the limitations, BMI is considered to be the most useful, albeit crude, population level measure of obesity and the risks associated with it.

Waist Circumference

This helps to measure abdominal fat. It is measured at a mid point between the lower border of the rib cage and the iliac crest. It is an approximate index of intra-abdominal adipose tissue and total body fat. It is a convenient and simple measurement, not related to height and correlates closely with BMI and waist-hip ratio. Furthermore, changes in waist circumference reflect the changes in risk factors for cardiovascular diseases and other forms of chronic diseases like diabetes mellitus.

The risk of metabolic complications of obesity (waist circumference) is observed to be high among men with a waist circumference >102 cm and among women >88 cm.

Waist-hip Ratio

It is accepted that waist-hip ratio (WHR) of more than 1.0 in men and 0.85 in women indicates abdominal fat accumulation.

Magnitude of the problem: Prevalence of overweight and obesity is increasing worldwide at an alarming rate, affecting children and adults alike in both developed and developing countries. It is more among urban population. The increasing prevalence is due to changes in the lifestyle of the people.

In India about 8 percent of population is estimated to have a BMI of more than 25.

Public health importance: Obesity is a risk factor in the natural history of other noncommunicable diseases like diabetes, cardiovascular diseases, osteoarthritis, cancer, hyperlipidemia and their consequences. So obesity is called 'King' of diseases.

In simple terms, obesity is a consequence of an energy imbalance, where energy intake is greater than the energy expenditure, resulting in positive energy balance and an increase in the energy stores and body-weight. Obesity has its own risk factors.

Risk Factors

Nonmodifiable Risk Factors

- *Age:* Obesity can occur in any age group. Generally it increases with age. Obese children usually will have a tendency to remain obese in future adult life.
- *Sex:* The prevalence of overweight is more among men but obesity is more among women, specially during the postmenopausal age, between 45 to 49 years. Many physiological processes contribute to an increased storage of fat in females.

  Studies have shown woman's BMI increases with successive pregnancies. On the other hand in developing countries successive pregnancies with short spacing is associated with weight loss rather than weight gain, due to depletion of maternal reserve.
- *Genetic factors:* Obesity is a complex multifactorial phenotype with a genetic component that includes both polygenic and major gene effects. Obesity therefore tends to run in families, with obese children frequently having obese parents.

Modifiable Risk Factors

Physical activity: The physical activity pattern (including occupational work, household work and leisure time activity like sports and exercise) determines the food intake and fat balance.

The physical activity level (PAL) of a physically active individual is 1.75 and that of sedentary male individual is 1.4 and that of female individual is 1.2. The likelihood of becoming overweight is reduced at a PAL of 1.8 and 1.6 in men and women respectively. To elevate PAL by 0.5, it requires one hour of moderate activity such as brisk walk of 6 km/hour or running at a speed of 12 km/hour or cycling at a speed of 15 km per hour.

Thus, regular physical activity burns the fat and is protective against obesity, whereas sedentary lifestyle constitutes a risk-factor. Sedentariness is an account of factors like affluence, motorized transport, mechanical aids for work (like washing machine), too much TV viewing, internet surfing, etc.

- *Socioeconomic status:* High socioeconomic status correlates positively with obesity in the developing countries. Interestingly, this association is reversed in the developed countries, specially among women.
- *Literacy level:* The relation has been observed to be reverse, i.e. higher the literacy level, lesser is the prevalence of obesity.
- *Body image:* Traditionally it is considered that an increase in body-weight is a sign of prosperity. But this concept is now changed. Thin and slim body symbolizes competence, success, control and sexual attractiveness, while obesity represents laziness, lack of willpower and self indulgence.
- *Eating habits:* Over nutrition is responsible for 95 percent cases of obesity. This is known as 'Regulatory obesity:' Nonnutritional causes like genetic, endocrinal, metabolic, etc. account for the remaining 5 percent. These are known as 'Metabolic obesity', e.g. Cushings syndrome, Hypothyroidism, Hypogonadism, etc. The capacity for storage of fat in human beings is highly efficient and unlimited compared to protein and carbohydrate. Therefore weight gain occurs primarily due to high fat intake leading to anomalous fat balance.

  Fat makes the food more palatable and pleasurable resulting in increased consumption. Consumption of sugars also leads to excess energy balance.

  Food habits of relevance are eating between the meals, frequent consumption of sweets, chocolates, toffees, ghee, butter, fried foods, fast-foods, etc. Often the foundation of adulthood obesity is laid in infancy. If a growing child is overfed, the number of adipose cells increase. In later life these abundant cells store excessive fat and cause obesity.

  Thus, the composition of the diet, the periodicity of eating and the amount of energy obtained are relevant to the development of obesity, as far as eating habits are concerned. This is predisposed by heavy advertisements of fast-foods and beverages in television.
- *Alcoholism:* Every gram of consumption of alcohol provides 7 kcals of energy. Since the body is unable to store alcohol, it is oxidized first thereby allowing the

greater proportion of energy to be stored obtained from other foods. Thus alcohol intake is associated with increased risk of abdominal fat. However, the controversial report is that heavy alcohol intakers tend to be thinner, later resulting in paradox, i.e. such people eat less and drink alcohol more to get their energy requirement. A recent report is that the relationship between alcohol consumption and development of obesity is positive among men and negative among women.

- *Smoking:* Smoking increases the metabolic rate and decreases food consumption. Thus smoking and obesity are inversely related. Smokers often gain body weight after giving up the habit.
- *Psychological factors:* People who are under constant emotional strain find satisfaction in eating the food. Another motive for overeating is the yearning for companionship. This forces the individual to spend much time in the company of friends and foods.
- *Drugs:* Use of certain drugs like corticosteroids, oral contraceptive pills, insulin, β-adrenergic blockers, etc. can promote weight gain.
- *Environmental factors:* Fast process of industrialization and urbanization has resulted in the modernization of standard of living affecting the physical activity pattern contributing to the development of obesity such as using LPG (gas) for cooking purpose, washing machines for washing clothes, vaccum cleaners for cleaning purpose, elevators, escalators and automatic doors. Television viewing, using vehicles for traveling short distances rather than going by walk or cycling, etc. are other factors.

The relative risk data of various health hazards associated with obesity are enumerated in the **Table 21.8**.

Health Hazards of Obesity

Table 21.8 shows the relative risk of health problems associated with obesity.

Table 21.8 Relative risk of health problems associated with obesity

Greatly increased	Moderately increased	Slightly increased
(R.R > 3) NIDDM*	(R.R 2–3) Coronary heart disease*	(R.R 1–2) Cancer*
Gallbladder disease*	Hypertension*	Impaired fertility
Dyslipidemia	Osteoarthritis	Low back pain
Insulin resistance	Hyperuricemia and Gout	Fetal defects associated with maternal obesity
Breathlessness		
Sleep apnea		

**Life-threatening chronic health problems:* Others are nonfatal but debilitating health problems.

Prevention and Control

It is difficult or not possible to control obesity, caused by nonmodifiable factors like age, sex or genetic factors. The preventive measures should start early in childhood, because once obesity is developed, it is difficult to treat and the health consequences associated with obesity may not be fully reversible by weight loss.

Aims

- To maintain BMI between 18 and 25 throughout the adulthood.
- To prevent the development of overweight.
- To prevent the progression of overweight to obesity.
- To prevent regain of weight among those obese patients, who have already lost some weight.

Strategies

Dietary Changes

- Refrain from over consumption of fats and carbohydrates.
- Diet should contain suitable proportion of cereals, legumes and vegetables, fibre content should be increased.
- Food energy intake should not be greater than what is necessary for energy expenditure.

Physical Activity

Regular physical activity helps in increasing the energy expenditure. So sedentary lifestyle should be discouraged. Leisure persuits like gardening, dancing, cycling and swimming should be encouraged. Walking should be preferred to other means. Exercises should be encouraged. Yoga exercises should also be encouraged.

Health Education

People are educated about hazards of obesity and its prevention by healthy diet and lifestyle, to be promoted from early age.

Barrier Surgery

Among those whose BMI is >40 and is not possible to control obesity with the routine measures of exercise and change in life-style practices, 'Barrier surgery' is of great help, wherein food consumption is minimized, thereby facilitating the subcutaneous fat to dissolve for energy purposes.

CANCER

INTRODUCTION

Cancer is a most fearful disease, next to AIDS and Rabies. It is characterized by the following features:

- Abnormal and uncontrolled growth of the cells.
- The presence of aberrations in the nucleus.
- Ability to invade the surrounding tissues and even distant organs (metastasis) later.
- Eventual death of the person, if the tumor has progressed beyond a certain stage at which it can be successfully removed.
- Cancer can occur at any site, at any time, in any individual.

Magnitude

Cancer constitutes the second leading cause of death, next to coronary artery disease, in the developed countries and fourth cause in the developing countries. At any given point of time, there are about 10 million people suffering from one or the other type of cancer in the world and more than 6 million have been dying every year due to cancer. Different types, of cancers are occurring in different parts of the world. About 1 million cases occur every year, 60 percent occurring in developing countries.

In India, it is estimated to be 2 to 2.5 million cases existing at any given point of time with about 7 lakh new cases being added every year, killing nearly 3 lakhs of people every year only due to cancer.

Distribution

Different types of cancer show different distribution in different countries **(Table 21.9)**.

Table 21.9 Different types of cancer show different distribution in different countries

Country	Most common cancer
Japan	Stomach
Central Africa	Liver
USA	Colon and rectum
Australia	Skin
India	• Respiratory tract, oropharynx (males) • Cervix uteri, breast (females)

Risk Factors

The risk factors of cancer are grouped into agent factors, host factors and environmental factors.

Agent Factors

Various agent factors **(Table 21.10)** have been incriminated in the etiology of cancer. In some cases the association has been proved to be causal (e.g. Epstein-Barr virus and Burkitt's lymphoma) while in some cases the association has been suspected on epidemiological grounds.

Table 21.10 Types of agent factors and the resulting cancers

Agent factor	Type of cancer
Physical agents	
Heat (Reverse smoking)	• Oral (*Chutta*) cancer • *Kangri* cancer
Solar radiation	Basal cell carcinoma
Ionizing radiation	Leukemia
Mechanical	
Friction	*Dhoti* cancer
Chemical	
Aniline	Bladder cancer
Asbestos dye	Pleural mesothelioma
Benzol	Leukemia
Nickel, Chromate	Lung cancer
Coal tar	Skin cancer
Biological	
Hepatitis B-virus	Hepatocellular carcinoma
Cytomegalo virus	Kaposi's sarcoma
Epstein-Barr virus	Burkitt's Lymphoma and nasopharyngeal carcinoma
Human papilloma virus	Cancer cervix
Human T cell lymphoma virus	Human T cell lymphoma
Aspergillus flavus	Liver cancer
Herpes virus	Cervical cancer
Nutritional	
Smoked fish	Stomach cancer
Beef	Bowel cancer
High fat intake	Breast cancer, colon cancer
Alchol	Esophageal cancer, Liver cancer
Socioenvironmental	
Tobacco (as smoking, chewing)	Cancer of lung, larynx, pharynx, esophagus
Over use of estrogen drug	Carcinoma of uterus
Parasite—Schistosoma hematobium	Bladder cancer
Sunlight	Malignant melanoma

Host Factors

Age incidence: Usually cancer occurs among elderly people. In the developing countries, the prevalence is more among

young people compared to developed countries, because developing countries are 'demographically young.'

Some cancers exhibit a bimodal age curve, being common in young adults and elderly persons, e.g. Leukemia, Hodgkin's disease and kidney cancer.

When cancers occur among the members of the same family, they tend to occur at an earlier age.

Age of onset of Ca cervix is related to age at marriage, earlier the marriage, earlier is the development of this cancer.

Sex: Cancers are more frequent among men than among women except cancers of reproductive organs and to some extent that of thyroid and gallbladder. Cancers of the reproductive system constitute 50 percent of all cancers among women; whereas in men they constitute only 15 percent.

Racial, familial and genetic factors: Black skinned races are at a greater risk of cancer of skin than whites.

Records have shown the existence of cancer of stomach and colon to run among certain families.

Genetic factors have also been incriminated as risk factors in certain types of cancers, as follows:

- A defective gene located in the long arm of chromosome 13 predisposes to familial retinoblastoma.
- Translocation of long arms of chromosomes 9 and 22 is seen in chronic myeloid leukemia.
- Translocation in the long arms of chromosomes 8 and 14 are seen in Burkitt's lymphoma.
- Mongols are more likely to develop leukemia than normal children.
- Stomach cancer has been observed to be more among people of blood group A than among other groups.

However, genetic factors are less conspicuous and more difficult to identify.

Occupation: Certain types of cancers occur in certain types of industries, due to prolonged exposure to the carcinogens. They are called as 'occupational cancers' (Industrial cancers).

The different types of cancers, carcinogens and the (risk group) industry of occurrence are given in **Table 21.11**.

Habits: Specific cancers are associated with specific habits and customs **(Table 21.12)**.

Environmental Factors

Air pollution: Air polluted heavily with automobile exhaust predisposes to lung cancer.

Depletion of ozone layer in the stratosphere due to use of chlorofluorocarbons and the emission of exhaust of supersonic air craft leads to skin cancer.

Pre-existing Conditions

Obesity predisposes to postmenopausal breast cancer and cancers of gallbladder, colon, rectum and kidney.

Table 21.11 Industrial cancers

Type of cancer	Carcinogen	'At-risk' group
Skin cancer	Coal tar, soot, pitch Anthracene, oils, Dyes Heat and UV radiation	Tar distillers, gas workers oil refiners, road makers, dye stuff makers agriculturist laborers
Lung cancer	Nickel, chromium, asbestos, tobacco, beryllium, uranium	People working in nickel refineries, asbestos factories, tobacco industries, mines of uranium and chromium
Bladder cancer	b-naphthylamine, Benzidine, aniline, auramine, aromatic amines	Dyeing industry, cable industries
Blood cancer (Leukemia)	Ionizing radiation. Radioactive isotopes Benzol	People working in radiology department, Atomic energy establishments

Table 21.12 Habits and related cancers

Habit or custom	Related cancer
Smoking	Lung cancer
Alcoholism	Liver cancer
Sunbath	Skin cancer
Pan, zarda and tobacco chewing	Oropharyngeal cancer
Reverse smoking	Oropharyngeal cancer
Low fiber diet	Colon cancer
Excessive sex with multiple partners	Cancer cervix

The conditions predisposing to the development of cancers are called as "precancerous conditions.' They are xeroderma pigmentosa, Down syndrome, leukoplakia of mouth, syphilitic glossitis, pigmented nevus of foot, thyroid adenoma, rectal polyposis and papillary tumor of bladder.

Pernicious anemia, ulcerative colitis and prolapse of uterus are also precancerous, as they predispose to cancers of stomach, colon and cervix respectively.

Prevention and Control

Primary Prevention

This consists of health promotion and specific protection.

Health promotion: Different health promotive measures are as follows:

Health education

a. The people are educated about the following 'Danger Signals' of cancer:

- A lump in the breast
- A nonhealing ulcer
- Sudden change in the wart or mole
- Persistent indigestion or difficulty in swallowing
- Hoarseness of voice
- Unusual bleeding from any natural orifice
- Any change in the usual bowel habit
- Unexplained loss of weight.

People are exhorted to seek medical advice, if they experience any of the above signals.

b. People are also educated to avoid alcohol, smoking, tobacco, pan, zarda, etc.
c. To increase the use of legumes, grains, fruits and vegetables and to avoid coloring agents, fast foods, etc.
d. To maintain high standard of personal hygiene, specially among industrial workers.
e. Women are educated about self examination of the breasts.

Control of air pollution: By various measures such as containment, dilution, replacement and legislation form a part of cancer control activities.

Oral hygiene: Maintenance of oral hygiene and correction of nonalignment of teeth resulting in aphthous ulcers, goes a long-way in prevention of oral cancers.

Legislation
- To control consumption of alcohol, tobacco and food related carcinogens.
- To control air pollution.
- To protect 'at-risk' industrial workers.

Specific Protection
- Avoidance of carcinogen
- Immunization against hepatitis B to prevent liver cancer.
- Treatment of precancerous lesions.
- At-risk industrial workers should wear protective gadgets (like respirators, lead-apron, lead glove, etc.) and apply barrier creams.

Secondary Prevention

- *Early diagnosis and treatment:* Early diagnosis—is done by history, clinical exam and investigations. Screening of those who come with 'Warning Signals' and those 'at-risk' (those having precancerous lesions and those, who are at risk because of their occupation).
- *Clinical examination:* Doctor should have an high-index of suspicion and detect about 75 percent of cancer cases by thorough clinical examination because they occur in those body sites that are readily accessible.
- *Investigations:* These also help in early detection of cancers.
- Exfoliative cytology (Pap smear) to detect Ca cervix.
- X-ray chest and sputum cytology—to detect bronchogenic carcinoma.
- Mammography—to detect Ca-breast.
- Endoscopic examination—to detect Ca of stomach, colon and other hollow viscera.

Treatment
- Surgery
- Chemotherapy
- Radiotherapy
- Immunotherapy (High doses of vaccines like BCG, DPT, etc. alone or in combination with dead leukocytes)

Tertiary Prevention

Disability limitation: This is done by giving intensive treatment to prevent the development of further disability.

Rehabilitation: This is given for those who have undergone surgery such as amputation of leg, colostomy, mastectomy, etc. and are rehabilitated with a prosthesis and training, later placed in a suitable job.

EPIDEMIOLOGY OF CANCER CERVIX

Cancer cervix (Ca Cx) is the most common cancer among women affecting approximately 5 lakhs women each year, resulting in 2,70,000 deaths worldwide. 85 percent of them belong to developing countries.

In India, Ca Cx is the leading type of cancer. It is estimated that nearly 1,00,000 new cases of cervical cancer occur annually contributing significantly for the deaths of Indian women and it is on the progressive increase. Ca Cx and Ca breast together constitute 60 percent of all cancers.

Agent Factor

Human papilloma virus (HPV) has been incriminated as the important cause of Ca Cx. It is a DNA virus belonging to the family papillomaviridae. The virus infects the squamous epithelium of the genital tract, and region, perianal region and the mucosal epithelium of the larynx. There are many types of HPVs. The high-risk types are HPV-16 and HPV-18, which are associated with cervical cancer and the low risk types are HPV-6 and HIP-11, which cause genital warts. The virus commonly spreads through sexual intercourse.

Increasing number of HPV related carcinomas of the anal mucosa are also being reported among homosexuals (men having sex with men).

At birth HPV can infect the mucosa of the pharynx and cause large wart like lesions that can obstruct the respiratory passage. The role of HPV was discovered in 1983.

Host Factors (Risk Factors)

Age: Ca Cx is more common among middle aged and after menopause. However it is related to age at marriage.

Age at marriage: Early marriage, early coitus, early child bearing and repeated pregnancies weakened immune system are associated with increased risk of cervical cancer. Thus sexual intercourse plays an important role. Ca Cx is virtually not reported among celibate population.

Marital status: Incidence is high among multiparous mothers than among nulliparous mothers and spinsters.

Occupation: Ca Cx is not an occupational disease. However, the incidence has been found to be high among commercial sex workers.

Socioeconomic status: It is reported to be high among women of lower income groups.

Other risk factors: These are illiteracy, ignorance, lack of genital hygiene, promiscuous sex, presence of genital warts, prolonged use of estrogen containing pills, multiple sexual partners, etc.

Points of concern for the increased incidence:

- Changes in the lifestyle
- Early diagnosis by exfoliative cytology
- Lack of health services in remote areas
- Increase in life expectancy.

Pathogenesis: The pathogenesis of cervical cancer is initiated by HPV infection of the cervical epithelium during sexual intercourse. The initial morphological changes, classified as cervical intraepithelial neoplasia (CIN) are associated with continuous virus replication and virus shedding. In 90 to 97 percent of women, the infection resolves spontaneously in less than two years. However 3 to 10 percent of women, in whom the infection does not resolve, they become persistent HPV carriers and constitute a high-risk group, in whom the infection progresses to the cancer of cervix.

Prevention and Control of Cancer Cervix

The basic approach is by primordial prevention, specific protection and secondary prevention.

Primordial Prevention

There are two strategies—population strategy and high-risk strategy.

- *Population strategy:* This consists of health promotive measures such as cancer education. The women are made cancer conscious by educating about the warning signs such as bleeding after coitus and bleeding after menopause. They are also educated about maintenance of genital hygiene.
- *High-risk strategy:* This consists of screening of high-risk group of women such as professional sex workers, multiparous women of lower socioeconomic group, mothers above 35 years of age, women having multiple sexual partners and women having bleeding disorders. Thus primordial prevention has a hopeful approach.

Specific protection: Two types of vaccines are available for the prevention of HPV infection, namely Gardasil (manufactured by Merek and Co., Inc., Whitehouse Station, NJ) and Cervarix (by GlaxoSmithKline, Philadelphia). Gardasil is a quadrivalent vaccine incorporating HPV types 6, 11, 16 and 18, whereas cervarix is a bivalent vaccine incorporating HPV types 16 and 18. Both are liquid, killed vaccines.

Gardasil has been approved by US Food and Drug Administration (FDA) during 2006 for immunization of girls aged 9 to 26 and women. It is the first and only vaccine to prevent cervical cancer, vulvar and vaginal precancers caused by HPV types 16 and 18 and genital warts caused by HPV types 6 and 11 **(Fig. 21.3)**.

Both the vaccines have offered 100 percent protection for the type specific lesions. Ideally females should be vaccinated before their sexual debut because the vaccine is most effective in women who have not yet acquired any HPV type infection.

Vaccine schedule consists of three doses, each of 0.5 mL, intramuscularly, in the deltoid muscle, over a period of three months. Gardasil = 0, 2 and 6 months and cervarix = 0, 1 and 6 months. Vaccine is shaken well before use and stored at 2 to 8°C. It should not be frozen. Cost factor is the greatest barrier to introduce in the developing countries. Three doses cost $360. Trials are under study to observe its efficacy and safety in Indian population.

Challenges: The challenges to the introduction of HPV vaccine in India are:

- Relatively high cost of the vaccine
- Reaching the target population

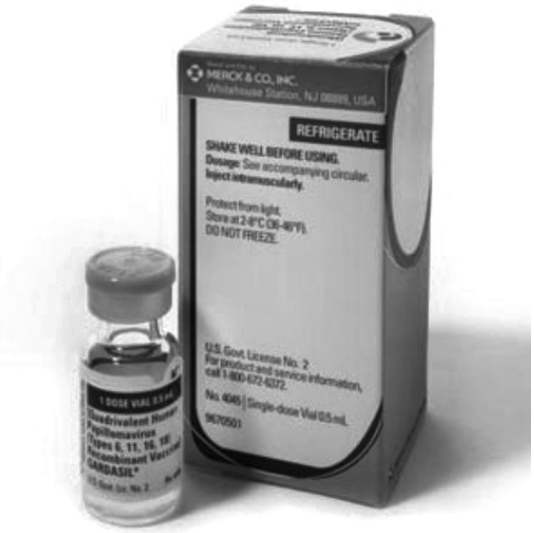


Fig. 21.3 Human papilloma virus vaccine (HPVV) (Gardasil)

- Poor health care infrastructure, inadequate maintenance of cold chain and injection safety
- Competition faced from other newer vaccines like hib, pneumococcal, rotavirus, meningococcal, JE vaccines, etc.
- Poor success of secondary prevention methods like HPV screening, Pap testing, etc.
- Religious barriers, cultural taboos and misconceptions influencing acceptance by the public at large
- Lack of political will.

Secondary Prevention

The aim is to make an early diagnosis of early cancer for early treatment. This is done by screening procedure. As far as Ca Cx is concerned, this goes a long way in the prevention of cancer, because of the following favorable factors.

- It is preceded by a premalignant localized lesion such as cervical tear, chronic cervicitis, erosion, ectropion (the relation is suspected but not proved),
- It has a preinvasive stage (i.e. Ca *in situ*),
- The site is accessible unlike that of viscera or intestine,
- The lesion is localized (and not spread) for a fairly long time of about 8 to 10 years, before it becomes invasive.

Selective screening or high-risk screening is done by:

a. Pap smear (Cervical smear) examination for exfoliative cytology
b. Colposcopic examination
   i. *Pap smear (named after Papanicolaou):* This procedure not only helps in detection of more number of cases but also prevents them from developing invasive cancer. Now the current policy is that all women should undergo a 'Pap test', regularly once in 3 years and also a thorough pelvic examination. Best time for pap smear examination is after the cessation of menstruation.

   There are two problems encountered in screening for Ca Cx.

   - Problems related to the disease
   - Problems related to the test
   - *Problems related to the disease* are two*:*
     - The frequency with which the pre-invasive stage (Ca *in situ*) progresses to invasive stage,
     - The frequency with which invasive cancer is preceeded by abnormal smears.
   - *Problems related to the test* are two*:*
     - Response rate
     - Sensitivity of the test

     Response rate: This is least among women of poor socioeconomic status and also among illiterates.

     Sensitivity of Pap test: It is the ability of the test to identify correctly all those who have the disease. Pap smear test has a sensitivity of 80 percent (That means 80 percent of diseased women give 'True-positive' result) and false-negative is 20 percent (i.e. 20 percent of diseased women are wrongly identified as not having the disease because the test result is negative). The percentage of false-negatives can be reduced by taking the smears correctly and by giving the report correctly by the expert pathologist.

     Thus the screening procedure is the main weapon for early detection of early cancer, so that both the incidence and the mortality can be reduced and there is no point in detecting the Ca Cx early unless facilities for treatment and after care are available.

     Such screening procedures require cancer infrastructure starting at primary health care level.

   ii. *By colposcopic examination* among high-risk women, and application of Shill's iodine or acetic acid is applied over the cervix and looked for the change in coloration of that area, which indicates cervical dysplasia, which is still an earlier stage to Ca *in situ*. Cauterization (electrical diathermy) of the affected area goes a long-way in the prevention of the development of even the precancerous lesion (*in situ*).

Treatment

- Cervical dysplasia (intraepithelial neoplasia) can be detected by Pap smear and is 100 percent treatable.
- Cauterization for discolored area of cervix.
- Total hysterectomy for all cases of Pap smear positives.
- Surgery/Radiotherapy/Chemotherapy for invasive stage—a multimodality approach.

The philosophy in cancer care is the management of pain. 'Freedom from cancer pain' is now considered a right for cancer patients.

Thus early diagnosis of early cancer of cervix and early treatment is a classical example of preventive service of high order.

Tertiary Prevention

Tertiary prevention is by rehabilitation for all those who have become disabled following major surgery like total hysterectomy. They are rehabilitated physically, mentally and socially.

DIABETES MELLITUS

Diabetes in Greek means siphon (passing water); Melitus in Latin means honey (sweet).

It is a metabolic syndrome, clinically characterized by polyuria, polyphagia, polydypsia, hyperglycemia and glycosuria, due to absolute or relative deficiency of the hormone insulin (either by action or by secretion or both), that controls the metabolism of carbohydrate, protein, fat and electrolytes. Acute metabolic decompensation leads to immediate death

whereas chronic metabolic decompensation results in damage or dysfunction, ultimately failure of various organs especially brain, eyes, kidneys, nerves, heart and blood vessels resulting in complications like encephalopathy, retinopathy, nephropathy, neuropathy, coronary artery disease, intercurrent infections, etc. leading to irreversible disability and death.

CLASSIFICATION OF DIABETES MELLITUS

Primary

Type 1

Insulin dependent diabetes mellitus (IDDM).

Type 2

Noninsulin dependent diabetes mellitus (NIDDM)—(As per the International Expert Committee, the terms IDDM and NIDDM are eliminated). The differences between type 1 and type 2 diabetes mellitus are shown in **Table 21.13**.

Table 21.13 Differences between type 1 and type 2 diabetes mellitus

Type 1	Type 2
These are insulin dependent diabetes mellitus (IDDM) (i.e. Absolute deficiency of insulin)	These are noninsulin dependent diabetes mellitus (NIDDM) (Partial or relative deficiency of insulin)
These are called 'Juvenile-type' of DM	These are called 'maturity-onset' type of DM
It is common among young people below 30 years of age	It is common among people above 30 years of age
It is sudden in onset	It is gradual in onset
Patients are usually thin built	Patients are usually obese
Obesity is not a 'risk-factor'.	Obesity is a 'risk-factor'
It has HLA (human leukocyte antigen) linked genetic predisposition	It is not HLA linked
It is associated with other autoimmune diseases	It is not associated with auto-immune diseases
Acute metabolic decompensation leads to sudden death	Chronic metabolic decompensation leads to complications
Complications are likely to occur suddenly and are fatal	Complications occur slowly resulting in irreversible disability and death
It is not associated with obesity and under activity	It is associated with obesity and under activity
It is common among men	It is common among women
Family history is usually absent	Family history is usually present

Note: Overlapping can occur in age at onset, duration of symptoms and family history.

Secondary

Pancreatic Pathology

Congenital	–	Cystic fibrosis
Inflammatory	–	Pancreatitis.
Neoplastic	–	Tumors of pancreas.
Surgery	–	Pancreatectomy.
Others	–	Hemochromatosis, trauma, auto-immunity (Genetic defects.)

Excessive production of hormones antagonistic to insulin (called insulin antagonists) such as:
Catecholamines—in pheochromocytoma
Growth hormones—in acromegaly
Glucagon—in glucagonoma
Glucocorticoid—in Cushing's syndrome
Thyroid hormones—in hyperthyroidism
Placental lactogen—in pregnancy (gestational diabetes)

Long-term use of drugs like:
- Corticosteroids
- Thiazide diuretics
- Phenytoin
- Oral contraceptives.

Liver diseases can also result in diabetes mellitus (DM):
- *Diabetes mellitus associated with genetic syndromes*
  - Huntington's chorea
  - Lawrence Moon Beidel syndrome
  - Friedreich's dystrophy
  - Lipoatrophy
  - Muscular dystrophies
  - Down's syndrome
  - Klinefelter's syndrome
  - Turner's syndrome
  - Wolfram's syndrome.
- *Impaired glucose tolerance*

Magnitude

Diabetes mellitus is an 'Iceberg disease'. It is an ubiquitous malady of the world today, affecting about 150 million people worldwide. This number is predicted to double by the year 2025, with the greatest number of cases being expected in China and India. It is 4th leading cause of death in USA. It is varying in different parts of the world.

The trend of the disease, which was affecting middle aged and elderly, the type 2 DM, has shown to affect younger age, affecting the health status of that country. This rising prevalence in the developing countries is associated with industrialization and urbanization, indicating the role of not only genetic factors but also environmental factors like quality of life and lifestyle.

In India, DM is gaining momentum. Studies have shown the prevalence rate of DM to be 2.4 percent in rural and 4 to 11 percent among urban dwellers. WHO has declared that India will become the 'Diabetes Capital of World' by the year

2025. The number of diabetic persons is expected to increase from 31 million in the year 2000 to 79 million by 2030.

Impaired glucose tolerance (IGT) is a state between Diabetes mellitus and normalcy. It constitutes an 'at-risk' group. The prevalence of IGT is ranging from 3.6 to 9.1 percent, indicating the potential for further rise in prevalence of DM in the coming decades.

The diagnostic criteria for DM by oral glucose tolerance test (OGTT) is fasting blood sugar value >120 mg/dL and 2 hours after glucose load >180 mg/dL of venous blood. And for impaired glucose tolerance, fasting value <120 mg/dL and 2 hours after glucose load 120–180 mg/dL of venous blood (Normal fasting blood glucose level = 70 to 120 mg/dL and 2 hours after glucose load = 140 mg/dL). However in case of pregnant women, lower criteria is used. A FBS of 105 mg/dL or >165 mg/dL, 2 hours postprandial, confirms DM.

Agent Factors

The underlying cause of DM is deficiency of insulin, which is absolute in IDDM and relative or partial in NIDDM. This could be due to unknown cause as in primary type of DM or secondary to pancreatic pathology (congenital, inflammatory, neoplastic, traumatic or surgical), excessive production of insulin antagonists, drugs, liver disease, due to genetic defects or due to pregnancy. Diabetes diagnosed for the first time during pregnancy is called gestational diabetes. It is due to secretion of placental lactogen in excess, acting as insulin antagonist.

The overall effect of these mechanisms is reduced utilization of glucose leading to hyperglycemia and glycosuria.

The other causes could be decreased insulin sensitivity and increased insulin resistance or synthesis of abnormal, biologically less active insulin molecule.

Host Factors (Risk Factors)

Age

Diabetes can occur in any age group. Type 1 is common among younger age group below 30 and type 2 among middle aged and elderly. Thus age constitutes a risk-factor for DM specially type 2. Younger the age, worse is the prognosis.

Sex

Type 1 DM is common among men and type 2 among women.

Genetic Factors

Type 2 shows 90 percent concordance genetic component whereas type 1 shows only 50 percent. The concordance is greater in identical twins than in that of binovular twins. Maturity onset diabetes of the young (MODY) is an autosomal dominant hereditary disease. If both the parents are such diabetics, the children have 100 percent chance of developing it. It is thought that the susceptibility to diabetes is the function of a defective gene, which is inherited as recessive Mendelian pattern.

The genetic markers are different types of human leukocyte antigen (HLA). Type 1 is associated with HLA-DR 3 and DR4, whereas type 2 is not associated with HLA.

Obesity

Particularly central adiposity (waist circumference or waist: hip ratio) is a greater risk factor than BMI specially for development of type 2 DM and the risk is related to both the degree and the duration of obesity. The central adiposity reflects the abdominal or visceral obesity. Obesity increases the insulin resistance and/or reduces the number of insulin receptors on target cells.

Obesity associated with underactivity still increases the risk. However, many obese persons are not diabetics. Obesity plays no role in type 1 DM.

The risk of metabolic complications is higher for men with a waist circumference of >102 cm and women with >88 cm.

Pregnancy

Pregnancy places a burden on the β-cells of pancreas to secrete more insulin. If the woman is genetically predisposed to diabetes, pancreas may not be able to meet this demand and so she develops DM of either type. This hyperglycemia occurring for the first time during pregnancy is called 'Gestational diabetes.' This may or may not disappear following delivery. But repeated pregnancies increases the likelihood of developing permanent diabetes, to the extent of 80 percent, more so in obese women, posing a high health risk to both the mother and the fetus.

Glycosuria in pregnancy can also occur due to fall in the renal threshold. So blood glucose concentration should be carefully monitored.

The newborn of the diabetic mother is usually over-weight at birth, tends to remain obese during childhood and thus is at a greater risk of developing DM at an early age. Those, born to mothers after they have developed DM have a three fold higher risk of developing diabetes than those born before.

Environmental Factors

These factors trigger the development of DM specially among genetically susceptible individuals by causing β-cell destruction of the pancreas. These factors are:

- *Viral infections:* The important viruses that can result in the development of DM are Rubella, Mumps, Human coxsackie B_4, EMC virus, Mengo virus 2T and Rheo virus type I. They tend to result in type 1 DM.
- *Diet:* There is no evidence that a particular food item is diabetogenic. However, studies have shown that wheat and cow's milk have diabetogenic factors.

A high saturated fat intake has been associated with higher risk of DM type 2. Studies have shown that replacement of saturated fatty acids by unsaturated fatty acids leads to improved glucose tolerance.

Studies have also shown that 'Prudent diet' consisting of fruits and vegetables was associated with a reduced risk and 'Conservative diet' consisting of butter, potatoes and whole milk is associated with an increased risk of type 2 DM. This also showed that the risk can be reduced by changing the dietary pattern.

Diet containing nonstarch polysaccharides (NSP) like cereals, vegetables and fruits which are rich in fibers have a potential protective effect on the development of DM. A minimum of 20 g dietary fiber intake is recommended in the balanced diet.

Cyanide containing foods, certain fungal toxins and food additives predispose to type 1 DM by their toxic effects on pancreas.

- *Malnutrition:* In early infancy and childhood predisposes to type 1 DM by affecting the function of β-cells of pancreas. However, there is no convincing evidence to show that diabetes can be directly caused by protein deficiency. Hence the class 'Malnutrition related diabetes mellitus' has been eliminated.
- *Alcoholism:* Excessive intake of alcohol can increase the risk of type 2 DM by damaging the liver and pancreas by promoting obesity.
- *Lifestyle:* Sedentary lifestyle with lack of exercise, associated with over nutrition, obesity, alcoholism, is a risk factor for DM type 2.
- *Immunological factors:* Type 1 DM is a slow autoimmune disease, occurring over many years. Evidences are:
  - HLA linked genetic predisposition,
  - Association with other autoimmune disorders,
  - Infiltration of β-cells with mononuclear cells, resulting in their destruction (i.e. 'insulinitis').
- *Stress and strain:* Such as pregnancy, surgery, trauma and such other stressful situations may 'bring out' the disease.
- *Socioeconomic class:* Prevalence of DM is no longer related to socioeconomic status. Previously it used to be more in higher class compared to lower class. Now the gradient is reverse because of changes in the 'life style' due to advancement in industrialization and urbanization.

Potential Diabetic

It is a one who has a risk of developing DM due to genetic reasons (e.g. having a first degree relative with DM).

Latent Diabetic

It is a one who has risk of developing DM due to stressful conditions like pregnancy, surgery, trauma, infections, etc. they may return to normal if stress is removed.

'Black zone' is a state of affairs in a type 2 DM patients, in whom blood glucose levels are high but do not have symptoms, although the process of complications is going on.

The factors that allow the patients to slip into the black zone are:

- Lack of health services provided to diabetics
- Lack of knowledge in the patient (Or defects in the health education program provided to diabetics)
- Negligence by the patient (i.e. not accepting the presence of disease and practicing a self-damage behavior such as alcoholism).

INDIAN DIABETIC RISK SCORE (IRDS)(DEVELOPED BY MADRAS DIABETES RESEARCH FOUNDATION)

This scoring is done to identify high risk group for Diabetes and also to raise awareness about diabetes and its risk factors. Scoring method makes the screening procedure more cost effective by at least 50 percent. Cut off point/score at or above 60 constitute very high risk group, 30 to 50 constitute moderate risk group and less than 30 constitute low risk group. Risk score also helps in prevention of type 2 diabetes by increasing physical exercise and reducing waist measurement.

This risk score was derived based on a mathematical modeling from a large population based study named 'The Chennai Urban Rural Epidemiology Study (CURES)'. Grading/Scoring is based upon the parameters of Age, Waist circumference, physical activity and family history, as follows.

IDRS Analysis

Age

Descriptions	Score
<35 years	0
35–49 years	20
>50 years	30

Waist Circumference

Female	Male	Score
<80 cm	<90 cm	0
80–89 cm	90–99 cm	10
>90 cm	>100 cm	20

Physical Activity

Vigorous or strenuous work	0
Moderate exercise	10
Mild exercise	20
No exercise/Sedentary work	30

Family History

No family history	0
Either parent	10
Both parents	20

Early complications can be detected by

- Examination of the urine for albumin (for microalbuminuria) to rule out renal involvement
- Examination of the retina for vascular changes.

It is possible to avoid falling into Black-zone by early detection of complications and also by avoiding risk-factors.

Screening for Diabetes

Examination of Urine

Testing the urine for glucose (Benedict's test) is the most usual procedure for detecting diabetes. It is better, if it is done on urine passed about 2 hours after a main meal, because this will detect more of milder cases of diabetes than a fasting urine specimen.

It is simple, easy and economical test. But the disadvantage is that it yields false-positive and false-negative test, depending upon the renal threshold.

False-positive: Means the nondiabetics are wrongly identified as diabetics, because the test result is positive (urine positive for sugar). This could be because of low renal threshold.

False-negative: Means the diabetics are wrongly identified as not having the disease, because the urine test is negative. This could be due to increased renal threshold.

Because of these limitations, examination of urine is not considered as an appropriate tool for case finding (screening) procedure.

Examination of Blood

Examination of blood for glucose in fasting, postprandial and random sample are different methods. But the 'Gold Standard' test is 'oral glucose tolerance test' (OGTT) **(Fig. 21.4)**. However, under field conditions, glucometer can be employed for screening purpose.

OGTT: The patient should have been taking an unrestricted carbohydrate diet for at least 3 days prior to the test, fasts overnight. Next morning fasting blood sugar estimation is done first. Then 75 g of glucose, dissolved in 300 ml of water is given to drink. Thereafter samples of blood are drawn at half hourly intervals for at least 2 hours (minimum 5 samples in total) and their glucose content is estimated and plotted on a graph. The pattern of the curve is noted.

- In normal person, blood glucose curve reaches normal level by 1½ hours.

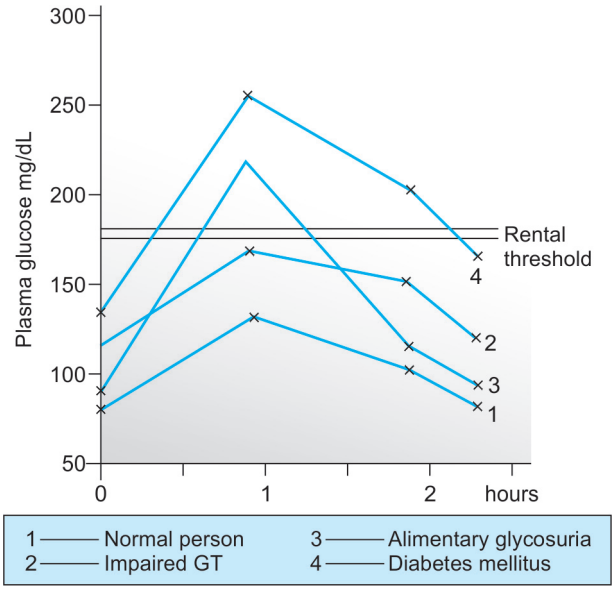


Fig. 21.4 Oral glucose tolerance test (OGTT)

- In a diabetic person, the blood glucose curve does not reach normal even after 2½ hours.
- In renal glycosuria (urine test is positive for sugar), the renal threshold is low. But the pt does not have features of diabetes. This often occurs in pregnancy temporarily.
- In alimentary glycosuria (lag storage), there is rapid but transitory rise of glucose in the blood. This is due to increased rate of absorption of glucose from the gut. It often occurs among normal people and also after gastric surgery.

The last two types of curves are called 'impaired glucose tolerance' (IGT). Such curves need further evaluation including history. OGTT may have to be repeated later.

High-risk screening: Screening of the whole population is not a rewarding exercise. However, screening of 'high-risk' groups is appropriate.

These groups are:

- Individuals above 30 years of age
- Those with a strong family history of DM
- Obese individuals
- Sedentary workers with lack of exercise. Other than high-risk group, the following group of persons should also be screened for diabetes, as a routine.
- A pregnant mother gaining more than 3 kg body weight in any month
- A patient with premature atherosclerosis
- A person complaining polyuria, polyphagia, polydypsia sudden loss of weight, repeated infections, nonhealing ulcer (pruritus vulvae in a lady) and the like
- All expectant mothers attending antenatal clinic
- Patients undergoing surgery, including tooth extraction

- Industrial recruits, business executives
- A woman who has given birth to a baby weighing more than 3.5 kg at birth.

Glucose Memory Test (Glycosylated Hemoglobin)

Glycosylated hemoglobin (HbA_{1c}) test is done to find out the average plasma glucose concentration over a period of three months. The blood glucose values provide only a snapshot of glycemic control at the moment of test done and hence cannot be used in monitoring a patient's control over diabetes.

During life span of 120 days of red blood cells, hemoglobin is constantly exposed to glucose molecules. As a result some glucose molecules are attached to hemoglobin in a nonenzymatic reaction forming glycosylated (glycated) hemoglobin (HbA_{1c}). Once the hemoglobin is glycated, it remains so in an irreversible form during the lifespan of red cells. Thus HbA_{1c} provides an index of average blood glucose level during the past 2 to 3 months. If blood glucose level is increased, as in an uncontrolled diabetic patient the level of HbA_{1c} is also increased and HbA_{1c} does not depend upon the momentary high or low glucose value. Thus it reflects the long term blood glucose control.

Based on the level (percentage of HbA_{1c}, control of diabetes is graded as follows:

<6%	–	Normal
6 to 7.5%	–	Good control
7.5 to 10%	–	Unsatisfactory control
>10%	–	Poor control

This test forms the basis of making appropriate adjustments in the treatment and thus it assists the diabetics as well as the physicians to reduce the risks associated with the development of complications.

Prevention and Care

Primary Prevention/Primordial Prevention

There are two strategies: Population strategy and high-risk strategy.

Population strategy: In this strategy the efforts are directed towards the children and adults from adopting harmful lifestyles, so that there will be elimination or modification of risk-factors (i.e. primordial prevention). This is done only through mass education. The main points are:

- Improvements in the nutritional habits (such as avoiding sweets and fatty foods, alcohol, diabetogenic drugs like oral pills, steroids, regular and adequate intake of proteins, high intake of dietary fibers)
- Maintenance of body weight by doing moderate exercise.

Genetic counseling: There is no practical justification for genetic counseling as a method of prevention. However, consanguineous marriages to be discouraged.

Prospective eugenics: One diabetic should not marry another diabetic.

Retrospective eugenics: If they are already married (i.e. if both the couples are diabetic) they should not have children.

High-risk strategy: In this type, the efforts are directed towards those who are at high-risk of diabetes (list already given). Preventive care is given to all those people, such as:

- Correction of obesity
- Avoiding over nutrition and alcohol
- Changing lifestyle
- Regular exercises
- Maintenance of normal body weight
- Avoidance of oral contraceptives and steroids
- Reduction of factors promoting atherosclerosis such as hypertension, smoking, cholesterol level, etc.

Yoga exercises and meditation goes a long-way in the prevention and control of diabetes mellitus.

Secondary Prevention

It is by early diagnosis and prompt treatment of DM. Early diagnosis is done by screening procedures. The aims of treatment are:

- To maintain normal blood glucose level
- To maintain normal body weight.

The principles of treatment are:

- Diet alone—small balanced meals more frequently
  No fast and no feast.
  More of raw vegetables, less of cereals.
- Diet and oral antidiabetic drugs, i.e. restriction of the diet associated with oral hypoglycemic drugs for type 2 DM.
- Diet and insulin, i.e. restriction of diet and administration of insulin injection daily for Type 1 DM.

The ultimate objective of the management of DM is to prevent complications.

Self Care in Diabetes Mellitus

- *Personal hygiene:* A diabetic should maintain a high standard of personal hygiene from head to toe.
  He/she should look more at the feet than at the face, because pedal complications are many, frequent and often unnoticed.

Should take protective care of the feet as follows:

- By looking for changes in color, temperature, swelling, cracks and wounds
- Always use diabetic chappals or shoes while walking
- Keep the feet clean, dry and warm
- File the nails and not to cut them
- Change the socks daily
- Ensure that there are no stones/nails inside the shoes.

Habits: Should avoid smoking, spirit (alcohol) and steroids (smoking predisposes for coronary artery disease and alcohol predisposes for obesity and also damages liver and pancreas).

Exercise: Should do moderate exercise regularly (Brisk walk of 4–5 km) morning and evening.

Diet
- Strict prohibition of sweets, bakery items, fatty foods and fast foods
- Unrestricted intake of leafy vegetables and dietary fibers
- Restricted intake of beetroot, potato, sweet-potato, and refined cereal products like maida floor, noodles and vermicelli
- Adequate intake of proteins, (limited nonveg like fish)
- Avoidance of egg-yolk
- Small but frequent balanced meals
- No fast and no feast.

Drugs
- Should take the treatment daily and regularly
- Should administer insulin by self (in case of Type 1 DM).

Self-examination
- Of urine for sugar and protein
- Of blood for sugar (Availability of precoated tapes and glucose analyzer has made the examination of blood and urine an easy job).

Instructions

A diabetic individual
- Should maintain blood glucose level within limits
- Should maintain optimum body weight
- Should take prompt treatment following injuries and infections
- Should undergo periodical medical checkup including BP and examination of eyes
- Should avoid marriage with another diabetic
- Should avoid stress and strain
- Should avoid future pregnancies
- Should always carry little sugar and take it, whenever symptoms of hypoglycemia occurs (such as sweating, giddiness)
- Should carry an identification card showing the name, age, address, phone number, details of treatment taking, name of the physician, etc.
- Should know the common complications such as retinopathy, neuropathy, nephropathy, gangrene, silent heart attack and coronary artery disease.

Tertiary Prevention
- *Disability limitation:* This is to limit the development of further disability in a diabetic person, who comes late with complications. This consists of giving an intensive treatment in diabetic clinics.
- *Rehabilitation:* This is given for those who have become disabled and handicapped due to complications resulting in blindness, amputation of leg, etc. They are rehabilitated physically, mentally, socially, psychologically and vocationally.

ACCIDENTS

INTRODUCTION

Accident is an event, independent of human will power, caused by a rapidly acting external force, resulting in physical with or without mental damage/injury.

If death occurs at once or within a week after the accident, it is called fatal accident; if death occurs after a week but within a month, it is called death due to accident or killed in accident and if death occurs after one year, it is called the sequel of accident.

Global Problem

Currently road traffic accidents rank ninth among the leading causes of deaths in the world. It is projected to be second leading cause of death by the year 2020, next to coronary artery disease. For every accidental death, there are about 10 to 15 serious injuries. Injuries in turn are responsible for about 9 percent of all causes of death and about 16 percent of disabilities, i.e. respectively it corresponds to about 5 million deaths and about 9 million disabilities every year. Road traffic accidents constitute the primary cause. More than 25 percent of these deaths occur in SE Asia only.

India

In India, the trend of accidents is on the increase, which is not only due to population explosion, but also due to industrialization and urbanization including mechanization in agricultural industry, predisposed by lack of awareness and safety precautions. Out of 5 million accidental deaths occurring in the world, about 0.5 million occur in India alone every year.

Measurements of Accidents and Injuries

Mortality Indicators
- *Proportional mortality rate:* For example, percentage of total deaths due to accidents (This can also be estimated per 1000 total deaths).
- Number of deaths per million population
- Number of deaths per 1000 (or 10,000) registered vehicles per year
- *Ratio of number of accidents:* Number vehicles (or passengers) per kilometer.

Morbidity Indicators

This is measured in terms of 'Serious injuries' and 'Slight injuries', assessed by a scale known as 'Abbreviated Injury Scale'.

Disability Rate

Since the outcome of the accident is death or disability, disability is measured in terms of 'disability adjusted life years' (DALY), which is the number of healthy years lost due to disability. This depends upon the severity of the accident and the duration of disability.

Types of Accidents

They are grouped into following major types:

- Road traffic accidents.
- Railway accidents.
- Domestic accidents.
- Industrial accidents.
- Other accidents include violence, homicide, suicide, air accidents, drowning, poisoning, field accidents, fire accidents, etc.

Road traffic accidents: Motor vehicle accidents contribute highest in the total deaths due to accidents. For every fatal accident, there are about 10 to 15 serious injuries and about 50 minor injuries. The accident rate in India is about 8 per 1000 registered vehicles. It is highest in USA (80% fatality).

In India there has been unprecedented increase in the number of motor vehicles in this decade. Death rate is more among men than among women. Among men, it is more among children and adults. It is more with two wheelers than four wheelers. Pedestrians are affected most compared to vehicle riders. The important reasons for this type of distribution of accidents are:

- Pedestrians and animals share the road-way
- Poor maintenance of vehicles
- Large number of vehicles
- Overloading of the vehicles
- Low driving standard
- Poor road conditions, poor street lighting and speed checkers (humps)
- Lack of traffic knowledge
- Over speed
- Alcoholism by the drivers
- Diversion of attention while driving due to talking over mobile phone, advertisements on the road side, etc.

Railway accidents: There has been an increase in the number of trains and the passengers. Proportionately casualties are also increasing. This is mainly due to human failure including antisocial activities of the terrorists.

Domestic accidents: These are the accidents occurring in and around the house. These include burns, drowning, poisoning, falls, injuries, and from animals.

Burns: By flame, hot liquids, electricity, crackers, chemicals (like acids). It is more among women due to dowry problem.

Drowning: This takes place in ponds, rivers, and ocean specially during floods and cyclones. It is more among children.

It can also occur while crossing the waterways by boats.

Poisoning: This is often caused by pesticides, kerosene and drugs. Organophosphorous compounds are often used to commit suicide.

Falls: These occur from trees while picking fruits, coconuts, tapping toddy, from construction of buildings, children falling from rooftops while flying kites, etc.

Injuries: These can occur from any of these above and also from sharp instruments. Injuries can also result from animal bites.

Industrial accidents: Agricultural industry being the largest industry in India, the agriculturist workers are at risk caused by mechanized equipment, tractors, use of fertilizers, pesticides, etc.

Miscellaneous

Violence: This has been increasing very rapidly caused by war, terrorists, and antisocial activities. The predisposing factors are availability of weapons, as a means to solve problems, consumption of alcohol, political unrest, ethnic and communal violence and such others.

Suicides: Suicides have also been increasing. It is more among women due to ill treatment by the husband and/or family members, dowry harassment, among students due to failure in the examination, among certain people due to depression, heavy economic loss, etc. Common methods adopted are hanging, poisoning and drowning.

Agent Factors

These are vehicles in road accidents, machines in industries.

Host Factors

Age: Accidents are high in the extremes of age. But due to road traffic accidents, it is high in the age group of 15 to 34 years.

Sex: Usually accidents are more among men than among women. However, in case of burns, suicides, falls, females are the usual victims.

Medical conditions: Existence of medical conditions like epilepsy, vertigo, refractive errors, etc. contribute to accidents.

Experience and training: Industrial accidents are more common among unexperienced, untrained and unskilled workers associated with lack of protective devices to the machines.

Habits: Certain habits like drugs, alcoholism, smoking, etc. play a significant role in accident causation.

Other Factors

Like fatigue, boredom, anxiety, fantasy also predispose to accidents. 'Accident proneness' is a condition that drives the person subconsciously to take unnecessary risk. In industries, 75 percent of accidents repeatedly occur among the same 25 percent of workers. Curiosity (as among toddlers), haste and negligence (e.g. to wear safety gadgets) also contribute to accidents.

Environmental Factors

- *Relating to road*
  - Accidents are more common in urban than rural areas
  - Defective, narrow roads, too many curves, slippery roads
  - Presence of cross-roads, poor lighting
  - Acute humps, etc.
- *Relating to vehicles*
  - Overspeed
  - Poorly maintained
  - Overload
  - Low driving standard.
- *Season*
  - Due to fog and bad weather conditions as in winter and rainy season (So more from July to December).
- *Mixed traffic*
  - By pedestrians and animals
  - Children playing on the streets.
- *Legislation*
  - Ignoring the traffic rules
  - Paucity by the traffic police in enforcing traffic regulations
  - Fraudulent issue of driver's license
  - Traveling on footboard of buses.
- *Domestic environment*
  - Greasy floor
  - Vegetable and fruit peelings on the floor
  - Badly lit stair-case
  - Dark corners
  - Faulty electrical connections (improper earthing)
  - Hanging of electrical wires
  - Smoking in the bed
  - Keeping burning candles near window curtains
  - Forgetfullness to switch off LPG cylinders
  - Use of soft pillows for infants, etc.

Prevention

Safety Education

People are educated to impress that accidents are not inevitable and that they are caused and so they can be prevented. 'If accident is a disease, education is its vaccine'. Safety education is related mainly to prevent road, domestic and industrial accidents. So the target groups are school children, housewives and industrial workers. They should also be trained in first-aid.

Parents are educated to take care of their young children, specially if they are naughty.

Safety Measures

Road safety: Roads are made broader, free from curves and intersections, properly illuminated during night times, self-luminescent sign boards are set up along the highways, multi-track roads, being ideal preferably with a separate pedestrial traffic. Attention should be given to accident prone areas.

Vehicle safety: Vehicles are fitted with seat belts, shoulder traps, indoor locks and with radial tyres.

Personal protection: By the following gadgets:

Protective device	Class of persons
• Seat belt	Motor drivers
• Crash helmet	Motor cyclists, scooterists, mine workers
• Lead aprons	Persons working in Radiology department
• Rubber gloves	Electricians
• Steel-capped shoes	Persons engaged in lifting and carrying heavy objects
• Life jacket	Crew of ships

Machine safety: In industries, the machines must be properly installed and periodically serviced and maintained. There should not be loose moving parts.

Legislative Measures

Following rules must be enforced strictly:

- Wearing of helmets by two wheeler drivers
- Use of seat belts by the drivers and passengers, of cars
- Prohibition of talking over mobile phone, consumption of alcohol, and drugs like sedatives, antihistamines, barbiturates and such others while driving
- Prohibition of over load of trucks and buses
- Regular inspection of vehicles, and imposition of speed limits
- Periodical medical examination of drivers.

Similarly Indian Factories Act provides many compulsory safety rules for industrial workers.

BLINDNESS

INTRODUCTION

Blindness is defined as (WHO) 'Visual acuity of less than 3/60 (in Snellen chart) or its equivalent.' (Inability to read letters or decipher symbols at a distance of 3 meters in day light, which is large enough to be read by a normal person at a distance of 60 meters). Inability to count fingers at 3 meters is equivalent to a vision of 3/60 or less.

Uniocular blindness is not blindness because the other eye is normal. Visual acuity of more than 6/18 is normal vision.

Visual acuity of less than 6/18 to 6/60 is considered as 'Low vision.' Less than 6/60 to 3/60 is considered as economic blindness (i.e. it prevents the persuit of the routine vocational activities).

Extent of the Problem

Global

Presently about 180 million are disabled visually due to low vision including 45 million who are totally blind. This number is likely to double by the year 2020, if necessary preventive measures are not adopted.

Blindness is not only an economic and social problem, but also a health problem because it results in premature death.

One to two million blind people are added each year to this pool.

India

Out of 45 million blind in the world, India's contribution is 7 million. About 80 percent of these is either preventable or curable, provided health care services are made available and people take active measures.

National Survey has shown the prevalence of blindness in general population to be about 1.1 percent, among children between 10 and 14 years to be about 6 to 7 percent and among elderly to be about 8.5 percent.

Causes

The most common cause of blindness is cataract. This accounts for about 60 percent of all cases of blindness (and about 90 percent of total blindness among elderly people above 55 years of age). Senile cataract occurs a decade earlier in India than in the developed countries.

Refractive Error

Uncorrected refractive error is responsible for about 20 percent of all blindness.

Glaucoma

This contributes to nearly 6 percent of total blindness.

Causes in the Retina

Such as retinopathy (due to various causes like diabetes, hypertension, prematurity, etc.) and detachment of retina constitutes about 5 percent of the blindness.

Other causes of blindness are trachoma (infection), trauma, congenital defects (Rubella), diseases of conjunctiva, retina and malnutrition (vitamin A deficiency). These are common among children, leading cause being xerophthalmia and blindness due to vitamin A deficiency.

Less common causes of blindness among children are retinitis pigmentosa, retinoblastoma (tumor), retrolental fibroplasia, congenital glaucoma, keratoconus and burns from crackers.

Childhood blindness is more prevalent in the developing countries.

Idiopathic causes constitute minimum percentage.

Avoidable Blindness

These are the blindness, which could have been prevented or cured by reasonable access to affordable health care. This includes blindness resulting form cataract, infections (like trachoma), vitamin A deficiency, glaucoma, ocular trauma and refractive errors.

Host Factors

Age: The cause of blindness among children are different from those of adults. Thus a clear dichotomy has been observed. Refractive errors, trachoma, vitamin A deficiency, opthalmia neonatorum, congenital rubella are common causes among children whereas cataract, refractive errors, glaucoma, diabetes, accidents among adults.

Sex: Female preponderance has been observed to be high among Indian women than among men.

Nutritional Status: Malnutrition, specially deficiency of vitamin A constitutes an important cause of preventable blindness among young children.

Occupation: Industrial workers are at a higher risk of blindness due to injuries (accidents) and exposure to dust, fumes, gas, radiation, (welding flash); electrical flash, etc. Injuries to eyes are on the increase due to increase in cottage industries like carpentry, black-smithy, stone crushing, chiseling, hammering, chopping wood, etc.

Environmental Factors

Socioeconomic Status

The prevalence of blindness has been observed to be high among lower socioeconomic class than among higher class.

Other Factors

These are illiteracy, ignorance, negligence, lack of knowledge, low standard of personal hygiene, over crowding, and lack of availability of health care services are all responsible for the prevalence of blindness in India.

Prevention and Control

This is studied under three headings.

Eye care, specific ophthalmic programs and rehabilitation.

Eye Care

Provision of eye care services is considered at three levels.

Primary eye care: This consists of promotion and protection of eye health along with the treatment of minor eye ailments at the 'grass-root' level, to be provided by trained primary health care workers such as village health guide, multipurpose workers, a concept of primary health care approach, which has been internationally accepted. The services provided are:

- Vitamin A supplementation to under five children.
- Treatment of minor eye ailments such as removal of superficial foreign-bodies, treatment of conjunctivitis with ophthalmic ointments, recognition and treatment of xerophthalmia.
- Identification and referral of difficult cases (like corneal ulcer, penetrating foreign bodies, infectious and painful eye conditions) and cataract cases to nearby primary health center and District hospitals.
- Follow-up of beneficiaries.
- Health education is given on personal hygiene of the eyes.

Secondary eye care: This consists of early diagnosis and treatment of blinding conditions like refractive errors, cataract, glaucoma, trichiasis, entropion, occular trauma, etc. This is provided in the middle level health institutions like Primary Health Centers and District Hospitals, where eye clinics are established.

Such secondary eye care is also provided by mobile ophthalmic units. One of the major innovation in the eye care has been the cataract operations through 'Camp approach' which has been highly successful.

Tertiary eye care: This consists of providing eye care by the super-specialists, working in Medical College Hospitals, National Institutes and Hightech Hospitals. They provide sophisticated eye care like retinal detachment surgery, laser radiations, corneal grafting, correction of squints and such others.

Other than providing specialized services, such institute provide training of the health personnel and undertake research activities.

Specific Ophthalmic Programs

Trachoma control: The National Trachoma Control Program, which was launched in 1967, was merged in National Program for Control of Blindness in 1976 (Described under National Programs).

School eye health services: This consists of mainly periodical examination of school children, not only for general physical health, but also screening for visual defects and diseases like correction of refractive errors, and counseling with teachers and parents for getting corrections of squint, amblyopia, trachoma, etc.

This also consists of giving promotive eye health services such as adopting good posture while reading and writing, proper lighting, avoiding glaring, distance between eyes and the book and also about consumption of green leafy vegetables, etc.

Vitamin A prophylaxis: Under the National Program, this consist of administration of 5 mega doses of vitamin A to all children between 6 months and 3 years, to control xerophthalmia and prevent nutritional blindness.

Occupational eye health services: This consists of using protective devices, education of prevention of eye hazards, prevention of eye accidents by improving safety measures of machines, etc.

Rehabilitation

This is provided to those who have become handicapped due to blindness. They are given rehabilitation physically, socially, psychologically and vocationally. Physical rehabilitation consists of providing specialized, eye care, social rehabilitation consists of removing social ostracism, psychological rehabilitation consists of giving psychological support and vocational rehabilitation consists of training them for economically gainful employment.

Such rehabilitation can be provided by establishment of schools for the blind, where they are educated with Braille script. Trained dogs and sonic torches help them walk through streets.

The National Institute for the Blind in Dehradun has been working on new approaches and strategies to solve the problems of the blind.

Other Preventive Measures

- Penicillin eye drops is instilled in the eyes of the newborn babies.
- High concentration of oxygen is avoided in managing LBW babies.
- Mass chemotherapy of trachoma with tetracycline ointment is carried out together with surgical correction of entropion (inturned eye lids).

- Early detection and treatment of diabetics is carried out to ensure that they maintain normal blood glucose level.
- Health education of people to use goggles fitted with shatter proof glasses against the danger of flying splinters, to use visors while welding, to be careful while bursting crackers and to donate eye after death.

Vision 2020: The Right to Sight

This is a global initiative, launched by WHO on February 18, 1999. Government of India launched the same on October 14, 2004 and is also committed to this.

The objective of vision 2020, is to reduce avoidable blindness (Preventable and treatable) by the year 2020 and the goal is to reduce the prevalence of blindness in India to 0.5 percent by the year 2012 and no child should go blind after 2012.

The concept is centered around the Rights issues, i.e. Recognition of sight is a fundamental human right.

The target diseases are centered, refractive errors, childhood blindness, corneal blindness, glaucoma, diabetic retinopathy, by the year 2020.

For this, four tier structure has been proposed to develop human resources, infrastructure and technology, which includes centers of excellence (20), training centers (200), service centers (2000) and vision centers (20,000) **(Fig. 21.5)**. The challenges associated with global initative are:

- 45 million people are blind globally and 135 million have low vision
- 90 percent of all blind people live in developing countries
- In India at least 9 million people are blind, in China 6 and in Africa 7 million
- 80 percent of blindness is preventable
- People in the developing countries are ten times at a greater risk to become blind than developed countries
- The world over, every five seconds one person goes blind and every minute a child goes blind
- Every year at least 7 million people go blind
- By the year 2020, a total of 100 million people are to be saved from going blind.

'Restoration of sight and blindness prevention strategies are amongst the most cost-effective intervention in health care.'

'World Sight Day' is observed on second Thursday of October every year to raise public awarness of blindness, to influence the Governments to designate funds for blindness prevention programs and to educate the target audiences about blindness prevention.

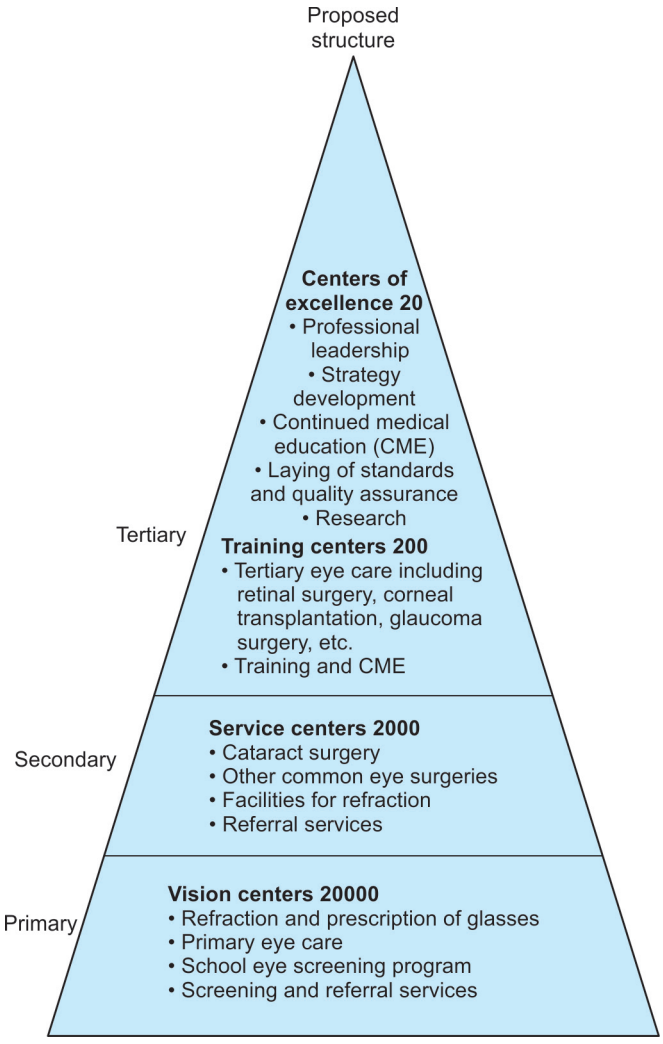


Fig. 21.5 Proposed structure of service delivery model for vision 2020: The Right to Sight

Source: Park K. Park's Textbook of Preventive and Social Medicine, 18 edn. 2005.

MOBILITY OF BLIND

Blindness imposes restriction on the ability to move about. Following are the ways of mobility for a visually impaired person.

- Mobility with the help of a companion
- Sensory training and mobility.

Mobility with the Help of a Companion

Long Cane

The cane can help finding surfaces of different textures, stairs, etc. A person can use certain clues and landmarks while using cane for his independent travel. Teaching of long cane technique should be assisted by the efficient use of tactile maps. The long cane technique includes: Walking on shoreline, side path, trailing with cane, touch technique,

touch and drag technique, touch and slide technique, three point top technique for walking, using cane on stair ways, exploring of immediate environment with cane, road crossing, safety crossing, setting into bus, train and cart with cane, etc.

Electronic Devices

Sonic guide, laser cane, path sounder are some electronic aids available for mobility but are not common in India because they are expensive.

Guide Dogs

Using guide dogs is popular in Europe and US. This has not developed in developing countries due to enormous cost and traffic confusion.

Sensory Training and Mobility

In a visually impaired individual, the loss of sight is compensated by sense of touch and hearing. Sense of touch enables the person to determine his position and direction. Hearing plays a dominant role in mobility.

Exploration of an object through touch determine the definiteness of the object and help the individual to form a neat conception of them. Sense of touch also has a lot to do with reading. During his travel the smell of a gutter, the smell of smoke of a chemical industry, (like paper factory, sugar factory, etc.), smell of kitchen products, etc. are source of information for the person to locate where he is. This leads to a greater level of confidence in mobility.

Daily Living Skills

These are also called as 'Survival skills.' These built up confidence specially among visually impaired children. These are necessary for day to day living. Some of the common daily living skills are eating manners, using toilet, dressing, body hygiene, cleanliness, taking bath, washing cloth, handling money, shopping, shaving, proper use of electrical appliances, food preparation, cleaning a place, using medicine, etc. Learning daily living skills of a visually impaired child are means of his proper social development also. These skills are difficult but not impossible to learn.

COMMUNITY OPHTHALMOLOGY

Synonyms

Public health ophthalmology; preventive ophthalmology; preventive eye care.

It is that branch of community medicine that deals with the study of preventive, promotive, curative, referral and rehabilitative ophthalmic services to the community. Thus it is a community approach aiming at improving the eye health of the entire community. This is based upon the fact that there are many people in the community needing eye care but don't go to doctors, because of barriers such as ignorance, illiteracy, indifferent attitude, lack of knowledge, poverty, lack of availability of health services, etc.

It is a well known fact that one person in the world goes blind every five seconds and a child goes blind every minute. Globally about 150 million are disabled visually, including 45 million who are totally blind. Nearly 1 to 2 million blind people are added each year to this pool.

Out of 45 million blind people globally, about 8 to 9 million people are in India alone with an additional 52 million visually impaired. Thus, the prevalence of blindness in India is about 1 percent. Thus, India shoulders the world's largest burden of blindness. It is to be noted that because of variations of blindness criteria, there is paucity of reliable and accurate data. However it is observed that for every one patient coming to ophthalmic clinic, there are about ten people in the community having eye problem. It could be an infection of the eye, cataract, squint, refractive error, disease of the cornea, conjunctiva, retina, etc. They go untreated, ultimately becoming blind.

The visual impairment has immediate and long term consequences in people of all the age groups resulting in lost blind person years, low educational status and low employment opportunities, poor economic gain for individual, families, societies and decreased quality of life, resulting in premature death. Thus blindness is an economic problem, a social problem and a health problem. The fortunate part is that almost 80 percent of blindness is avoidable.

From the perspective of the community, we need to know the ophthalmic felt needs of the people. This requires investigating the size of the problem, types of the eye problems, availability of health services, attitude of the people towards eye diseases, and barriers from using eye services.

To put solutions for all these, it needs proper program implementation, management, communication and health education for community participation. In otherwords, to establish community based eye care delivery system, there needs to be a concentrated deliberation for easy accessibility, effortless affordability and absolute availability of services in the community by the providers.

Thus the aim of community ophthalmology is to provide ophthalmic services to the community at affordable cost in identifying and preventing blindness and reducing the disability caused by poor vision.

Thus, community ophthalmology is a new field. The differences between clinical ophthalmology and community ophthalmology are as shown in **Table 21.14**.

The various components of community ophthalmology are shown in the flow diagram **Flow chart 21.1**.

Thus, community ophthalmology gives a holistic view of eye health.

Flow chart 21.1 Various components of community ophthalmology

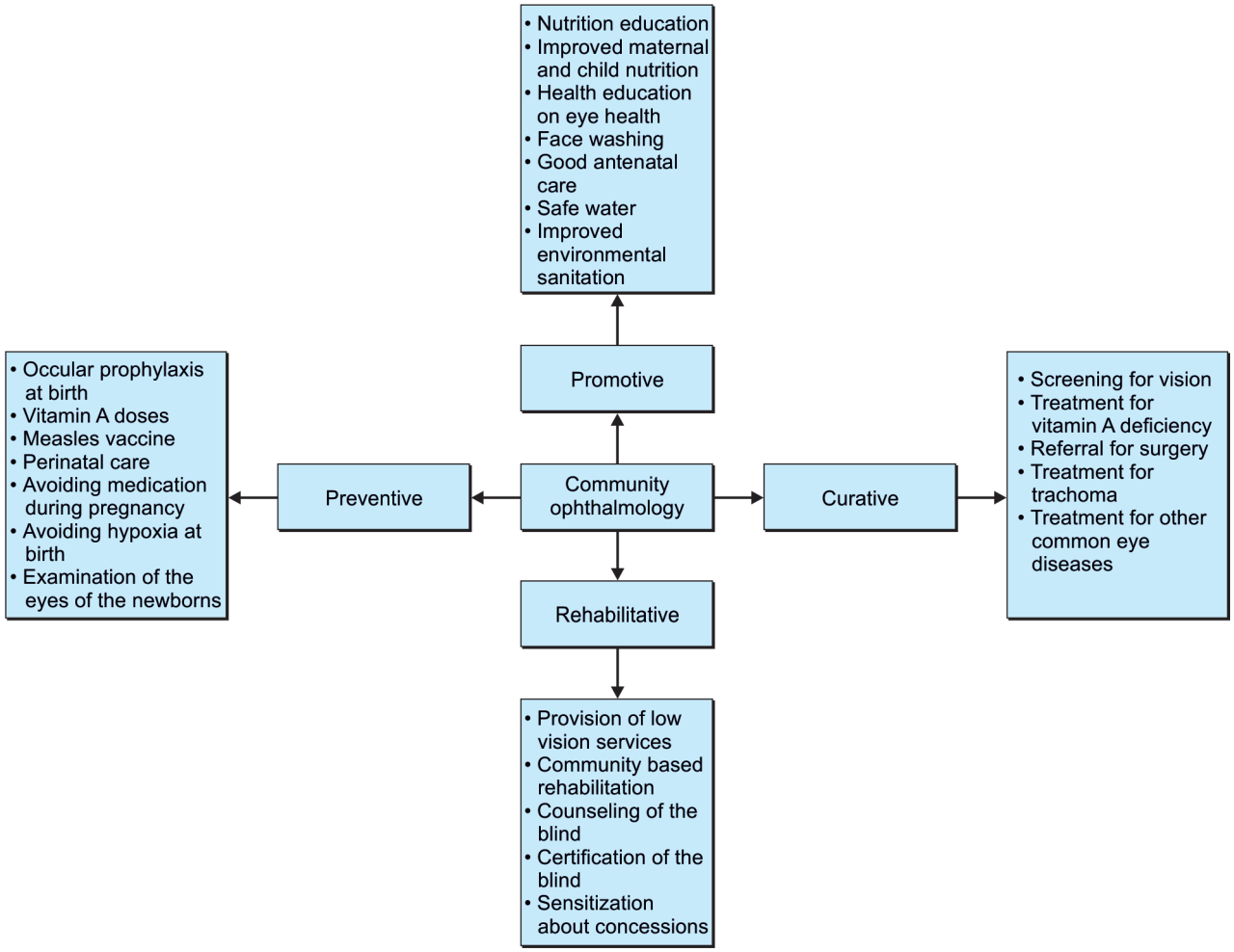


Table 21.14 Differences between clinical ophthalmology and community ophthalmology

Distinguishing factors	Clinical ophthalmology	Community ophthalmology
Goal	Treatment and cure	Preventive, promotive, curative and rehabilitative approach and epidemiological research
Target	Single patient	Entire community population
Diagnosis	Physical exam, laboratory investigations and tests	Health survey (screening camps)
Therapy	Medicine/Surgery	Health education; Counseling
Base	Clinic based	Community based
Relationship	Doctor and patient	Doctor, patient, social workers, community volunteers
Patient mobilization	Low	High
Accessibility and affordability	Not flexible	Patient friendly
Research interest	Mostly clinical	Population based survey
Drive	Provider driven	Community driven

Contd…

A community ophthalmologist is one who has knowledge on all the components of community ophthalmology and has managerial and communication skills and encourages community participation by organizing eye camps and does research in eye diseases and uses appropriate technology in implementing mobile eye services, primary eye care programs and blindness prevention activities. He is overall inchrage of community ophthalmology center.

"Vision-2020-Right to Sight" is an initiative to eliminate avoidable blindness by the year 2020.

In India, as of today only three centers namely Rajendra Prasad Institute of Ophthalmology, AIIMS, Delhi, LV Prasad Institute Hyderabad and Lions Aravind Institute of Community Ophthalmology, Aravind Eye Hospital, Madurai are considered as professional agencies that render community ophthalmic services. This is highly insufficient for a country like India, having second largest population of the world.

Community participation in ophthalmology envisages the involvement of health functionaries, non governmental organizations, teachers, social workers, voluntary/charitable organizations, opinion leaders and local practitioners of different systems of medicine.

BIBLIOGRAPHY

1. Available at www.kcco.net/what is commopth.html
2. Available at www.ncbi.nlm.nih.gov
3. Govt of India. Annual Report. Ministry of H and FW 2003-4.
4. Govt of India. National Program for Control of Blindness. Ministry of H and FW 1996.
5. Gupta MC. Indian Practitioner 1989;42:991.
6. Hegde BM. JIMA 1992;90:166-7.
7. IJCM. Special Issue on Noncommunicable Diseases (36), Dec 2011.
8. Keerthi Bhushan Pradhan. Dimensions of Community Ophthalmology. Madurai.
9. Kishore J. National Health Programs of India 5th edn, 2005.
10. Leavell HR, Clark EG. Preventive Medicine for the Doctor in His Community 2nd edn, 1958.
11. Manocha S, Gupta MC. Indian J Med Research 82, 1986.
12. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.
13. Pradeepa R, et al. Epidemiology of Diabetes in India – Current Perspective and Future Projection. JIMA 2002;100(3).
14. Priyanka Mukhopadhay, Bhaskar Paul. Introducing HPV vaccine in developing countries – Addressing the challenge, IJCM 2009;34(4):370.
15. Rajkumar, et al. Leads to Cancer Control Based on Cancer Patterns in Rural Population in South India 2000;11(5).
16. Rose G. British Medical Journal 1981;282:1847.
17. Savitha Sharma. Vaccines against Human Papilloma Virus and Cervical Cancer, An Overview. IJCM 2008;33(3).
18. Sood S, Nada M and Nagpal RC. Prevention of blindness and mobility of a blind. IJCM Vol. xxix:Apr-June 2004. pp. 92-3.
19. Sundaram C, Vrunda JP. Second Life After Heart Attack, 1st edn, 2002.
20. Swasth Hind. Prevention and Control of Diabetes – An Interview 40, 1991.
21. WHO Annual Report. Elimination of Avoidable Blindness in S-E Asia 2000.
22. WHO Global Elimination of Blinding Trachoma – WHA Resolution 1998.
23. WHO Tech Rep Ser No 322, 1986.
24. WHO Tech Rep Ser No 636, 1979.
25. WHO Tech Rep Ser No 695, 1983.
26. WHO Tech Rep Ser No 727, 1985.
27. WHO Tech Rep Ser No 732, 1986.
28. WHO Tech Rep Ser No 764, 1988.
29. WHO Tech Rep Ser No 777.

SECTION 6

Health-related Disciplines

- Maternal and Child Health Services (Preventive Obstetrics and Pediatrics)
- Demography
- Family Planning
- Biostatistics
- Social Science
- Information, Education and Communication
- Human Genetics
- Preventive Geriatrics
- Mental Health
- Adolescent Health
- Alcoholism and Drug Addiction

CHAPTER 22

Maternal and Child Health Services (Preventive Obstetrics and Pediatrics)

Child is the future citizen of the nation. Health of the child depends upon the health of the mother. Thus, maternal care and maternal health are intimately associated with the child care and child health. So protection and promotion of the health of the mothers and children is of prime importance for building a healthy and sound nation. Special health services have been formulated and concentrated for mothers and children in our country, as maternal and child health (MCH) services, which has been upgrated into national program as Reproductive and Child Health Program (RCH-Program described under National Program).

Services have been concentrated because of the following reasons:

- Together, the mothers and children constitute a 'major group' of the population (Mothers = 20% and children below 15 yrs = 40%; together = 60%).
- They also constitute a 'vulnerable group' (Special risk group). The risk is connected with the child bearing among mothers and with the growth, development and survival among children.
- They constitute a 'Priority group'.
- The morbidity and mortality is high among them.
- Most of the diseases and deaths are preventable among them.
- Mother and child is considered as one unit.

The deaths of the children in our country contributes to 40 percent of total deaths. To this if we add the deaths of the mothers, abortions, stillbirths that are recorded or unrecorded, it is estimated that there are about 4 million deaths, each year, in this group, which is about 100 times more than the developed countries. Most of these deaths are preventable.

To start with, the MCH services were patchy. That means the services were different for mothers and children, at different places and at different timings, specially during Fourth Five Year Plan (1969–74) when Family Planning Services were also provided along with the traditional Mother and Child Health Services. So mothers had to go to one place to receive care for herself and to another place for her children. This resulted in lot of inconveniences, dropouts and failure in the services.

Therefore, to reduce the dropouts and to improve the quality of services, Government of India during Fifth Five Year Plan (1974–79) initiated a new approach of providing different services to mothers and children, such as maternity services, Family Planning Services, Nutritional, Immunization and Educational Services, in an integrated manner as 'Health Care Package' (a set of preventive, promotive and curative services) under 'Primary Health Care'.

MOTHER AND CHILD—ONE UNIT

Reasons

- During antenatal period, fetus is part of the mother. Fetus gets diet, drugs and diseases from the mother.
- At birth, the health of the newborn (i.e. birth weight) depends upon the health of the mother.
- After birth, the newborn is dependent on the mother for at least 6 to 9 months.
- The growth and development of the child is dependent upon the health of the mother.
- The mother is the first teacher of the child.

MCH Problems

In the developed countries: There are congenital disorders, genetic disorders, behavioral, psychological disorders, etc.

In the developing countries: There are mainly three—malnutrition, infections and uncontrolled fertility, aggravated by social problems related to the management of pregnancy such as poverty, illiteracy, ignorance, poor living conditions, overcrowding, lack of sanitation, taboos and cultural practices, all resulting in increased morbidity and mortality among mothers and children.

a. *Adverse effects of malnutrition:*
   - *Among pregnant mothers:* Anemia, toxemias, post-partum hemorrhage, low birth weight (LBW) baby.
   - *Among children:* Growth failure, infections.

b. *Adverse effects of infections:*
   - *Among mothers:* Abortions, still-births, LBW baby, puerperal sepsis.
   - *Among children:* Infection results in malnutrition and vice versa.

c. *Adverse effects of uncontrolled fertility* (*i.e. Hazardous reproduction*): Increased birth rate followed by population explosion and its hazards.

Objectives of MCH Services

- To protect the health of the mothers and children
- To promote the health of the mothers
- To promote the growth and development of the children
- To prevent the occurrence of diseases among them
- To reduce the morbidity and mortality among them.

Components of MCH Services

Services to the Mothers

- Preconceptional care
- Antenatal care
- Intranatal care
- Postnatal care
- Family planning services.

Services to the Children

- Essential and immediate care of the newborn
- Care of the 'at-risk' newborn
- Continuing care of the infant
- Care of the toddlers (preschool children)
- Care of the school children
- Care of the children of the employed mothers
- Care of the handicapped children
- Placement of the children.

SERVICES TO THE MOTHERS

Preconceptional Care

This is the service provided to the woman before she conceives. Ideally it should start (for a potential mother) much before marriage.

The components are educational, informal and genetic counseling.

a. *Educational:* The high-school and college girl students are given knowledge about anatomy and physiology of reproductive system, pathology of STDs including HIV/AIDS. They are also given education about planned parent-hood, family welfare and mother-craft.

b. *Informal:* They are informed about the benefits of medical supervision during pregnancy and the facilities available for the same. They are also informed about the Medical Termination of Pregnancy Act (MTP-Act).

c. *Genetic counseling:* This means improvement in the genetic constitution in the individual family by counseling the individual or the couple. Here the measures are directed to the individual family level.

   There are two types—prospective and retrospective.

   1. *Prospective counseling:* This is true prevention. A heterozygous individual with recessive traits should not marry another heterozygous individual. Diseases like thalassemia, sickle cell anemia, G6PD deficiency are prevented.
   2. *Retrospective counseling:* This is done, when a hereditary disorder has already occurred in the family. The different methods adopted are contraception, termination of pregnancy, in the event of diagnosing a defective fetus by sonography, sterilization of person with harmful trait, *in vitro* fertilization and embryo transfer (tubal pregnancy), avoiding exposure to mutagens such as X-rays, ionizing radiations, etc. treatment of hemophilia with antihemophilic globulin, etc.

Other general measures of prevention of genetic diseases are prevention of consaquinous marriages, avoiding late marriages among women, etc.

Antenatal Care (Care of the Mother During Pregnancy Period)

Antenatal period starts from the time of conception to the onset of labor. In the rural areas, antenatal care is provided by Health Worker Female.

Objectives

- To promote the health of the mother and to maintain it
- To protect her health
- To preserve the physiological aspects of pregnancy
- To detect the 'high-risk' mothers and to give them special attention
- To prevent complications of pregnancy
- To prepare her physically fit and mentally alert to cope up with pregnancy
- To prepare her for breastfeeding
- To teach her the mother craft
- To sensitize her the need for family planning
- To see that she brings forth a healthy, live child with a good birth-weight
- To reduce MMR and IMR.

Visits

Antenatal visits should be made to the clinic periodically, regularly, as follows:

- Once a month, till 28 weeks of pregnancy
- Then twice a month till 36 weeks
- Then once a week, till 40 weeks (delivery).

If everything is normal, minimum of 3 antenatal visits must be made to the antenatal clinic by the mother as recommended under the National Program, respectively at 20 weeks (or as soon as pregnancy is known), 32 weeks and 36 weeks. Significance is as follows:

First visit (at 20 weeks)

- To confirm pregnancy
- To register the mother
- To detect 'high-risk' mothers
- To give first dose of tetanus toxoid
- To give antenatal advice.

Second visit (at 32 weeks)

- To deworm her
- To give second dose of tetanus toxoid
- To detect position and presentation of the fetus
- To give antenatal advice
- To decide the place of delivery
- To give warning signals
- To give one pack of (100) IFA tabs (Iron and folic acid).

Third visit (at 36 weeks)

- To exclude cephalopelvic disproportion
- To give antenatal advice
- To give disposable delivery kit to the mother in the rural areas.

Components of Antenatal Care

- Antenatal registration and maintenance of antenatal card
- Antenatal history
- Antenatal examinations
- Antenatal investigations
- Antenatal advice
- Antenatal services.

Antenatal registration: Registration of the mother is done in the antenatal register after confirming the pregnancy clinically in the hospital and after 12 weeks of missing the period in the rural areas by the Female Health Worker. An 'Antenatal Card' is prepared by writing the registration number, identifying data, and details of previous and present health history, including present complaints if any. Preparation of the card not only helps in enumeration of the mothers (as a denominator) to calculate infant mortality rate and maternal mortality rate, but also helps in evaluation of other MCH/FP services. It also helps in knowing the outcome of pregnancy.

Antenatal history: This should include the following:

- *Gynec history:* Age at menarchae, history of menstrual cycles, date of last menstrual period (LMP) to calculate duration of amenorrhea and to calculate the expected date of delivery (EDD) (EDD = LMP plus 7 days minus 3 months). For example, LMP = 10.04.2009; EDD = 17.01.2010.
- *Obstetric history:* Age at marriage, duration of married-life, age at first pregnancy and the detail history of previous pregnancies and deliveries, including gravida status (order of pregnancy), para-status (number of viable deliveries), abortions, still-births, number of living children, number of dead children and their causes.

Antenatal examinations: This consists of physical, systemic, abdominal and pelvic examinations.

a. *Physical examination*: It is done to look for built, nourishment, anemia, edema, BP, height and weight and position of the nipple. Examination of the mother without the examination of the breast is an incomplete examination.

'Weight height product index (WHPI)' is used to assess the nutritional status of the mother.

$$\text{WHPI} = \frac{\text{Current weight (kg)} \times \text{Height (cm)}}{\text{Expected weight (kg)} \times \text{Height (cm)}} \times 100$$

$$\text{WHPI} = \frac{\text{Weight} \times \text{Height}}{6750} \times 100$$

Where,
Exp. weight = 45 kg
Exp. height = 150 cm
= Less than 100 indicates malnutrition.

b. *Systemic examination:* It consists of examining the various systems like CNS, CVS, RS, alimentary and genitourinary systems to find out systemic diseases if any.

c. *Abdominal examination:* It is done to monitor the progress of pregnancy, fetal growth, fetal lie position, presentation and fetal heart sounds.

d. *Pelvic examination:* It is done in the last check-up to exclude cephalopelvic disproportion.

Antenatal investigations

a. Urine for albumin (to exclude toxemia and urinary infection) sugar (to exclude diabetes). Diabetes during pregnancy is called 'Gestational diabetes (Temporary/Permanent) and microscopy (to exclude urinary infection)
b. Blood for:
   - Hb percent (to know the severity of anemia)
   - VDRL (to exclude syphilis)
   - ABO grouping (to arrange for blood if necessary)
   - Rh typing (to prevent erythroblastosis fetalis)
   - Tridot (to exclude HIV infection)
   - Hepatitis B surface antigen (to exclude HBSAg carrier state).
c. Stools for ova and cyst (to deworm her)
d. Other investigations, if necessary, like scanning, X-ray, ECG, etc.

All the investigations must be done, preferably in the first visit itself and only relevant investigations to be done in the subsequent visits. If there is history of previous birth of a malformed child, certain investigations can be done to detect congenital anomaly *in utero*.

Prenatal diagnosis of congenital anomalies

a. *Alfa fetoprotein:* Detection of a specific protein called alfa-fetoprotein in maternal blood during pregnancy helps to detect neural tube defects, like spina bifida.
b. *Ultrasound:* This helps to visualize the fetus and its congenital anomalies.
c. *Nuchal translucency scan (NT scan):* Nuchal translucency is a collection of fluid under the skin of the neck of the fetus, which measures the thickness of the fluid to assess the risk of Down's syndrome.

The skin of the neck of the fetus appears as a white line and the fluid under the skin will look black. An NT measurement up to 2 mm is normal at 11 weeks of pregnancy and up to 2.8 mm by 14 weeks.

If there is collection of more fluid NT measurement is increased, it indicates the risk for Down's syndrome and other genetic syndromes. Another sign of Down's syndrome is the shape of the nasal bone.

Definitive diagnosis is by amniocentesis and chorionic villi biopsy. However these tests carry a risk of miscarriage.

NT scan is usually advised in primigravida, high-risk pregnancies and pregnant women over 35 years of age.

NT scan is usually performed between 11 to 14 weeks of pregnancy. Before 11 weeks, it is technically difficult and after 14 weeks the excess fluid may be absorbed by the baby's developing lymphatic system.

The results are given in the form of ratio. For example, 1:200 means that out of 200 women who have this risk level, one will have a baby with Down's syndrome. 1:300 is a low-risk case and 1:150 is a high-risk case.

The detection rate is 75 percent. When combined with blood test, the detection rate improves to about 90 percent.

d. *Amniocentesis:* This is to be done only in the second trimester to detect abnormalities like Down's syndrome, neural tube defects (by alpha-fetoprotein), sex determination and RH status of the fetus.
e. *Chorionic villi biopsy:* This is done during 10th week of pregnancy, helps to detect the sex of the fetus and the chromosome status.

These procedures help the parents the option of therapeutic abortion.

Antenatal advice: During pregnancy, mother is very receptive. She constitutes a 'captive audience'. Thus, health education becomes effective. She is advised on the following topics:

On nutrition

- No restrictions in the diet (if she is a normal case)
- Balanced diet should provide 2200 kcals/day
- No food or fruit is abortifacient
- Should consume more of green leafy vegetables
- Should avoid spicy foods because of physiological acidity during pregnancy
- Should gain weight at the rate of 1.5 kg per month, as to get 3.0 kg newborn baby.

On personal hygiene

- Daily bath, not to be very particular about nipples
- Oral hygiene to be maintained
- Should wear clean, light and loose clothes.

On rest and sleep

- 2 hours after lunch
- 8 hours during night.

On exercise

- Light house-hold work can be done
- Walking in the morning and evening is preferred
- Excessive physical labor to be avoided
- *Dance therapy:* Simple graceful, smooth dance movements inspires emotion, reduces stress, keeps the body supple, lowers serum cholesterol level, makes the woman more cheerful, avoids depression, strengthens body muscles, relaxes the mind and thereby facilitates smooth and easy labor.

  It is recommended during second trimester only. Antenatal *yoga* exercises are shown in the pictures **(Fig. 22.1)**.

On drugs

- She should not take any drugs without consulting the doctor (Should avoid self-medication)

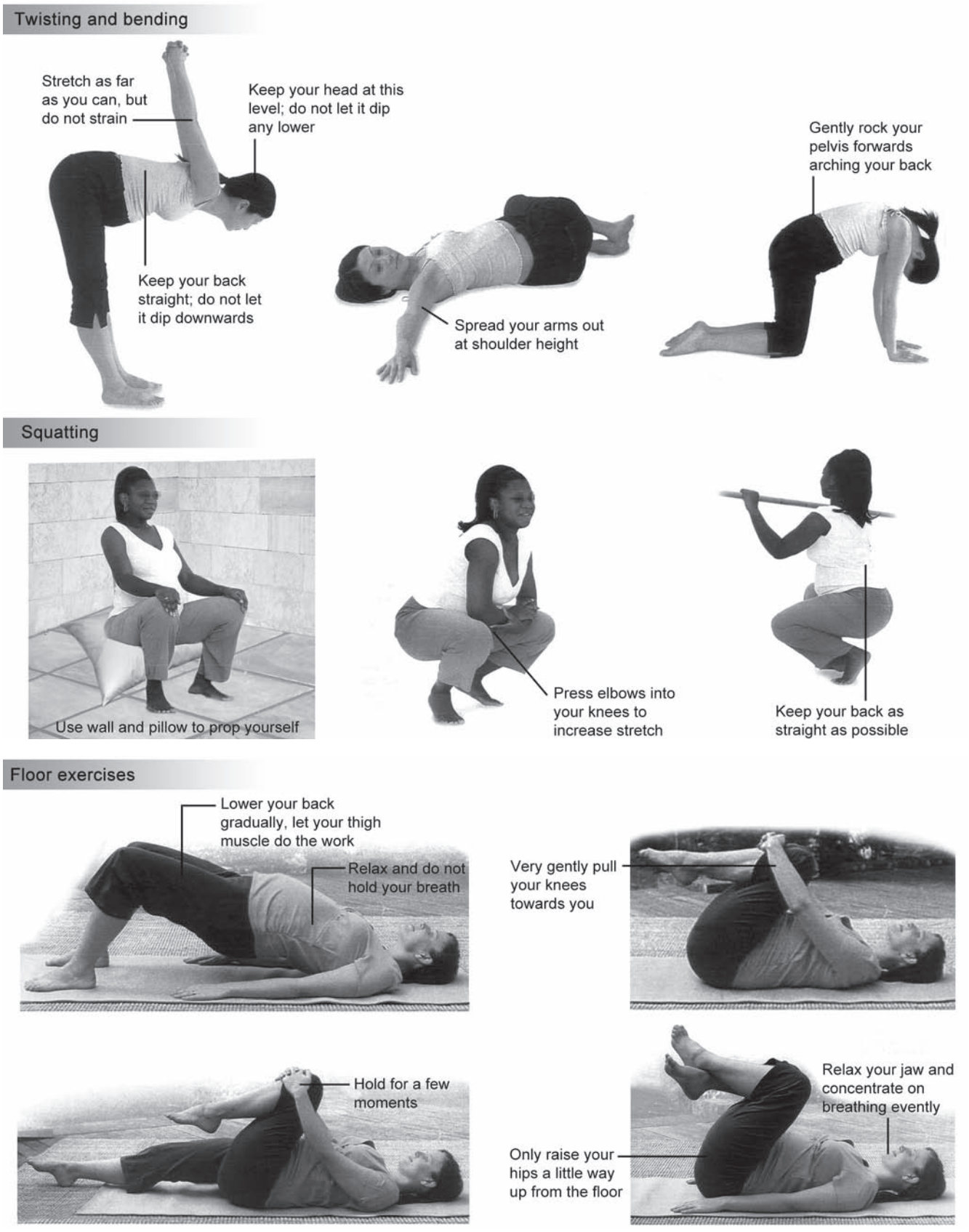


Fig. 22.1 Antenatal *yoga* exercises

- Doctors should not prescribe tetracycline, steroids, LSD, streptomycin, thalidomide, gastric irritants like bruffen, etc. because they affect fetal growth and development
- X-rays to be avoided because of radiation hazards.

On habits: Alcohol and smoking are strictly prohibited because alcohol affects fetal growth and development and smoking results in LBW newborn.

On sexual relation
- Restricted during last trimester
- Prohibited if there is history of miscarriage or premature delivery.
- Can be indulged if position is comfortable and pressure free.

On warning signs
- Mother is adviced to report, if she develops the following signs and symptoms:
  - Bleeding per vagina
  - Blurring of vision
  - Convulsions
  - Loss of fetal movements
  - Severe headache or giddiness
  - Any other unusual symptoms.

Antenatal services: (Rendered by Government of India)
- Nutritional services
- Immunization services
- Medicinal services
- Family welfare services
- Educational services.

Nutritional services: Under the National Program of Integrated Child Development Services Scheme (ICDS) all rural, expectant, malnourished mothers are given a 'Supplementary food' daily, which provides 600 kcals of energy including 20 g of proteins, for 300 days in a year, to prevent malnutrition among mothers, which in turn prevents LBW newborn (Under revised nutritional norms of ICDS).

Immunization services

i. *Against tetanus:* First dose of tetanus toxoid should be given to the mother in the first antenatal visit and second dose after one month. This is mainly to prevent neonatal tetanus. If she has conceived within the 5 years of previous complete immunization, one booster dose of tetanus toxoid is enough. Suppose the mother comes very late in the pregnancy, at least one dose should be given. 'No pregnant mother should be deprived of at least one dose of tetanus toxoid.'

ii. *Against erythroblastosis-fetalis:* If the mother is Rh –ve and the fetus is Rh +ve, mother is given Rh anti-D immunoglobulin during 28th week and 34 week to prevent erythroblastosis-fetalis, (Rh-incompatibility) characterized by congenital hemolytic anemia. If the newborn is Rh +ve, mother is given another dose soon after delivery. One dose should be given after abortion.

The intrusion of Rh +ve fetal red cells in the maternal circulation of Rh –ve mother, provokes an immune response in her, resulting in the production of Rh-antibodies, which can cross the placenta (usually during labor or cesarean section or therapeutic abortion) and produce fetal hemolysis. Since the isoimmunization occurs during labor, usually the first child escapes from the risk, unless the mother is already sensitized by Rh+ve blood transfusion.

The Rh status of the fetus can be detected by 'amniocentesis' for the presence of a pigment called 'bilirubin protein complex', which normally goes on decreasing as the pregnancy advances and goes on increasing in case of erythroblastosis fetalis.

iii. *Against German-measles (Rubella):* Single dose of Rubella-vaccine has to be given to all potential mothers, but it should not be given to a mother during pregnancy, because the live vaccine is attenuated to maternal cells and not to fetal cells. So it may result in congenital rubella, if given to a pregnant mother. Thus, pregnancy is an absolute contraindication.

iv. *Against hepatitis B:* If the pregnant mother is HBSAg negative, she should be given hepatitis B vaccine course. However, it will not provide immunity to the newborn unlike tetanus toxoid.

If the mother is HBsAg positive, hepatitis B vaccine should not be given to her because vaccine does not provide immunity in an already infected person (carrier). The fetus gets the infection from the mother only perinatally at the time of the birth. Since the incubation period of hepatitis B is long (50–150 days) active immunization is given to the newborn as a postexposure prophylaxis with hepatitis B vaccine starting with the first dose within 48 hours of birth followed by rapid schedule (0, 1, 2 and 12 months), each dose of 10 mcg, intramuscularly. However, it is advisable but not mandatory to give passive immunization with hepatitis B immunoglobulin, one dose (alongwith hepatitis B vaccine) but on different site intramuscularly with a dose of 0.05 to 0.07 mL/kg body weight (≈ 2 mL).

Medicinal (supplementation) services

i. Under National Anemia Control Program, the expectant mother is given a pack of 100 IFA tablets during the last trimester, each large tablet contains 100 mg of elemental iron and 500 micro-grams of folic acid, with an instruction to take one tablet a day, after food. This is a prophylactic measure to prevent nutritional anemia. If the mother has visible signs of anemia, she is advised two tablets a day to control anemia.

ii. Anthelmintic drug (mebendazole) should be given once during the second trimester, to deworm her.

iii. If VDRL test is positive, congenital syphilis can be prevented by giving long acting penicillin (Benzathine penicillin 24 to 48 lakhs units) if she is suffering from primary or secondary syphilis.

Family welfare services: If the mother is primi gravida, she is sensitized about different contraceptive methods and if she wants to have a second child, she is motivated for spacing with an IUD after delivery.

If she is second gravida, she is motivated for sterilization.

Educational services: As and when the mother develops any health problem, she is educated about that to take treatment correctly and completely. She is also educated about the art of child care.

Prevention of Mother to Child Transmission of HIV (PMTCT)

Described under epidemiology of HIV/AIDS.

Antenatal clinic: It is a place, where the expectant mothers are taken care of. Such clinics are established in all sub-centers, primary health centers, *taluka*, district and general hospitals. Clinics are conducted once in a week in sub-centers and primary health centers and daily in general hospitals.

The clinic in a subcenter has two rooms—reception room and examination room.

Reception room: Where mother is registered, weight recorded and a card is prepared.

Examination room: Where she is examined and delivery is being conducted.

Functions of antenatal clinic

- To provide antenatal (AN) care for the mothers
- To educate on mother craft and child care
- To detect 'high-risk' mothers
- To refer high-risk mothers to institutions.

Mother craft: This is the art of child care. Special classes are conducted in the AN clinic by the Health Worker Female, for all the expectant mothers of her area, covering a population of about 3000, distributed over 3 to 5 villages and the following topics are taught:

- Physiology of pregnancy and child birth
- Preparation for confinement
- Preparation for breastfeeding
- Preparation of baby clothes by demonstration of sewing and knitting
- Different family welfare methods
- Mother is allowed to talk freely and frankly, so that all her doubts are cleared, thereby the fear borne out of ignorance is removed and the anxiety and tension associated with delivery are also relieved (mental preparation).
- She is educated about breastfeeding practices such as initiation of breastfeeding within half an hour of birth, feeding colostrum, avoiding prelacteal feeds, exclusive breastfeeding up to 6 months and strict prohibition of bottle feeding.

Risk approach: It is an approach toward antenatal mothers to detect 'high-risk' cases, who are responsible for increased maternal morbidity and mortality. They require special institutional care, supervision and treatment.

The high-risk cases are grouped into following four groups:

I group

- Too young a mother (< 18 yr)
- Too old a mother (> 30 yr)
- Too short a mother (< 140 cm height)
- Too obese a mother
- Too many pregnancies (multigravida)
- Too frequent pregnancies
- Too prolonged pregnancy (> 14 days after expected date of delivery)
- Toxemia
- Twins, triplets and hydramnios
- Mother with malpresentation and malposition of the fetus.

II group: Mothers with previous reproductive wastage, such as:

- Abortion
- Stillbirths
- Neonatal deaths
- Monsters.

III group: Mothers with bad obstetric history, such as:

- Instrumental delivery
- Cesarean section
- Prolonged third stage of labor
- Antepartum or postpartum hemorrhage.

IV group: Mothers with systemic diseases, such as:

Diabetes, hypertension, liver disease, lung disease, renal disease, etc.

Such high-risk mothers require meticulous antepartum care and institutional delivery. Thus, 'risk-approach' is a managerial tool for improved MCH care.

Eighty-five percent of expectant mothers will have normal delivery. Fifteen percent require institutional care and only 5 percent (out of 15%) require cesarean section. Thus, pregnancy is a normal physiological process but with a great pathological potential.

Home visits: Home visiting by the Health Worker Female in the rural areas is the back-bone of all MCH services. Since most of the deliveries take place at home, she should pay at least one home visit, eventhough the mother is attending regularly the antenatal clinic. She should observe the environmental and social conditions of the home and prepare to receive the new guest.

Intranatal Care

It means care taken during delivery. This consists of taking care of not only the mother but also the newborn at the time of child-birth.

Objectives

- To promote clean and safe delivery
- To prevent infections (complications) in both the mother and newborn
- To recognize the 'danger signals' and be ready to manage them
- To take immediate and essential care of the newborn at birth
- To reduce infant mortality rate and maternal mortality rate.

Clean and Safe Delivery

Means preventing or minimizing injury to the mother at the time of birth. The traditional birth attendant (TBA) (*Dai*), who conducts the delivery at home in rural areas is trained to conduct safe delivery with good perineal support without episiotomy to prevent lacerations of the perineum. Episiotomy is given only in institutional deliveries. The room where delivery is conducted should be clean, dust free and warm. Clean delivery means conducting delivery under aseptic precautions and safe delivery means causing minimal damage to the mother.

Prevention of Infections

She is also trained to conduct clean and safe delivery by observing 'five cleans':

- Clean hands
- Clean surface
- Clean razor blade
- Clean ligature
- Clean cord-stump.

To observe these 5-cleans, the mother, during the last antenatal check-up, is given a 'disposable delivery kit' (DDK) by the Health Worker Female, with an instruction to be opened by TBA only at the time of delivery.

Observing 5-cleans, helps to conduct delivery under aseptic precautions, which will prevent infections like neonatal tetanus, ophthalmia neonatorum and puerperal sepsis, thereby reducing IMR and MMR.

Contents of DD kit

- Gauze piece (7.5 cm × 1 m) - 1 No.
- Ligatures - 2 No.
- Razor blade (ISI) - 1 No.
- Soap (10 g) - 1 No.
- Antiseptic lotion - 10 mL
- Cotton - 10 g
- Chloramphenicol applicap - 2 Nos.

All these contents are placed in a plastic bag, sealed and sterilized by gamma radiation. The other variant of DDK is '*Suraksha*', which contains first four items only.

Danger signals at the time of delivery are:

Maternal Signals

- Obstructed labor (Good pains but no progress)
- Sluggish labor pains for more than 24 hours
- Bleeding during labor
- Convulsions
- High temperature
- Placenta not separated even after 30 mt of delivery (i.e. prolonged third stage of labor)
- Collapse of the mother.

Fetal Signals

- Meconium stained liquor amnii
- Sudden change in fetal heart rate (< 120 or > 160/min)
- Prolapse of umbilical cord or hand.

Mothers with normal obstetric history can have their delivery at home with the help of trained *dai* or Health Worker Female. This is known as 'Domiciliary Midwifery Service'.

Use of Partograph in the Management of Labor

A partograph is a graph/record which helps in the early detection of obstetric emergencies, such as obstructed labor (good uterine contractions but no progress) and prolonged labor (cervix dilates slowly and incompletely) which contribute significantly to fetal mortality and about 10 percent of maternal mortality.

Recording the partograph during labor helps in the identification of women who are not likely to have a normal delivery and who need medical assistance thereby transferring them to a hospital in time from the peripheral health institution. Recording partograph is one of the components of training the Traditional Birth Attendants (TBA) to provide a better quality of intrapartum care, to reduce the fetal and maternal mortality thus helping to achieve better maternal and infant salvage.

The graph has the following sections **(Fig. 22.2)**:

a. Fetal heart rate
b. Cervical dilatations and descent of head
c. Uterine contractions
d. Maternal condition
e. Drugs and IV fluids given
f. Temperature, pulse, BP
g. Urinary findings.

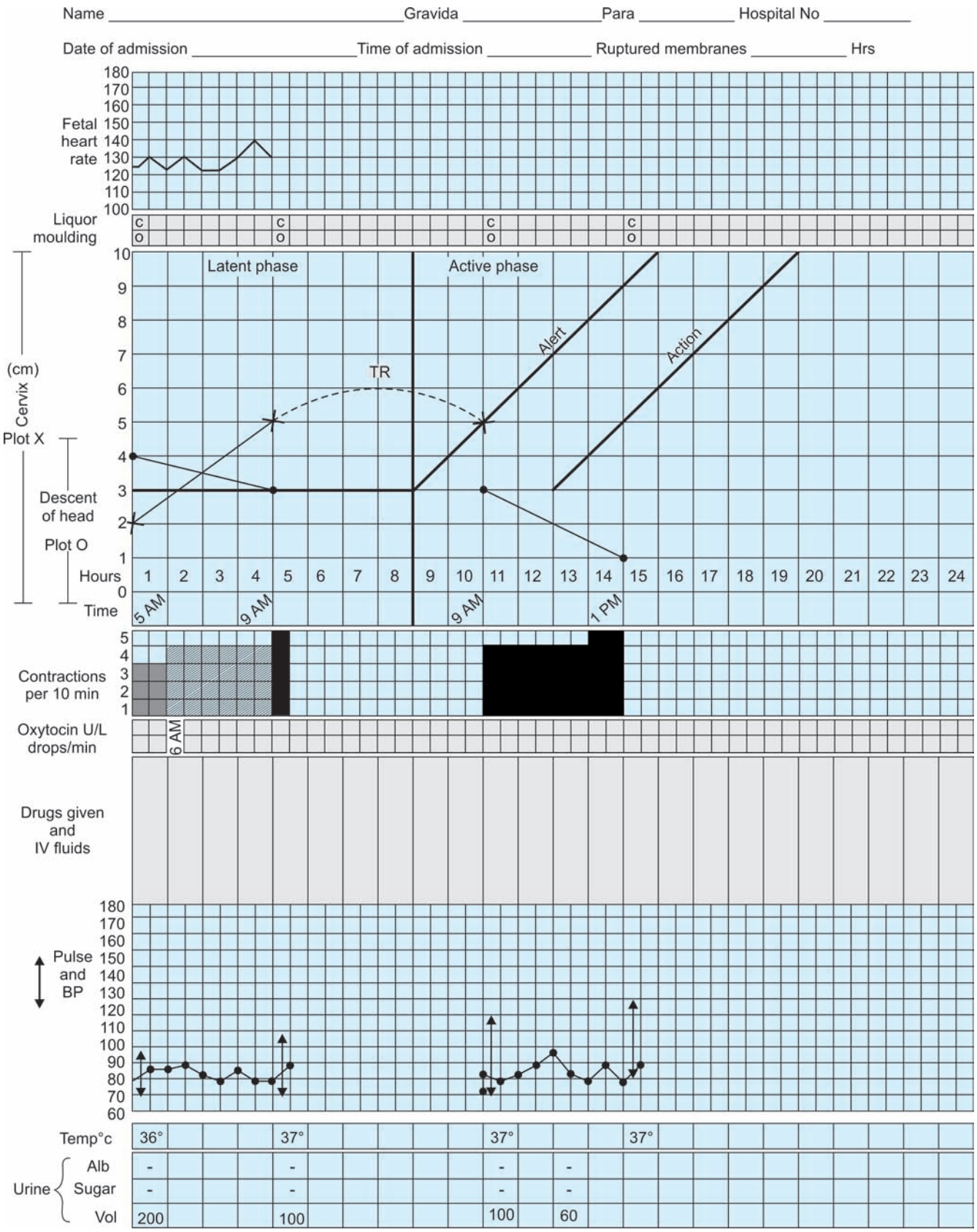


Fig. 22.2 The partograph

Source: Miriram stoppard. New pregnancy and birth. Revised edn. published by Dorling Kindersley, London, 2009.

Partograph should be started after checking that there are no complications of pregnancy requiring immediate action.

a. *Fetal heart rate*: This is recorded every 30 minutes and is plotted as a line graph. Each box on X-axis represents half an hour (Horizontal axis). The lines 120 and 160 are darker indicating the limits of the normal fetal heart rate. A rate above 160/min (tachycardia) and below 120/min (bradycardia) is a sign of fetal distress and therefore action should be taken. Below 100/min is a sign of very severe distress and immediate action should be taken.

b. *Cervical dilatation*: Normally it takes about 8 hours for the cervix to dilate to 3 cm. Subsequently, it dilates at least 1 cm every hour. Full dilatation is 10 cm.
   - Latent phase (Period of slow cervical dilatations)
     To start with cervix dilates slowly from 0 to 3 cm with gradual shortening. Normally, this phase should not take longer than 8 hours.
   - Active phase (period of faster cervical dilatation)

   During this phase cervix dilates faster, from 3 to 10 cm (full dilatation) at the rate of 1 cm per hour.

   The first per vaginal examination is done on admission. Then done once in four hours under aspectic precautions. However, in multiparous women, assessment can be done more often since the duration of labor is shorter.

   Under field conditions, the health worker should be advised to avoid PV examination to prevent infection, unless absolutely necessary and to refer the woman to the hospital if she has not delivered in 12 to 13 hours after the commencement of pains.

   The horizontal X-axis represents time, each square box one hour. There are 24 such boxes. The vertical Y-axis represents cervical dilatations, numbered 0 to 10, each box representing 1 cm dilatation. The dilatations are plotted as 'X' against the time in the appropriate square. When labor proceeds from latent to active phase, plotting is also transferred to the active phase by a broken line, as shown in the **Figure 22.2**, i.e. to the right of ALERT line.

   For example, a patient was admitted at 5 am with 2 cm dilatation. It is marked as 'X' at 2 on Y-axis and recorded as 5 am on X-axis.

   After 4 hours, PV examination is done at 9 am. The dilatation was found to be 5, it is marked appropriately, that means now she is in the active phase and therefore plotting is transferred to the right side of the ALERT line with a dotted line.

   Third observation was made again after 4 hours at 1 pm. Cervical dilatation was found to be 10 and marked appropriately and the line is joined.

   Inference
   - Progress of the dilatation is normal.
   - Duration of first stage was 8 hours (5 am to 1 pm).
   - Delivery of the baby could be expected at any time before 3 pm. In the present case, a live female baby was born at 1.10 pm.
   - *Descent of the head*: This should always be assessed by abdominal examination immediately before doing PV examination. It is generally accepted that the head is engaged. It is plotted as '0' on the same part of the graph indicating cervical dilatation, but the line moves from 5 to 0.

c. *Uterine contractions*: The frequency of uterine contractions is assessed by the number of contractions in 10 minutes period. The duration of each contraction is also noted.

   Below the time line there are 5 squares along the Y-axis, each square representing one contraction. Contractions are recorded every hour in the latent phase and every half hour in the active phase. If there are two contractions in 10 minutes, two squares are filled. If the duration lasts for 20 seconds or less, the squares are filled with dots, if between 20 to 40 seconds by diagonal lines and if more than 40 seconds, squares are filled completely.

   In the above example, the woman had three contractions in 10 minutes, each lasting for less than 20 seconds. So filled with dots. After 1 hour (at 6 am), she had three contractions in 10 minutes, each lasting for about 26 seconds. So three squares are filled with lines.

   At 7 am the frequency of contractions increased to 4 in 10 minutes. Duration remained same as at 6 am. This is depicted on the graph by filling four squares with lines.

   At 9 am the frequency had remained same, i.e. 4 in 10 mts, but the duration was increased to above 40 seconds, which is marked by filling four squares completely. Since at 9 am, labor is in active phase, observations are made every half hour.

   At 12 noon, the frequency of contractions increased to 5 in 10 minutes and the duration remained above 40 seconds for each contraction. This is recorded by completely filling five squares.

d. *Maternal condition*: This is checked by recording (plotting) pulse rate half hourly, blood pressure fourth hourly, temperature fourth hourly and urine for albumin and sugar and for volume 2 to 4 hourly. Blood pressure and temperature to be recorded more frequently if indicated. Drugs and IV fluids given are also recorded.

Advantages of Domiciliary Care

- Familiar environment to the mother
- No chances of cross infection
- Mother can supervise the domestic affairs simultaneously
- No mental tension.

Disadvantages

- Absence of medical and nursing supervision
- Mother resumes back to her duties very soon
- Rest is less
- She may neglect her diet.

Eventhough pregnancy and child-birth is a normal physiological process, it is associated with great pathological potential. Therefore, institutional deliveries are preferred.

Advantages of Institutional Care

- All high-risk cases can be managed
- Medical and nursing supervision is constantly available.

Disadvantages

- Cross-infection can occur
- Associated with tension.

As the child is born, immediate care is taken—discussed under 'Services to the Children'.

Postnatal Care

This includes taking care of the mother after delivery and also the newborn.

Objectives

- To promote speedy recovery of the mother physically and psychologically
- To prevent the development of postnatal complications
- To check the adequacy of breastfeeding
- To provide family welfare services
- To provide care of the newborn
- To reduce IMR and MMR.

Promotion of speedy recovery physically: This is necessary because of stress and strain the mother had undergone during pregnancy and delivery.

It is done by:

- Regular postnatal check-up
- Postnatal advice.

i. *Postnatal check-up:* After delivery, the mother is examined regularly and periodically twice daily for first 2 days and then once daily for one week. At each of these examinations, seven things must be positively looked for, i.e. temperature, pulse, respiration, blood-pressure, breast, abdomen and perineum. Increase in first three (TPR) indicates infection (Puerperal sepsis). Breast to be examined for engorgement and tenderness, position of the nipple and cracks or sore nipple. Abdomen for assessing the involution of uterus and for tenderness. Perineum to be examined for the nature of the lochia and episiotomy wound if any. Normally, the lochia will be reddish during first 4 days (Lochia rubra), pale red during next 4 days (Lochia serosa) and whitish during last 4 days (Lochia alba). Foul smelling lochia with yellowish color indicates infection of the genital tract (puerperal sepsis).

ii. *Postnatal advice:* It is given on the following points:

On nutrition:

- No restrictions in the diet except for first 2 to 3 days
- Balanced diet should provide 2,500 kcals of energy per day (She should consume nearly 1 ½ to times the regular food).

On rest and exercise: Since she has undergone stress and strain, she must take absolute rest on the first day and from the second day onwards she must be up and about.

Postnatal *yoga* exercises after a few days, helps in restoration of the tone of the stretched abdominal and pelvic muscles; she can resume back to routine house-hold activities gradually **(Fig. 22.3)**.

On personal hygiene: She must maintain a high standard of personal hygiene by daily bath. She must not be too much concerned to use soap to the nipple because it may predispose for sore-nipple. Perineum must also be clean.

On sexual relation: She can resume, preferably after 6 weeks of delivery.

Promotion of Speedy Recovery Psychologically

This is necessary because a recently delivered mother will have anxiety, tension and a sort of fear complex borne out of ignorance. To remove this and to build up confidence in her, she is allowed to talk freely, frankly and freshly before the health personnel to solve all her problems, confusions and doubts about taking care of the child.

Prevention of the Development of Postnatal Complications

The dreaded postnatal complications are puerperal sepsis, thrombophlebitis and postpartum hemorrhage. The minor complications are mastitis, urinary infection, etc. Three major complications constitute important causes increased MMR in India.

Puerperal sepsis: This is an infection of the reproductive organs, acquired after an abortion or during labor, (delivery) or within 6 weeks (42 days) of delivery (i.e. postpartum period). This is a serious condition, as it can spread rapidly due to increased vascularization of the pelvic organs at the time of delivery.

Clinically, it is characterized by high fever, severe pain and tenderness of the lower abdomen, foul smelling yellow colored lochia, often leading on to septicemia, shock and death.

Other complications of puerperal sepsis are pelvic and general peritonitis, renal failure, coagulation failure and multiple septic emboli.

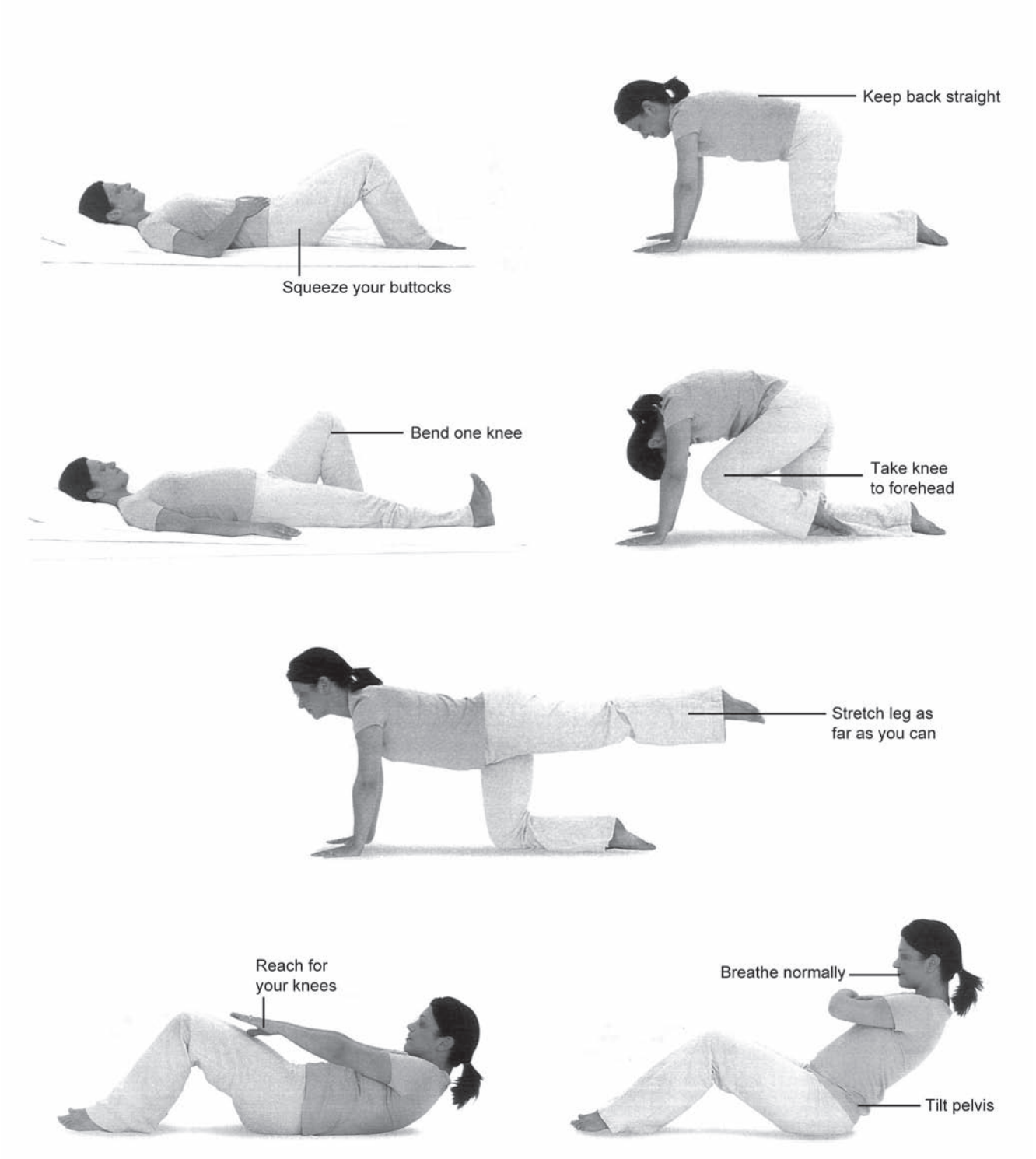


Fig. 22.3 Postnatal *yoga* exercises

Usually, it is due to lack of aseptic precautions while conducting delivery and lack of perineal hygiene after delivery. It can also occur after prolonged labor or in complicated deliveries. The risks of infection are also high if labor does not begin within 12 hours after the rupture of the membranes. The risk still increases if vaginal examination is done in this stage. Prolonged third stage is another cause of puerperal sepsis.

This can be prevented by observing 5 cleans (aseptic precautions) while conducting the delivery at home and maintenance of high standard of personal hygiene after delivery.

Thrombophlebitis: This is the infection of the deeper veins of the legs, characterized by high fever, painful swelling of the legs, tender legs, severe pain on movement of the legs, often may result in embolism.

Usually it is due to immobilization of legs, following absolute bed-rest after delivery.

This can be prevented by encouraging early ambulation of the mother, on second day after delivery.

Postpartum hemorrhage (PPH): Certain amount of bleeding per vagina does occur after delivery. The term hemorrhage is used, if the bleeding is more than 500 mL after birth. PPH is of two types—primary and secondary.

1. *Primary PPH:* It is called primary PPH if hemorrhage occurs within 6 hours of delivery. This could be from uterus or lacerated cervix or vagina. If it is from the uterus, it is usually due to atonia of the uterus or retained placenta (Placenta is said to be retained if not delivered within 30 minutes after the birth of the child). Atonia of uterus is managed by giving inj. ergometrine, bimanual compression of the uterus and blood transfusion. Lacerations of the cervix or vagina is managed by putting stitches followed by good pack of vagina with sterile gauze-piece and blood transfusion.

Atonia of the uterus cannot be prevented. However, administration of misoprostol (oral prostaglandin) can prevent PPH due to uterine atony.

2. *Secondary PPH:* It is called secondary PPH, if hemorrhage occurs after 6 hours of delivery (between 5th and 10th day). Usually it is due to retention of bits of placenta and often it is followed by puerperal sepsis.

This is managed by exploration and evacuation of uterus under general anesthesia. This can be prevented by careful, correct and complete removal of the placenta.

Minor complications like mastitis can be prevented by expression of milk as soon as there is breast engorgement and urinary infection can be prevented by personal hygiene of the perineum.

To Check Adequacy of Breastfeeding

This is necessary because most of our mothers think, whenever the child cries, that she is not secreting sufficient milk for the baby and very soon she will start external feeds. The adequacy of breastfeeding can be checked by asking the mother how many times the child is passing urine per day. If the child is on exclusive breastfeeding and passes urine about 8 times per day that means mother is secreting adequate amount of milk.

To Provide Family Welfare Services

This is most essential for our country. If it is the first delivery and the mother wants a second child, she must be motivated for spacing by IUD method, so that she can have a gap for at least 3 years. Copper T is fitted about 6 weeks after delivery. If the mother was taking oral pills before, she will have a tendency to take pills. She must be warned not to take pills, as it suppresses lactation. Progesterone only pills or injections can also be given but not recommended because of side effects like irregular bleeding and prolonged infertility.

If it is second delivery or third, she is motivated for permanent method, i.e. sterilization.

Birth spacing

A health measure: The risk of maternal complications and perinatal deaths increase if the pregnancies are frequent and closely spaced, because of depletion of maternal reserve of iron, calcium and other essential micro-nutrients.

- Prevents maternal depletion
- Promotes general health of the mother
- Promotes the health of the child
- Reduces the maternal morbidity and mortality
- Reduces the incidence of low birth weight
- Reduces perinatal and infant deaths.

To Provide Care of the Newborn

The mother is informed about the following:

- Scientific practices of breastfeeding
- Periodical immunization
- Growth monitoring.

ESSENTIAL AND IMMEDIATE CARE OF THE NEWBORN

This is important because the newborn is highly susceptible and if care is not taken, it will die. Nearly 66 percent (2/3) of all infant deaths occur in the neonatal period (first 28 days of birth) and among these nearly 66 percent (2/3) die in the first week of the birth and 66 percent (2/3) of these, die within first 24 to 48 hours. This is called 'Rule of 2/3'. Most of these deaths are preventable, provided essential care is taken as soon as it is born.

Objectives of the Neonatal Care

1. To provide immediate and essential care of the newborn.
2. To prevent neonatal complications such as infections, hypothermia and birth asphyxia.
3. To educate the mother about 'danger signs' of the newborn.
4. To detect 'at-risk' newborns and give them special attention.
5. To promote growth and development.
6. To educate the parents to shower on the newborn love and affection and to provide security.
7. To reduce perinatal and early neonatal mortality rate.

Essential care of the newborn consists of taking care of eyes, nose and throat, umbilical cord, rectum and skin of the body.

Care of the Eyes

As soon as the head is delivered, eyes are wiped clean with sterile, wet, cotton-swab or gauze-piece, wiping gently from medial to lateral side, using separate swabs for separate eyes. Then 1 drop of 1 percent silver-nitrate solution is instilled in the eyes to prevent conjunctivitis and ophthalmia neonatorum. Any discharge from the eyes of the newborn is pathological.

Care of the Nose and Throat

Then the nose and mouth are wiped clean with separate sterile gauze piece, which will help to establish and maintain cardiorespiratory function by making the air way clear. As the baby cries, lungs expand and child starts breathing.

Most of the newborns cry spontaneously.

Care of the Umbilical Cord

Soon after birth, the cord is still pulsating and it will continue to pulsate for few more minutes. That means the baby will continue to get some more blood from the mother even after birth till the pulse ceases. Then the cord is squeezed toward the child, so that it gets some more blood.

Then the cord is tied with a clean ligature. The first knot is put about 2½″ from the umbilicus. Then a second knot is put with an another ligature about 1″ beyond the first knot toward the placenta. It is ensured that these knots are tight.

Then the cord is cut between the knots with a clean razor blade.

Cord-stump should be inspected again after few minutes to ensure that there is no bleeding. No medication should be applied at the umbilical stump and no dressing is necessary. Thus cord stump is left clean. It dries by aseptic necrosis and falls off after about a week.

Care of the Rectum

Then the patency of the anal canal is ascertained. The meconium is made to expel by inserting the little finger with gloves into the rectum for about half an inch. This helps to exclude 'imperforate anus', a congenital defect, which constitutes a surgical emergency.

Care of the Skin

Then the body of the baby is wiped clean with a clean, dry cloth from head to toe so that the skin is made free from meconium, vernix and blood clots. The baby is then wrapped with a dry, warm cloth to prevent the heat loss and to keep the baby warm. Head is also covered.

Recording of delivery notes: This consists of recording the following details of the delivery:

- Date and time of delivery
- Place of delivery (Institution or home delivery)
- Person who conducted the delivery (trained or untrained)
- Nature of delivery (normal, difficult or cesarean section)
- Sex of the child
- Whether cried soon after birth or not
- Whether the placenta was healthy, totally expelled and had any congenital defects
- Birth weight of the newborn (within one hour of birth)
- Other anthropometric measurements such as length, circumference of head and chest
- Any obvious congenital defects seen in the newborn.
- Lastly 'APGAR' score of the newborn is recorded considering signs such as color, heart rate, respiratory effort, muscle tone and reflexes **(Table 22.1)**.

Table 22.1 APGAR score

Sign	Score		
	0	1	2
Color	Blue	Body pink extremities blue	Completely pink
Heart rate	Absent	<100	> 100
Respiratory effort (cry)	Absent	Slow and irregular (feeble cry)	Good cry
Muscle tone (Movements of limbs)	Flaccid	Sluggish	Active
Reflex response	No response	Grimace	Good (cry)
Grading	Severe depression 0-3	Mild depression 4-6	No depression 7-10

A newborn with Apgar score less than 5 is an 'at-risk' newborn and needs immediate special attention.

Then the baby is given to the mother for breastfeeding. Breastfeeding must be initiated within ½ an hour to 2 hours after birth. If the child is born by cesarean section, feeding can be postponed till the mother recovers from anesthesia. (i.e. for about 4 hours).

Bedding-in: Keeping the baby's crib near the mother's bed is called 'Rooming-in'. This gives an opportunity for the mother to know her child. But best thing would be to keep the newborn on the mother's bed only so that the child is in close physical contact with the mother all the time and is kept warm. This is called 'warm chain'.

Prevention of Neonatal Complications

Such as infections, hypothermia and birth asphyxia.

Prevention of neonatal infections: The newborn is highly susceptible for infections which can be prevented by the following measures:

- By keeping the delivery room clean, warm and dust free.
- By observing aseptic precautions (5-cleans at home) while conducting the delivery.
- By providing immediate and essential care of the newborn.
- By initiating of breastfeeding within half an hour of birth
- By avoiding prelacteal feeds and bottle feeding
- By avoiding handling of the newborn by sick persons
- By handling of the newborn by barely minimum number of persons
- By immunization of the newborn with OPV, BCG and hepatitis B vaccines.
- By providing special care of the 'at risk' newborns.

Prevention of hypothermia: Thermal range in the newborn is shown in **Figure 22.4**.

Hypothermia in the newborn is commonly due to lack of awareness and knowledge about the importance of maintenance of body temperature than due to lack of equipment.

The newborn is at risk for hypothermia because of the following factors:

- Relatively large body surface area
- Lack of hairs and subcutaneous tissue
- Increased insensible water loss due to thin skin
- Lack of thermal control mechanism
- Predisposition for sepsis, hypoglycemia, etc.
- Heat loss is more than the heat production
- The difference between the temperature of the mother's womb and the external environment varies widely from 10 to 20°C.

Importance: Hypothermia leads to multisystem damage with serious consequences and death. Most of these deaths are preventable.

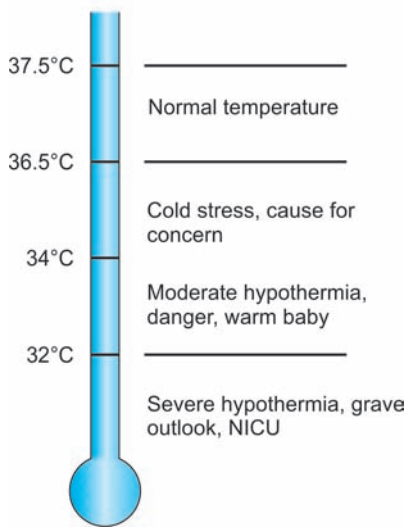


Fig. 22.4 Thermal range in a newborn

A child with hypothermia feels cold to touch. It becomes lethargic and refuses feeds. Hypothermia is an emergency. It must be managed promptly by keeping the child 50 cms under a burning 200 watts bulb. If the child does not improve within 30 to 45 minutes, it is referred to a health facility with intensive neonatal care using the quickest mode of transportation. Mother must be advised to keep the baby wrapped with warm cloth and close to her body during transport.

Hypothermia can be prevented by the following measures:

- By keeping the delivery room warm
- By avoiding bath soon after birth
- By giving bath after one week of birth
- By wrapping the baby with a clean, dry and warm cotton cloth, after cleaning the body
- By covering the head also
- By maintaining 'warm-chain' by encouraging 'bedding in' and by Kangroo mother care in case of LBW baby.

Prevention of birth-asphyxia: If the baby does not cry within 15 to 20 seconds after birth and looks blue, that means air-passage is blocked with secretions. This is called 'birth-asphyxia'. It is an acute emergency case. Every moment of delay increases the risk to the baby. Therefore, it has to be managed actively and energetically.

Management: The neck is hyperextended by 30° by placing a folded towel below the neck and air passage is cleared by using mucus extractor or by using suction apparatus (rubber catheter connected to suction apparatus). Meanwhile, the soles are flicked with fingers. If it does not cry or breath, assisted ventilation is initiated by giving controlled 'mouth to mouth' breathing with short puffs and not with deep inspiration. If resuscitation bag and mask is available, that is preferred. A gauze piece is put over the nose and mouth to

avoid droplet infection. Blowing with full force may damage baby's lungs resulting in pneumothorax. The artificial respiration is continued till the child becomes pink and breathes on its own.

If it fails to breath on its own, then resuscitation becomes necessary with oxygen.

If the heart rate fails to raise above 80 per min, external cardiac massage is indicated, continuing with assisted ventilation. If the heart rate continues to be less than 80/min, inspite of massage and assisted ventilation, then 0.25 mL of adrenaline inj may be given subcutaneously.

Danger Signs of the Newborn

Every mother must be educated about 'danger-signs' of the newborn. These are:

- Refusal of feeds
- Increased drowsiness (lethargy)
- Cold to touch
- Difficult or rapid breathing
- Convulsions
- Persistent vomiting
- Jaundice at birth
- Blue coloration of the extremities.

At-risk Newborns

These are the newborn babies, which are at a very high risk of dying, due to underlying 'risk-factor', contributing significantly to neonatal mortality rate, thus to infant mortality rate. Such newborns require meticulous care. Detection and care of such 'at-risk' newborns is one of the objectives of 'care of the newborns', under the National RCH Program (Reproductive and Child Health Program).

These 'at-risk' newborns are:

- Low birth weight (LBW) babies
- Birth asphyxia
- Birth injury (following instrumental delivery)
- Loss of mother
- Loss of mother's milk
- Born within 2 years of previous birth
- Loss of previous subling/s
- Illegitimacy
- Birth order of 5 and above
- With congenital defect/disease
- Born to hypothyroid mother
- Born to unimmunized mother with tetanus toxoid during pregnancy
- With jaundice at birth
- Born to infected mother with hepatitis B, HIV, syphilis, tuberculosis, etc. (infected newborn)
- With 'Apgar score' less than 5.

Care of the 'At-risk' newborn

- *Born to hypothyroid mother:* Congenital hypothyroidism or neonatal hypothyroidism leads to serious sequelae like mental retardation, which can be prevented by giving thyroxine within 1 to 2 months of life.
- *Born to unimmunized mother with tetanus toxoid:* The neonatal tetanus can be prevented by giving passive immunization with one dose of human tetanus immunoglobulin, soon after birth followed by regular DPT immunization commencing from 6th week onward.
- Born to syphilitic mother (If VDRL positive mother is not treated during pregnancy)

  Since clinical signs of congenital syphilis often do not occur at once, it is recommended to give 24 to 48 lakhs of units of Benzathine penicillin to the newborn in divided doses.
- *Born to HIV positive mother:* Described under epidemiology of HIV/AIDS.

  However, BCG vaccination in such newborns is contraindicated. This is only feasible at the end of several months, when the maternal HIV antibodies are completely eliminated from the child.
- *Born to hepatitis B positive mother:* Transmission of HBV takes place during perinatal period. The risk of transmission is 20 percent if mother has only surface antigen and it is 90 percent if she has e-antigen also. If the newborn is infected, there is a risk of becoming a carrier or developing chronic hepatitis, cirrhosis or primary hepatocellular carcinoma during adulthood. Since the incubation period of hepatitis B is long (50 to 150 days) one dose (i.e. zero dose) of 10 mcgm of hepatitis B vaccine is given within 24 to 48 hours of birth, followed by rapid schedule. (0, 1, 2 and 12 months with booster doses once in 8 years). However, it is recommended but not mandatory, to give one dose of hepatitis B-immunoglobulin also (passive immunization) along with zero-dose of HB vaccine. This prophylaxis has proved effective.

LOW BIRTH WEIGHT BABY

Definition

According to WHO, a newborn is said to have low birth weight (LBW) if it weighs less than 2500 g within 1 hour of birth, irrespective of the gestational age (because after one hour of birth it starts loosing weight, i.e. postnatal weight loss for 2 to 3 days and afterwards it starts gaining weight) and according to Indian scientists birth weight of 2 kg or less is considered as the criteria to call LBW, because of the widespread prevalence of maternal malnutrition.

Grading

Grading of the newborn as per birth weight.

Birth weight	Grade
> 3500 g	Obese
3500–2500 g	Normal birth wt (Av = 2.7 to 2.9 kg)
2500–2000 g	LBW
2000–1000 g	Very low birth weight
< 1000 g	Extremely LBW

Determinants of Birth Weight

Birth weight is determined by two processes:
1. Length of pregnancy period (gestation period)
2. Intrauterine growth rate.

Accordingly there are two types of LBW babies:
1. Preterm baby
2. Small for date baby.

Preterm Baby

Preterm baby is the one, born after 28 completed weeks and before 37 completed weeks of gestation, i.e. between 196 to 259 days. Normal gestation period is 40 weeks = 280 days). The intrauterine growth for that pregnancy period is normal but since it is born before 37 completed weeks, it is also called as 'premature baby'. This occurs in 30 percent of all LBWs in India. If care is taken, such a child will catch up the growth and will be normal within 2 years.

Small for Date Baby

Small for date baby (SFD baby) is a newborn, which is smaller and lighter than what it should have been for that pregnancy period due to failure in the intrauterine growth. This may be born preterm or after full term. This occurs in 70 percent of all LBWs in India.

Synonyms

Light for date, intrauterine growth retardation (IUGR), placental insufficiency syndrome, pseudoprematurity.

Thus, LBW can result either from preterm or from IUGR or from both.

Problems of LBW infant: Illustrated in **Figure 22.5**.

Importance

- Birth weight is the single most important determinant for the survival, growth and development of the infant

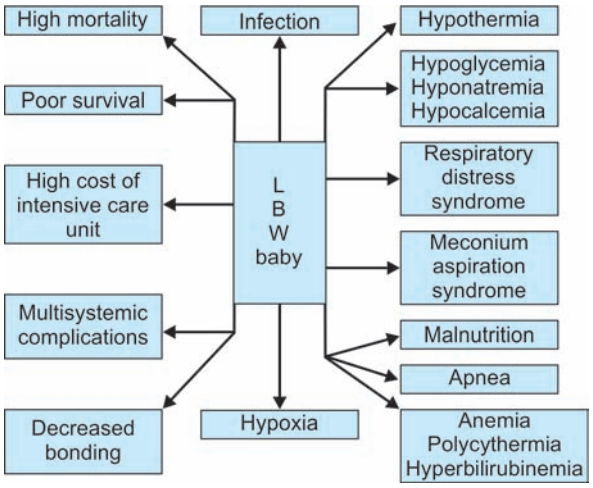


Fig. 22.5 Problems of LBW infant

- Thus, survival chances of a newborn is directly proportional to the birth-weight (Lower the birth-weight, lower the chances of survival and vice versa).
- Birth-weight reflects the health status of the mother during adolescence and pregnancy and also quality of antenatal care.
- Since LBW newborn is highly susceptible for complications, like infections and hypothermia, the incidence of LBW contributes significantly for increased morbidity and neonatal mortality rate, thus infant mortality rate in our country.
- Care of such LBW babies is of very high cost and requires intensive care unit, but still recovery rate is low
- Mortality rate is 20 times higher among LBWs than their healthy counterpart (full term babies).
- LBW causes considerable human wastage and suffering.
- About 50 percent incidence of LBW is preventable.

Because of these reasons a LBW baby constitutes an 'at-risk' newborn.

Computation of Low Birth Weight

The extent of the problem of LBW is calculated as the percentage of total livebirths weighing less than 2500 g at birth, in a given area, during a given year.

(%) Proportion of LBW =

$$\frac{\text{No. of newborns with birth weight}}{\text{Total no. of livebirths}} \times 100$$

Magnitude of the Problem

As per WHO criteria, the incidence of LBW in India is 33 percent each year (varies from 30–40%) and as per Indian

scientists, it is only 5.5 percent, because that cutoff point is lower than that of WHO criteria. In China and Canada as per WHO criteria, it is 6 percent, in USA and UK it is 7 percent and in Iran and Mexico, it is 12 to 14 percent. Incidence of LBW in India is highest in the world. LBW is a global problem particularly in developing countries. Approximately 25 million LBW babies are born every year all over the world. Out of which nearly 5 million die globally and nearly 1 million in India alone. LBW babies therefore represent a burden for the health and social systems globally.

Causes

In nearly 50 percent of the cases of LBW, the cause is not known. In remaining 50 percent, the causes are grouped into 2 blood groups—medical causes and social causes.

Medical Causes

These are further divided into three subgroups, namely maternal, placental and fetal causes.

i. *Maternal causes*: Are all 'high-risk' mothers except diabetic mothers.
ii. *Placental causes:* Placental insufficiency, placenta-previa, premature separation of placenta, congenital defects of the placenta.
iii. *Fetal causes*: Twins, triplets, quadruplets (i.e. multiple, gestation). Hydramnios, dwarfism, fetal abnormalities (with congenital defects), intrauterine infections, chromosomal abnormalities.

Social Causes

These are poverty, illiteracy, ignorance, poor standard of living, lack of knowledge on FP, early marriages, smoking and/or strenuous work during pregnancy. These occur as maternal causes.

Related Terms

- *Preterm baby:* Born after 28 completed weeks of pregnancy and before 37 completed weeks (between 196 to 259 days).
- *Term baby:* Born after 37 completed weeks and before 42 completed weeks (between 259 to 294 days). Normal gestation period is 40 weeks = 280 days.
- *Post-term baby (Postmaturity):* Born after 42 completed weeks of pregnancy (after 294 days).

Care of Low Birth Weight Babies

Depends upon the birth weight.

- Babies above 2500 g birth weight—require normal care at home.
- Babies between 2500 g and 2000 g birth weight—require special care at home.
- Babies less than 2000 g birth weight—require intensive neonatal care in the hospital (incubator)
- Babies less than 2000 g and more than 1800 g and stable hemodynamically—require Kangaroo mother care (Described later).

Normal Care at Home

- By essential care of the newborn
- By all measures to prevent infections, hypothermia and malnutrition (already explained).

Special Care at Home

(for LBW between 2500 g and 2000 g)

Principles

- Prevention of infections
- Prevention of hypothermia
- Correction of malnutrition.
- *Prevention of infections:* By the following precautions. This is important because infections become sudden and severe.
  - Gentle handling, minimum handling
  - Handling with clean hands, no handling by sick persons
  - Handling by minimum number of persons
  - Room must be warm, clean and dust-free
  - Immunization to be given right in time.
- *Prevention of hypothermia:*
  - Bath is not given till it gains 2500 g weight.
  - Wrapped with clean dry and warm cotton cloth. Cover the head also except face and body is covered with blanket to prevent heat loss
  - Bottles filled with warm water and covered with thin cloth are kept on either side of the newborn or baby without blanket is kept near 60 candle bulb burning.
- *Correction of malnutrition:*
  - Since a LBW baby cannot suck mother's milk actively, it gets tired faster. So frequent breastfeeding must be given, almost every alternate hour.

Special Care in the Hospital (Intensive Neonatal Care)

- *Prevention of infections:*
  - Prophylactic antibiotics to prevent septicemia.
  - Task nursing (separate nurses for feeding and for attending to the toilet.
  - Barrier nursing to prevent cross-infection.
  - Expert nursing care is of supreme importance.
- *Prevention of hypothermia:* The child is kept in the incubator, which maintains the temperature, humidity

and oxygen supply, till the child's weight increases to 2000 g. If oxygen supply is more, the oxygen level in the blood increases leading on to 'retrolental fibroplasia' (Retinopathy of prematurity) and if oxygen supply is less, it leads to hypoxia and cerebral palsy. Therefore, monitoring of O_2 supply is done carefully. Lower the birth weight, greater is the risk of development of ROP and blindness.

- *Prevention of malnutrition:* Since the newborn is already malnourished further malnutrition can be prevented and existing malnutrition is corrected by tube feeding of the expressed mother's milk almost every alternate hour. Tube feeding is done because it is in the incubator and it is too young to suck mother's milk.

Prevention of LBW Baby

a. *Direct intervention measures*: Such as efficient antenatal care, specially of high-risk mothers, with special attention to:
   - *Prevention of malnutrition:* By nutrition education and nutritional supplementation under ICDS
   - *Prevention of anemia:* By distribution of IFA tablets, during last trimester
   - *Control of medical infections:* By early diagnosis and prompt treatment
   - Avoid strenuous exercise (excessive stress and strain) smoking and alcoholism among pregnant mothers.

b. *Indirect intervention measures:* These are mainly Family Welfare Services such as:
   - Deciding age at marriage (not earlier than 18 in girls)
   - Deciding age at first child (to postpone the first issue)
   - To space for the next child
   - To decide number of children
   - Improvement of social measures such as literacy level, living conditions, quality of life, etc.
   - Improvement of availability of health services to women.

KANGAROO MOTHER CARE

Kangaroo mother care (KMC) is the care provided by the recently delivered mother to her low birth weight newborn baby, by placing the baby between her breasts, in direct skin to skin contact and serves as a natural and the best incubator, like the animal kangaroo, keeping the young-one in its pouch.

KMC is scientifically proved, comprehensive, humane and low cost method of providing care for those LBW babies, who are hemodynamically stable and are weighing between 1800 g to 2000 g (Newborns below 1800 g usually have significant problems and are soon transported to intensive neonatal care unit using the quickest mode of transportation).

KMC is scientifically proved in that it is highly superior to the existing sophisticated technologies available.

KMC is comprehensive in that it provides warmth (prevents hypothermia), promotes growth (by exclusive breast feeding) and protects from infection (specially from cross-infections of hospital). She also provides caring environment like safety and love.

KMC is humane in that it satisfies all the five senses of the baby as follows:

- Through skin (touch) - baby feels warmth
- Through ears (hearing) - hears mother's voice
- Through eyes (vision) - looks at mother
- Through tongue (taste) - sucks on breast
- Through nose (olfaction) - smells mother's odor.

KMC is a low cost method in that absolutely it does not require any investment unlike for incubators.

KMC is a lesson learnt from the animal kangaroo by 2 South American neonatologists namely Edgar Ray Sanabria and Hector Mortinez, in Bagota, Columbia during 1978, who initiated KMC for LBW newborns, because of lack of incubators, lack of personnel and separation of the mothers from their newborn, all resulting in increased neonatal mortality.

Thus, KMC is an early, prolonged and continuous skin to skin contact between the mother and LBW newborn both in the hospital and at home after discharge with regular follow-up. It should start soon after birth, continued 24 hours a day till it gains 2000 g. KMC gives the babies the best start in the life with humane touch.

Components of Kangaroo Mother Care

Components of Kangaroo mother care (KMC) are three:
1. Kangaroo position
2. Kangaroo feeding policy
3. Early discharge and follow-up.

Kangaroo Position

It consists of a specific 'frog' like position of the LBW newborn, in a 'Kangaroo-bag' with 'skin-to-skin' contact with the mother, in between her breasts, in a strict vertical position, under a *'dupatta'* and her clothes, 24 hours a day, till it gains at least 2000 g **(Fig. 22.6)**.

Materials required: Materials required are Kangaroo bag and *dupatta*.

- *Kangaroo bag:* The bag is made of soft, flannel cloth, specially tailored in a particular shape for placing the newborn, having two ties, one on either side, one very much longer than the other, so that mother can tie the bag herself on one side without the help of others and a loop to place around the neck of the mother for suitable

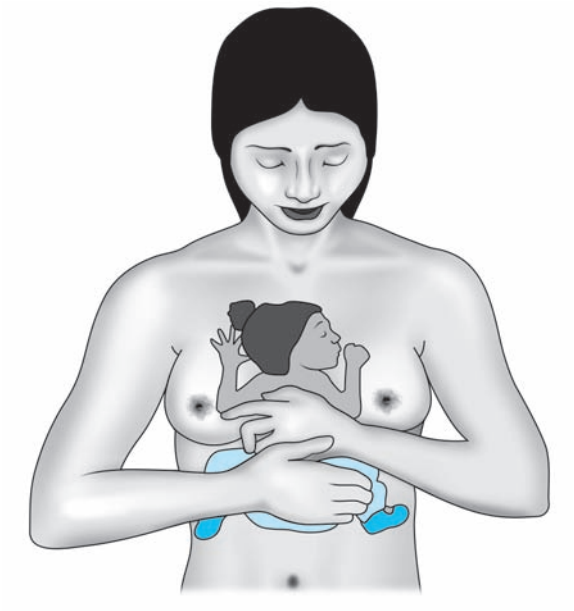


Fig. 22.6 Baby in Kangaroo position

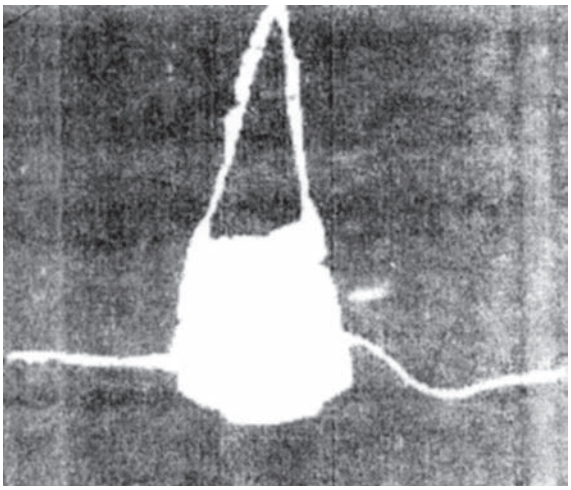


Fig. 22.7 Kangaroo bag

Fig. 22.8 Baby in Kangaroo mother care

adjustment according to the comfort of the mother and the baby **(Fig. 22.7)**.

- *Dupatta:* This is also made of soft hosiery cloth, worn by the mother after placing the infant in kangaroo position.

Preparation of the kangaroo baby: The baby must be suitably dressed in a cap, soak-proof diaper, socks and with an open shirt (of soft cloth) or sweater, so that there is direct skin to skin contact (chest-to-chest) between the mother and the baby. It is then placed in the bag.

Kangaroo positioning

- The bag with the baby is placed on the chest of the mother, with the loop of the bag around her neck **(Fig. 22.8)**.
- The infant should be in the strict vertical position, so as to prevent aspiration of gastric contents.
- The head should be turned to one side and the neck in a slightly extended position, so that air-way is kept open and allows eye to eye contact between the mother and the baby.
- The hips should be flexed and abducted in a 'frog' like position and the arms should also be flexed.
- The baby's chest should be in direct skin to skin contact with the mother's chest and the baby's abdomen should be at the level of mother's epigastrium
- The mother should then wear *dupatta* (in winter season additional warm coat may be worn by the mother).

Kangaroo position not only provides warm chain but also the respiratory movements of the chest of the mother prevents the occurrence of apnea in the baby.

The mother while sitting may be seated in a semi-reclining comfortable chair with adequate support to the back and while sleeping, she must lie in a semi-sitting position with the help of pillows.

KMC should be provided 24 hours a day. The position can be disturbed once in 2 hours for feeding purposes or for changing the diapers. Otherwise it should not be disturbed. Disturbances of the child frequently predisposes for hypothermia. If the mother needs to be away from the baby, any other family member, preferably father, can act as kangaroo care provider.

Mechanism of prevention of hypothermia: When the temperature of the baby decreases by 1°C, correspondingly the temperature of the mother increases by 2°C to warm up the baby rapidly. Conversely, if the temperature of the baby rises by 1°C, correspondingly the temperature of the mother decreases by 1°C. This phenomenon is called 'thermal synchrony'. Therefore the thermoregulation in KMC is far superior compared to any heaters—like bulbs, hot-water bottles or incubators.

Kangaroo Feeding Policy

- Kangaroo position is ideal for breastfeeding
- Feeding is given when the child is awake and alert (Mother should get into feeding position and feed)
- Exclusive breastfeeding is the policy
- Feeding is done once in 90 to 120 minutes
- If the baby can suckle, it is promoted
- If the baby cannot suckle, expressed breastmilk should be fed with a sterile spoon and cup
- If the baby is unable to swallow also, then expressed breast-milk is fed by nasogastric tube.

Early Discharge

The criteria for discharge are:

- Weight gain of at least 40 g a day for 5 consecutive days.
- Baby should feed well on breast milk
- Temperature should be maintained
- There should not be any evidence of illness
- Mother should be confident of taking further special care at home
- Successful 'in-hospital adaptation' of the mother and the other members of the family (i.e. Physical, psychological and social adjustment of the family members to the methodology of Kangaroo mother care).

Follow-up

After discharge KMC is continued at home. Follow-up is done daily by the health worker for one week and ensured that the baby is feeding well and gaining about 40 g weight daily. Afterward she visits once a week till the baby reaches 40 weeks of postconceptional age.

Duration of Kangaroo Mother Care

KMC is continued until the baby does not tolerate it any more. Child becomes restless and tries to come out of it. In otherwords, it is the infant, which decides the duration of KMC. This usually happens when the baby reaches about 40 weeks of postconceptional age, i.e. at about 2000 to 2200 g of body weight.

Benefits of Kangaroo Mother Care

- *Benefits to the baby:*
  - Baby is kept warm all the 24 hours by the mother, who serves as a natural incubator, preventing hypothermia
  - It gains physiological stability
  - It is at a minimum risk of apnea
  - It is at a reduced risk of nosocomial infections because of early discharge
  - KMC increases alertness and quiet sleep
  - KMC facilitates cognitive development and babies become more intelligent
  - Early growth is promoted
  - It gets safety and love.
- *Benefits to the mother:*
  - Mother becomes actively involved in taking care of her child
  - Mother is relaxed, confident and empowered
  - Bonding is better established between the mother and the baby
  - Mother gets satisfaction of motherhood
  - Breastfeeding becomes successful.
- *Benefits to the family:*
  - KMC is economical compared to the cost of intensive care
  - There is better follow-up
  - Father can return to the work early
  - KMC facilitates bonding among the family members
  - Child abandonment and child abuse is decreased.
- *Benefits to the hospital:*
  - KMC saves materials like incubators, oxygen cylinders.
  - It saves man-powers in terms of nursing staff and other health personnel
  - It saves money to the hospital in terms of not only incubators but also construction of intensive care units, air-conditioning, drugs, etc.
- *Benefits to the nation:*
  - KMC reduces neonatal mortality and thus infant mortality.
  - Children becoming more intelligent, adds to the nation's health and wealth.

Parameters to be Monitored during Kangaroo Mother Care

- *Temperature*: Once in six hours (every alternate hour for sick baby)
- *Respiration*: For apnea (to monitor cessation of breathing)
- *Feeding*: Once in 90 to 120 minutes.
- *Well-being*: By educating the mother about 'Danger signs', such as apnea, cold to touch, convulsions, refusal of feeds, diarrhea, yellow skin.

- *Growth*: Gain of 15 to 20 g/kg/day (i.e. about 40 g a day)
- Compliance with Kangaroo care.

Thus, Kangaroo mother care for low birth weight newborns is the need of the hour by constituting the best start in the life with humane touch, in terms of preventing hypothermia, apnea, infections, morbidity, mortality, promoting growth and in improving survival. Thus, KMC is an integral part of the management of LBW newborns, thus constituting a strategy of care of LBW babies, at low cost.

FEEDING OF INFANT

Breastfeeding

It is a beautiful process involving the mother and the child.

Process

Anatomy of the breast: The human breast consists of the nipple, the areola and the soft tissue **(Fig. 22.9)** (i.e. breast glandular tissue and supporting tissue).

The breast tissue is composed of the alveoli (the glands) which are small sacs, made up of millions of milk secreting cells. Their ducts open outside at the nipple area. While these ducts are beneath the areola, they become wider to form the lactiferous sinuses, where the milk is stored. This system of sinuses and ducts are interspersed in the supporting tissue which consists of fat and connective tissue, which determines the size of the breast.

Thus, the size of the breast varies from woman to woman depending upon the amount of fat. However, anatomy remains same. Therefore, the size of the breast is not the criteria for successful breastfeeding. A mother with a small breast is equally competent to breastfeed her child successfully.

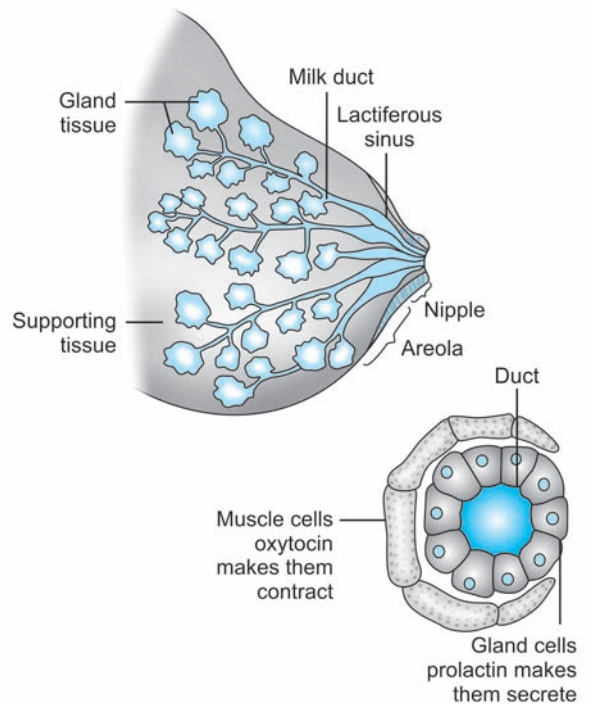


Fig. 22.9 Anatomy of the breast

Physiology of Breastfeeding (Breastfeeding Reflexes)

Reflexes in the Baby

They are rooting reflex, suckling reflex and swallowing reflex.

a. *Rooting reflex:* When the cheek of the newborn baby is touched, it turns its head toward that side and tries to find the nipple to suck. This is called 'rooting reflex.'
b. *Sucking reflex:* This reflex starts when the areola and the nipple is in the mouth and the nipple touches the palate of the baby. The problem starts only when the nipple does not touch the palate as in flat nipple or retracted nipple.

   If the baby sucks only at the nipple and not the areola, the lactiferous sinuses which are beneath the areola are not pressed or squeezed and therefore the child will not get enough milk. The reflexes also fail. The child is unsatisfied and it will cry. So position of the child is important for successful breastfeeding.
c. *Swallowing reflex:* This reflex starts when the mouth of the baby is filled with milk.

Reflexes in the Mother

They are prolactin reflex and oxytocin reflex. These reflexes are initiated simultaneously when the child starts sucking the breast.

a. *Prolactin reflex (Milk production reflex):* As the baby sucks, the nerve endings in the nipple are stimulated, which provides a sensory stimulus passing on to the anterior pituitary gland resulting in the release of a hormone called 'prolactin,' which stimulates the alveolar cells to produce milk. Thus, milk production is dependent on the sucking stimulus, i.e. more the baby sucks, more the milk is produced.

   Prolactin is not only responsible for breastmilk production, but also inhibits ovulation. Thus lactational amenorrhea is a natural contraceptive method.
b. *Oxytocin reflex (Milk ejection reflex):* Sucking by the baby also induces the production of the hormone 'oxytocin' from the posterior pituitary gland, which contracts the myoepithelium around the alveoli and helps the milk flow from breast to baby's mouth. Meanwhile oxytocin also

makes the uterus to contract, helps in involution of uterus and controls postpartum bleeding.

Factors Affecting the Reflexes

- *Physical:* Pain and tenderness in the breast, sore nipple, fever.
- *Psychological:* Anxiety, tension, depression, worries, etc.
- *Social:* Unwanted sex, illegitimate child, unfamiliar environment, presence of strangers, etc.
- *Others:* Oral pills, short and hurried feeds, improper position and technique, nipple confusion by the baby if pacifier or bottle is offered.

Position and Technique of Feeding

The mother should find a suitable, undisturbed place. She must position herself comfortably in sitting or lying position and must be relaxed physically and psychologically.

Different positions are classical Indian position, cradle position, foot-ball hold position, supine position and side lying position.

Then, she must hold and position the child in such a way that the body is in line, eyes towards the breast, the chin should touch the breast, lower lip is everted, tongue is under the areola, mouth is wide-open so that more of areola is in child's mouth **(Fig. 22.10)**. Mother should ensure that it latches on properly and see that the baby is not smothered by keeping her fingers in between the baby's nose and her breast. Improper position and technique of feeding predisposes for sore nipple and inhibition of reflexes.

Signs of Good Attachment (Fig. 22.11A)

- Baby's chin is close to the breast
- Baby's tongue is under the lactiferous sinuses and nipple against the palate

Fig. 22.10 Baby suckling in good position

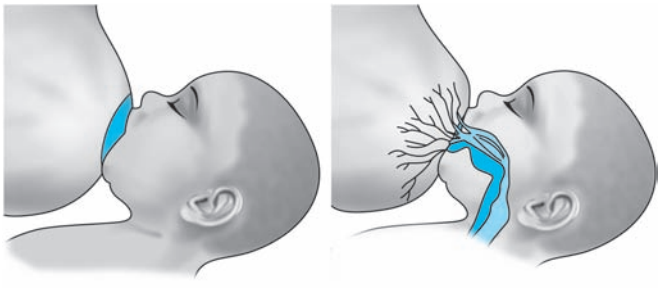


Fig. 22.11A A good suckling position. The breast is stretched into a 'teat' in the baby's mouth

Source: Government of India. National Child Survival and Safe Motherhood Programme. Programme interventions. MCH Division, Ministry of Health and Family Welfare, New Delhi, 1994.

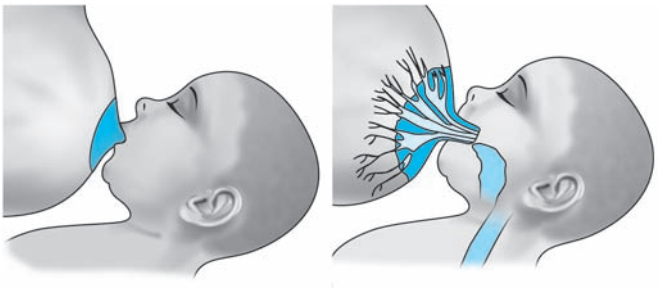


Fig. 22.11B A poor sucking position. The baby is sucking only the nipple, and the tongue is held back in the mouth

Source: Government of India. National Child Survival and Safe Motherhood Programme. Programme interventions. MCH Division, Ministry of Health and Family Welfare, New Delhi, 1994.

- Baby's mouth is wide open and the lower lip turned outwards
- More areola is visible above the baby's mouth than below it
- No pain while breastfeeding.

Signs of Poor Attachment (Fig. 22.11B)

- Baby sucks only at the nipple
- Mouth is not wide open, and much of the areola and thus lactiferous sinuses are outside the mouth
- Baby's tongue is also inside the mouth and does not cup over the breast tissue
- Chin is away from the breast
- It is painful while breastfeeding.

Right Technique of Feeding in a Right Position of the Child is the Key to the Success of Breastfeeding

Mother should feed the child 10 to 15 times a day, including 3 to 4 feedings during night times. Frequent sucking by the

child not only stimulates milk production and milk flow but also prevents engorgement of breasts.

Human milk is made for the human baby and cow's milk for the calf. Both cannot be equated.

Composition of the milk (per 100 mL) (Table 22.2): Foremilk is low in fat, and high in lactose (sugar), protein, vitamin, minerals and water.

Hind milk is rich in fat and supplies more energy than foremilk. Preterm milk (in a mother with preterm baby) is rich in protein, minerals (Na and Cl), immunoglobulins and lactoferrin than mature milk.

Volume of the milk: An average Indian woman secretes about 400 to 600 mL (av. 500 mL) of milk per day. It is more during the first 6 months (av. 700 mL) and after one year it is reduced slowly and by about 1½ years, it will be about 400 ml/day and by about 2 years, it will be still less.

Colostrum: It is the first few cc (about 60 mL) of the milk secreted after delivery. It differs from the regular milk in that it is yellowish in color, rich in proteins, Vitamin A and K and immunoglobulins (IgA) and poor in fat. IgA provides local immunity to the gut, thus acts as an 'intestinal antiseptic paint'. It is anti-infective in nature also. Thus it protects the child against respiratory, alimentary diseases and also against allergic bronchitis, asthma and eczema. It clears meconium. Thus acting as a purgative. Colostrum is the first natural vaccine the child receives from the mother. The public health importance is that the mother thinks it is not true milk, because it is yellowish in color and discards it, depriving the child from the benefits. So the mother must be informed about this during antenatal period itself. Informing after delivery may be too late.

Exclusive Breastfeeding

This means feeding the mother's milk only and no other drinks like honey, water, glucose water, gripe water, juices, vitamin drops, animal milk, powdered milk or foods are given to the newborns.

Principles of Breastfeeding

- Breastfeeding to be initiated within half an hour of birth, because the newborn is very active during the first hour of life and therefore the reflexes are strong. Early initiation also ensures that the baby gets colostrum positively
- Prelacteal feeds (like honey, sugar water, etc. mentioned above) are strictly prohibited because not only they introduce infection but also they replace colostrum and interfere with sucking.
- Exclusive breastfeeding should be given for first six months of life.
- Complimentary feeding, to be started from 6th month onwards only.
- However breastfeeding to be continued for at least 2 years.
- Bottle feeding and pacifiers are strictly prohibited to avoid nipple confusion and infection (As a result of nipple confusion the child will refuse to take breastfeeding).

Merits of Breastfeeding

Advantages to the Baby

- Mother's milk is the most complete food available in the nature (because it provides all the nutrients).
- All the nutrients are present in the definite proportions
- The nature of the nutrients are such that they are easily digestible and assimilable.
- Other than the nutrients, it also contains hormones, enzymes, protective antibodies (i.e. anti-infective factors).
- It also contains other protective substances such as leucocytes (lymphocytes and macrophages) which fight infection, lactoferrin which binds iron and prevents the growth of those pathogens which need iron, lysozyme which destroys pathogens and bifidus factor which helps Lactobacillus bifidus to grow in the intestine, which in turn prevents the growth of pathogens causing diarrhea.
- It is bacteriologically clean and pure (hygienic)
- It is obtained easily, freely, all the 24 hours and at a suitable temperature (cost effective).
- It improves the intelligent quotient (IQ) of the child and better visual acuity due to the presence of special fatty acids.
- It prevents obesity in the child.
- It prevents or postpones the onset of diseases like diabetes, cancer and hypertension.
- Anti-infective factors protect the child against respiratory, alimentary diseases and also allergies, eczema and asthma.
- Exercise while sucking helps not only in the development of jaws but also gives the child chubby-cheek appearance.

Table 22.2 Composition of the milk (per 100 mL)

	Proteins (g)	Fats (g)	Carbohydrate (g)	Vitamin C	Vitamin D	Calcium	Iron	Energy
Human milk	1.1	3.1	7.1	6 mg	5 IU	0.03 mg	0.1 mg	65 kcals
Cow's milk	3.3	3.5	5.0	2 mg	2.5 IU	0.1 mg	0.04 mg	67 kcals

Source: Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.

- Thus, it promotes overall growth and development of the child (i.e. physical, psychological, social, motor and mental development).

Advantages of the Mother

- Exclusive breastfeeding is a natural contraceptive method
- It prevents cancer of the breast
- It acts as an 'anti-diabetogenic factor', by reducing the requirement of insulin among diabetic mothers
- It adds beauty and complexion to the mother
- It helps in restoration of original physique
- It helps in quick and early involution of uterus and reduces postpartum bleeding.

Advantages to Both Mother and the Child

Breastfeeding helps in the establishment of a relation (bonding) between the two, which is of permanent, psychological benefit for both.

Advantages to the Family and Nation

Saves money, time, conserves energy and reduces infant morbidity and mortality. Therefore, it is an universal truth that breastfeeding.

- It is the 'best start' to life
- It is 'unique'
- It provides 'umpteen number of benefits' to both mother and the child
- It is the 'gold standard' of infant feeding
- It is safe, sound and sustainable
- It is the 'foundation' for fulfilling the rights of the child
- It is 'species specific' and 'eco-friendly'.
  Therefore breastfeeding is the best feeding

Malpractices in Breastfeeding

Any procedure other than the scientific method of breastfeeding is considered as malpractice, such as:

- Delay in initiation (beyond 2 hours in normal labor and 4 to 6 hours after cesarean section)
- Discarding colostrum
- Giving prelacteal feeds
- Scheduled feeding (i.e. timely feeding)
- Stopping the feed by clock
- Premature or delay in starting complimentary feeding
- Offering only one breast each time
- Bottle feeding and use of pacifiers.

Weaning

Weaning (Timely complimentary feeding): It means the process of withdrawal of the child from the breastmilk to external foods. This should be done gradually, so that the child gets adjusted to external foods. Complimentary feeding should be started from 6th month onward because mother's milk alone is not sufficient for the growth and development of the child. Breastfeeding is supplemented by suitable, soft foods rich in nutrients. These are called 'Supplementary foods'.

Weaning period is the most crucial period, because if done early, the child gets infection and if done late, develops malnutrition. Thus, the child is exposed to the synergistic action of both infection and malnutrition. Therefore, complimentary feeding should be done properly.

To startwith, the supplementary food should consist of liquid foods like fruit-juice, ragi-malt, vegetable soup, cow's milk, etc. later followed by semisolid foods like soft cooked rice, *dal*, smashed vegetables, soft fruits like banana, soft boiled egg, later *ragi-ladoo*. These items are given one at a time. When the child gets used to one item, another is started. If it does not accept, it is not forced. By one year, the child will be able to eat all the foods the adult eats. However, breastfeeding has to be continued at least up to 2 years. Bottle feeding, must be strictly discouraged because it predisposes for alimentary infections resulting in diarrhea, and for respiratory diseases.

Dangers of Artificial Feeding

- *In the child:* Infections, malnutrition, allergy, risk of chronic diseases, obesity, low intelligent quotient
- *In the mother:* Frequent pregnancy, risk of anemia, ovarian and breast cancer.

Demand Feeding

Demand feeding means breastfeeding the child, whenever it demands and as long as it demands. No restrictions on the frequency and duration of breastfeeding. Child is fed till it is contented and satisfied. That means the baby should be allowed to breastfeed unrestrictedly. It is the child who should decide the frequency and duration of feeding and not the mother. Sudden stoppage or premature termination of feeding often affects the growth, development and behavior of the child. Such child may develop adement nature.

Feeding by time, once in 2 to 3 hours (Scheduled feeding) only for few minutes and offering only one breast each time is malpractice.

Alternate breasts should be offered at each feed. One breast must be emptied out fully before the second is offered, so that the baby receives both foremilk (rich in proteins, sugar, vitamin and mineral) and hind milk (rich in fat and satisfies the baby's hunger).

Advantages of demand feeding

- Breast milk 'Comes-in' sooner
- Baby gains weight faster
- Prevents engorgement of breasts
- Breastfeeding is established more easily.

Four signs of good attachments
- Chin touching the breast
- Mouth wide open
- Lower lip turned out
- More areola visible above the baby's mouth than below.

Four signs of proper positioning
- Hold the infant's head, neck and body in a straight line
- Baby's face should be directly infront of mother's breast (En-face)
- Hold the infant's body close to her body (warm chain is maintained)
- Support infant's whole body and not just the head and neck.

Technique of Feeding

Guiding the baby by keeping the fingers over the breast to prevent choking and to insert more of areola in the mouth. Right position and right technique of feeding is the 'KEY' to the success of BF.

Expression of Milk

Indications
- Engorgement of the breasts
- Low-birth weight baby
- Employed mother.

Methods
Manual and mechanical methods.

Manual Expression

This is better from hygienic point of view. If the milk has to be expressed from the left breast, right hand to be used and vice-versa. The thumb should be above the nipple and the other four fingers below the nipple. The thumb is given a rolling movement over the areola as given in thumb impression, in the clockwise or anticlockwise direction or the breast is pressed against the chest wall but never squeezed because it results in cell destruction.

Expressed milk collected in a clean cup can be kept for 6 hours under ordinary conditions and in refrigerator for 24 hours. It should not be boiled because boiling destroys the anti-infective factors. After removing from the refrigerator, if it needs to be warmed, the cup is placed in a container of warm water and shaken gently to recombine fat globules with the rest of the milk. It should be boiled only if mother is HIV positive.

Mechanical Expression

Mechanical expression is by using trumpet pump. Hand breast pump, Swedish pump, by syringe method and warm bottle method:

Warm bottle method: A bottle is warmed by pouring hot water into it and discarded after a few minutes. Neck of the bottle is cooled and placed air tight over the nipple. As the bottle cools, it gently sucks the nipple into the bottle. The warmth stimulates oxytocin reflex and milk starts flowing and collecting in the bottle.

Breast Problems

Common Problems

- Too much milk
- Too little milk
- Flat or inverted nipple
- Sore nipple.

Too much milk: This is either due to hyperactivity of the reflexes or due to decreased feeding on that side, resulting in breast engorgement, if not relieved, may result in mastitis and breast-abscess.

This can be relieved by expression of milk and feeding the child more frequently.

Too little milk (milk dried up or not enough milk): This can be assessed only when the mother gives the history that the child passes urine less than 6 to 8 times in 24 hours. If it passes urine more than 6 to 8 times in 24 hours, that means mother is secreting enough of milk (Wetness test).

Adequacy to breastfeeding can also be assessed by recording the weight. If the baby gains 20 to 30 g (Av = 25 g) a day, about 400 g a fortnight or 800 g a month, that means breastmilk is adequate.

All the factors inhibiting the reflexes, result in this.

Physiological remedy is by feeding the child more frequently, in correct position and technique and correction of underlying causes if any.

Psychological remedy is by giving encouragement, support and reassurance to the mother.

If there is really 'too-little' milk, the best alternative is the milk of another healthy, lactating mother (i.e. wet nursing). Next best is humanization of cow's milk.

Use of galactogogues: Galactogogues are the drugs which increase milk production, such as metoclopramide, chlorpromazine, which act by increasing prolactin secretion. They also work psychologically and have a marginal effect on milk production.

However, breastfeeding in a correct position and technique is the best galactogogue.

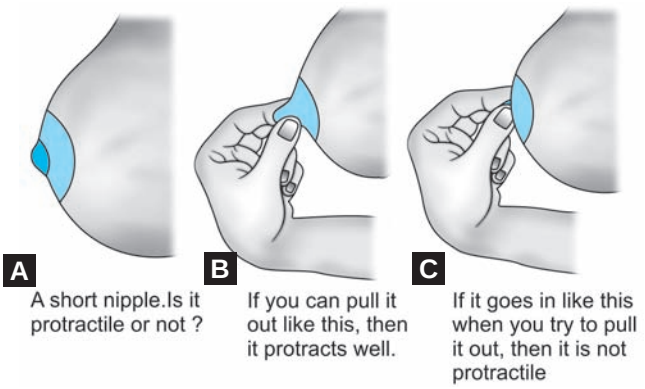
Flat or inverted nipple: The nipple is protractile (capable of being pulled out). If it is flat or inverted, the child cannot suck. So, mother must be examined during pregnancy-itself. Since nipple is an erectile tissue, it is stimulated with the fingers and held between the thumb and the index finger and pulled

several times a day, each time for few minutes. In due course of time it becomes normal **(Figs 22.12A to C)**.

If this is found after delivery, the following 'syringe' method should be tried **(Fig. 22.13)**.

- Cut the nozzle end of a 10 mL disposable syringe
- Introduce the piston from the ragged cut end side
- Ask the mother to apply the smooth side of the syringe on the nipple and gently pull out the piston and wait for a minute
- Nipple would then protrude into the syringe. Ask the mother to slowly release the suction and put the baby to breast, and the baby is able to suckle
- After feeding, the nipple may retract back, but doing it each time before feeding, over a period of few days, will help to solve the problem.

Sore nipple: Improper position and technique of feeding is the most common cause of sore-nipple and if continued leads to cracked nipple which is a very painful condition. Oral thrush in the baby is another cause.



Figs 22.12A to C Testing a nipple for protractility

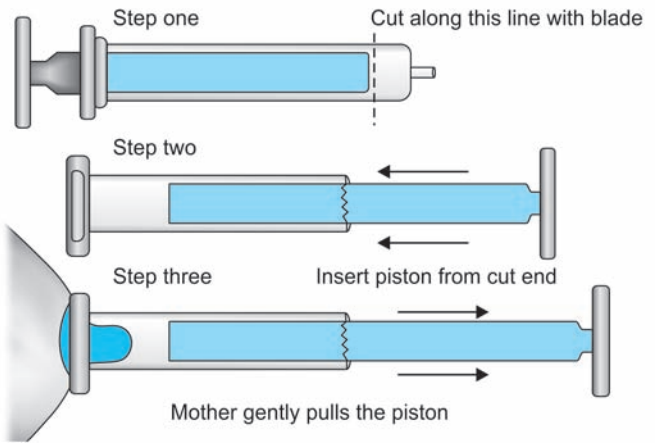


Fig. 22.13 Treatment of inverted nipples using disposable syringe
Source: Government of India. National Child Survival and Safe Motherhood Programme. Programme interventions. MCH Division, Ministry of Health and Family Welfare, New Delhi, 1994.

Feeding must be started from the healthy breast and when the reflex is established, the baby is changed over to the affected side. Frequent and short feedings in the correct position promotes speedy healing. If feeding is started from the affected side, pain inhibits the reflex. If both the sides are sore and painful, first little milk has to be expressed out to initiate the reflex and then short and frequent feeds given in correct position. She must apply hind milk drop on the sore nipple after each feed. This acts as a soothening agent and helps in healing. Medicated creams are avoided. If the baby has oral thrush, 1 percent gentian violet should be applied over the nipple as well as inside the baby's mouth. She must wash the nipple once daily with only water and should never use soap, dettol, spirit, etc. which make the nipple skin dry and worsens the condition.

Prevention of cracked nipples or sore nipples is by feeding the baby in correct position with more of areola in the baby's mouth and not just the nipple.

Breastfeeding under Special Conditions

Low Birth Weight Baby

Breastfeeding a preterm baby is a special challenge. First few days it may not be able to suckle. Expressed breast milk should be given by nasogastric tube feeding even in Kangaroo position. Tube feeding is continued till it reaches 30 to 32 weeks of gestational age. Then if it cannot suck, it is fed with spoon and a cup. After feeding it can be returned to Kangaroo position again. After 32 weeks of gestational age, babies are usually able to suck.

If a LBW baby is able to suck, Kangaroo position is ideal for breastfeeding. Mother should be encouraged to ensure correct position and attachment.

New Pregnancy During Lactation

Usually the mother stops feeding the child suddenly, which has got an adverse effect on the child. She is advised to continue to feed the child till delivery and after delivery, she can feed both the children. This is called 'Tandem nursing.'

However, sometimes she may get uterine colic or bleeding per vagina. Under such circumstances she can stop feeding.

A Newborn with Cleft Lip or Palate or Both

It there is cleft lip, mother can support the child for feeding by putting her finger over the cleft lip.

If there is only cleft palate and not lip, the child can be fed in an upright position, thereby nasal regurgitation is prevented.

If there is both cleft lip and palate, mother can feed by expressing the milk and fed by cup and spoon.

Twin babies: If there are twin babies, both the babies can be fed simultaneously in football hold position.

If the infant is ill: *Dribbling nose:* The nostrils are blocked. While sucking, mouth is also blocked. So, the baby can not breathe properly. So, it leaves the nipple and cries because of hunger and discomfort.

Best thing is to wipe the nose with thin cloth before feeding and instill 2 or 3 drops of mother's milk into the nostrils.

It releases the nose block and gives relief.

- *Vomiting and diarrhea:* Some mothers think that during diarrhea in the child, it should not be breastfed. They treat diarrhea by restricting the breastfeeding. This is very much wrong, because it predisposes for the development of dehydration very soon.

  Therefore, mothers must be informed not to stop breastfeeding during diarrhea and vomiting and on the other hand, they must feed more frequently. Meanwhile the child is treated accordingly.
- *Fever:* A febrile child may not suck the breast. Under such circumstances, it should be fed by expressed milk.
- *If the mother is ill:* No maternal illness is contraindicated for breastfeeding, except when she is on drugs like anticancer therapy, lithium, radioactive compounds and chloromycetin.

  However, the child should be under observation if the mother is suffering from tuberculosis, HIV, leprosy, diabetes and hepatitis B.
- If the mother is suffering from tuberculosis—see **Flow chart 22.1**.
- If the mother is HIV positive: Described under epidemiology of HIV/AIDS.

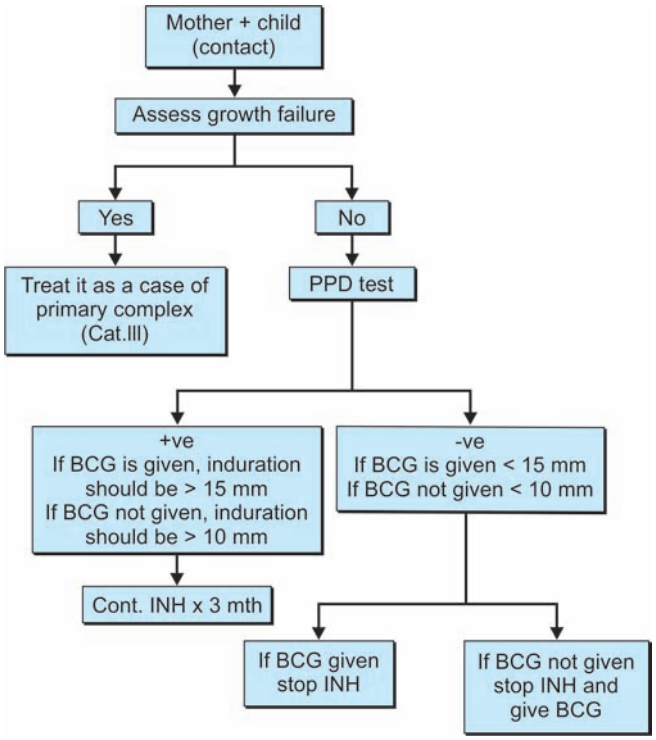
  If the mother is Hepatitis B positive, the newborn has to be immunized with hepatitis B vaccine (Actively and preferably passively also) followed by rapid schedule. However, breastfeeding has to be continued as usual.
- If the mother is employed (A working women).

She must apply all her leaves and practice exclusive breastfeeding up to first 6 months. If not possible, she must feed the child before going to work, then collect the expressed milk in a clean cup with an instruction to the attendant to feed intermittently and she must feed the child as soon as she returns from work. She must feed more frequently during night times. If crèches are established, she can come and feed during nursing breaks. Under no circumstances the working women should prefer bottle feeding.

RELACTATION

It means re-establishment of lactation in a mother, who has stopped nursing temporarily due to major illness or surgery. Reflexes start functioning, when the child is put to breast.

Flow chart 22.1 Management if the lactating mother is suffering from TB



Induced Lactation

It means establishment of breastfeeding in a woman, who has never been pregnant. Such circumstances occur when the couple adopt a child and the woman wants to develop motherhood. Afterall, what is required for establishment of breastfeeding is stimulation of the reflexes.

Since the child does not get milk, it may not suck, so mother should use nursing supplementer **(Fig. 22.14)**. It consists of a bottle of milk with a thin, long straw (scalp vein drip set), brought near the nipple alongside the breast. When the baby sucks, it gests milk from the bottle and so continues to suck thinking it gets the milk from the mother. Thus, the reflexes are stimulated and in due course of time milk production is established. Nursing supplementer can also be used for relactation.

Baby Friendly Hospital Initiative

Baby friendly hospital initiative (BFHI) is global movement, developed jointly by WHO and UNICEF in 1992. The word 'Friendly' implies cardiality and warmth.

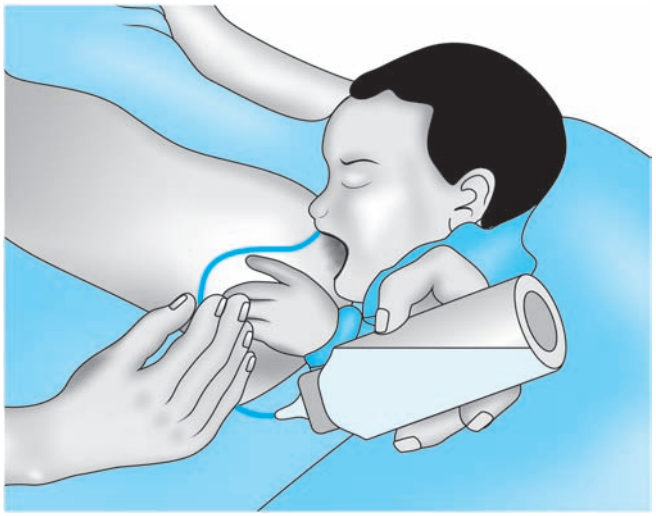


Fig. 22.14 Baby feeding from the breast and using a nursing supplementer

Aim

- To ensure that every newborn baby gets the best start in its life.
- To encourage correct scientific practices in breastfeeding.

Objectives

- To protect, to promote and to support breastfeeding practices
- To reduce infant mortality rate.

Importance

This concept of BFHI came into practice because of mal-practices in breastfeeding, which in turn is due to ignorance and lack of knowledge and also because of hinderance in breastfeeding by marketers of infant milk substitutes and infant foods (i.e. commercial influence).

In India, more than 1 million infants have been dying every year only because of improper breastfeeding practices. These are preventable deaths.

Criteria for Recognition of the Hospital as 'Baby Friendly'

Ten Steps

Baby friendly hospital initiative (BFHI) has listed ten steps to be fulfilled by the maternity hospitals for their recognition as 'Baby Friendly' hospitals.

1. Have a written breastfeeding policy to be communicated to all health care staff.
2. Train all the health care staff in the skills necessary to implement this policy.
3. Inform all the pregnant women about the benefits and management of breastfeeding.
4. Help mothers to initiate breastfeeding within half an hour of birth.
5. Show mothers how to breastfeed and how to maintain lactation when they are separated from their infants.
6. Give newborn infants no food or drink other than breast milk unless medically indicated.
7. Practice 'Rooming-in'. Allow mothers and infants to stay together 24 hours a day.
8. Encourage breastfeeding on demand.
9. Give no artificial teats, pacifiers, dummies or soothers to breastfeeding infants.
10. Help start the establishment of breastfeeding support-groups and refer mothers to them.

Benefits to the Hospitals

- Professional satisfaction of helping lactating mothers
- Infant mortality rate will come down
- Hospitals get National and International recognition without any financial investment
- Hospital will be kept on a global forefront.

Baby friendly hospital initiative (BFHI) has proved highly successful in encouraging proper infant feeding practices. This was started in 12 lead countries in 1992 and has now spread to 171 countries in the world. In India, The National Task Force at New Delhi, provides the policy guidelines and technical support. Each state has a State Task Force. Since 1995, the process of certification of Baby Friendly Hospital has been decentralized to State Task Force. Once the hospital has implemented the above 10 steps, the professional assessors conduct inspection. If they are satisfied, the hospital is given a certificate of being a Baby Friendly Hospital. However, the final certification is done by National Task Force.

IMS-Act

Infant milk substitutes, feeding bottles and infant foods (Regulation of production, supply and distribution) Act, 1992.

Inspite of traditional breastfeeding practices in India, it has been observed that there has been a decline in breastfeeding practices due to some reasons such as increased opportunities of employment among women, lack of information and support for the mothers, introduction of commercial baby foods and feeding bottles and also promotion of infant foods have been more extensive than spreading knowledge on breastfeeding, all resulting in increased incidence of infection, malnutrition and deaths among children, infants are being hit hardest.

In India, for about 27 million children born each year, about 1.9 million die before they see their first birth day and

around 2.5 million die by the time they are five years. India has the highest number of under five child deaths in the world. It is now known that many of these infant deaths are attributed to inappropriate feeding practices. Now, it is very clear that exclusive breastfeeding during the first six months and continued breastfeeding during next 6 months reduces highest percentage of infant deaths.

In order to reduce the infant mortality rate contributed by inappropriate feeding practices, it became necessary to control the marketing of products like Infant milk substitutes, feeding bottles and Infant foods. So Government of India enacted a law in 1992.

Infant milk substitutes: Means foods for consumption of the children up to the age of 6 months, replacing the mother's milk partially or totally, e.g. Amul-spray, Lactogen, Lactodex, Nestogen, etc.

Infant foods–means foods for consumption of the children after the age of 6 months up to 2 years, e.g. Cerelac, Nestum, Farex, etc.

In May 1982, World Health Assembly adopted an International Code for marketing of baby foods. Government of India recognized the code and adopted Indian National Code for protection and promotion of breastfeeding in December 1983. Finally, 'The Infant Milk Substitutes (IMS), Feeding bottles (FB) and Infant foods (IF) (Regulation of production, supply and distribution) Act 1992 came into force on August 1, 1993 alongwith the rules. It was further strengthened in June 2003.

The Act Prohibits

- Advertising to public about commercial baby foods
- Free samples to mothers
- Promotion in hospitals
- Gifts or samples to health workers
- Financial inducement to any person to promote the sales of such foods
- Commission on sales to employees
- Payment of any kind to a health worker, working for the sales of such foods.

Penalty

Violation of the Act can lead to fine up to ₹ 5,000/- or imprisonment up to 3 years or both.

Monitoring

The accurate collection and reporting of violations is called monitoring and health workers are specially responsible for success or failure of the Act. Monitoring is essential to enforce the Act.

Following voluntary organizations have been notified by the Govt. of India to make a written complaint to the court of law:

- Association for Consumers Action on Safety and Health (ACASH), Mumbai.
- Indian Council for Child Welfare (ICCW), New Delhi.
- Central Social Welfare Board (CSWB), New Delhi.

The one important organization working very hard for the BFHI movement in India is BPNI.

Breastfeeding Promotion Network of India

Breastfeeding promotion network of india (BPNI) is a registered, independent, nonprofit, national organization located at Delhi, that has been working toward protecting, promoting and supporting breastfeeding and appropriate complementary feeding of infants and young children. BPNI believes that breastfeeding is the right of all mothers and children. BPNI works through advocacy, social mobilization, information sharing, education, research, training and monitoring the company compliance with the IMS Act. BPNI does not accept funds or sponsorship of any kind from the companies producing infant milk substitutes, feeding bottles, related equipment or infant foods.

Goals

The main goal of BPNI is to empower all lactating women to practice exclusive breastfeeding for the first six months of infancy and continue breastfeeding up to 2 years or beyond alongwith adequate and appropriate complimentary feeding, starting after 6 months.

BPNI also works in close liaison with International Baby Food Action Network (IBFAN) and World Alliance for Breastfeeding Action (WABA).

GROWTH MONITORING

The growth of the child is monitored by recording the weight of the child periodically and plotting against the age, in a specially designed chart called 'Growth chart' or 'Road to health chart'. It is also called as 'Weight for age chart'. Weight is the most sensitive indicator for assessing the growth of a child and is a delicate measure of the nutritional status. It was first designed by David Morley and is recognized internationally.

The chart is a visible display of a graph, showing horizontal X-axis and longitudinal Y-axis. X-axis is divided into five main divisions, representing age from birth to 5 years, each division for one year. Further, each division of one year is subdivided into 12 subdivisions, representing months. Thus, in total, there are 60 subdivisions, each extending below the X-axis as a box, for recording the month of that year.

The vertical Y-axis, representing the weight, has 22 solid lines representing kilograms. Across the graph there are 'Reference-curves'. There are many types of Growth charts.

Important Growth Charts

The New WHO Growth Chart

WHO has adopted a New International Growth Standard for assessing the physical growth and development of children of various countries, from birth to five years of age, who were predominantly breastfed during the first six months of life and continued breastfeeding with appropriate complementary feeding up to two years. Therefore, the new chart will allow inter country comparability of the breastfed infants.

The old growth standard chart was that of National Centre for Health Statistics (NCHS) which was based upon a sample of children, who were mostly fed* during infancy. So, it was felt that new growth curves were necessary.

The new chart shows a deviation to a significant extent compared to NCHS standard. It is accurate and Golden standard. Implementation is feasible. It is a powerful entry point to accelerate the reduction of undernutrition and promotes early child development.

Following the World Health Assembly resolution, endorsing the recommendations, the WHO Multicentre Growth Reference Study (MGRS) was undertaken between 1997 and 2003 in various countries like Brazil, Ghana, India, Norway, Oman and USA, to collect primary growth data that would allow the development of new growth charts consistent with best health practices i.e., exclusive breastfeeding up to first six months and continued breastfeeding with appropriate complementary feeding up to 2 years and not smoking during and after pregnancy.

The new standards were generated for boys and girls between 0 and 60 months - percentile or Z score curves for weight for age, height/length for age, weight for height/length and Body Mass Index (BMI) for age. **Figures 22.15 and 22.16** show comparison between WHO and NCHS weight for age growth curves from 0 to 60 months of age, for boys and girls respectively.

The new chart provides good opportunity for countries to work towards one national standard and for reviving national action for overall improvement and young child nutrition and achieving Millennium Development Goal No 1, namely 'Eradicate extreme poverty and hunger'.

New Growth Charts in India

New growth chart has been used in India since February 2009. It is as per new WHO growth standards of 2006. It is called 'Mother and Child Protection Card', which is separate for boys and girls from 0 to 60 months of age, used for monitoring their growth and development, under NRHM and ICDS. It helps the child care workers to take timely corrective action at different levels.

This card provides space for recording the family identification and registration, birth record, pregnancy record, institutional identification, care during pregnancy, preparation for delivery, registration under Janani Suraksha Yojana, details of immunization, breastfeeding and introduction of supplementary feeding, milestones of the baby, birth spacing and reasons for special care. It is kept by the mother and is brought to the center at each visit.

The chart of ICDS shows normal zone of weight for age, under nutrition (below - 2SD) and severely underweight zone (below - 3 SD) **(Figs 22.17A and B)**.

On the other surface of the card, provision is made to record the information such as name, age, sex, address, date of birth, weight at birth of the child and also about the immunization status, nature and commencement of supplementary food, any episodes of sickness of the child, etc.

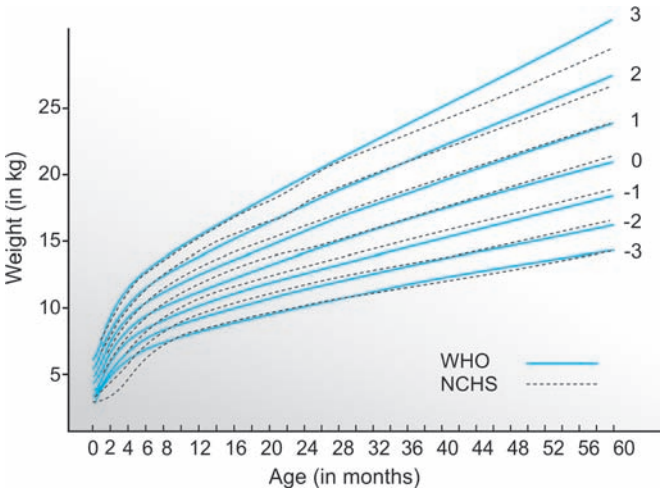


Fig. 22.15 Comparison of WHO with NCHS weight-for-age z-scores for boys

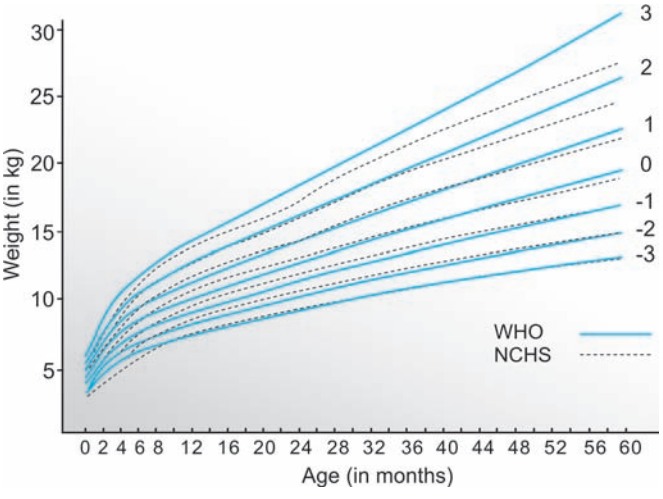
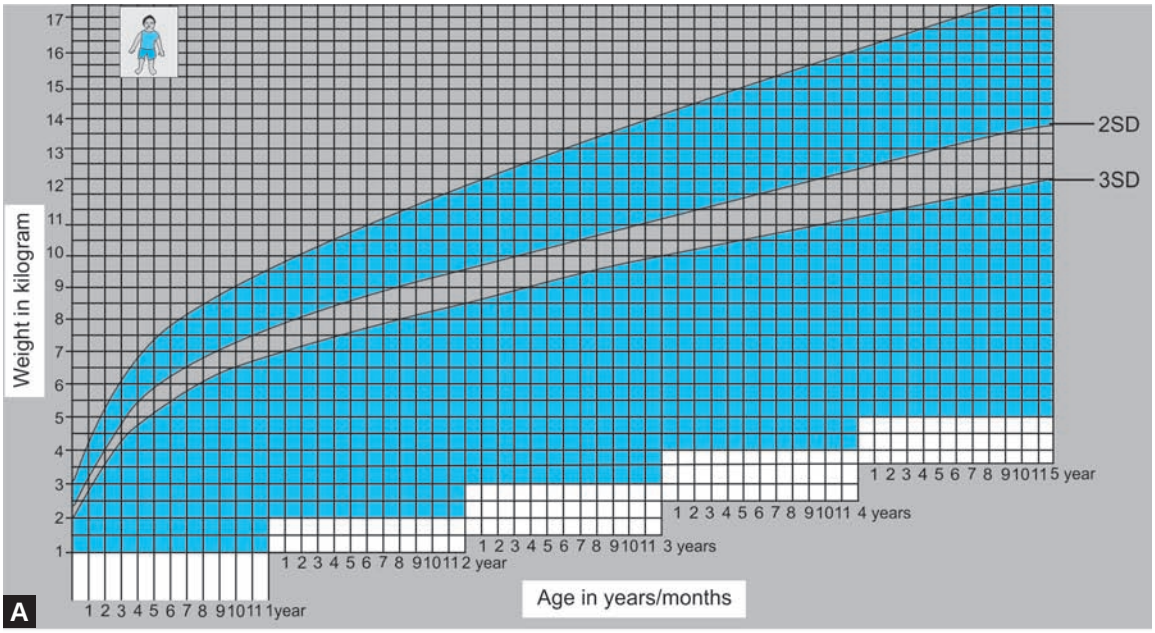
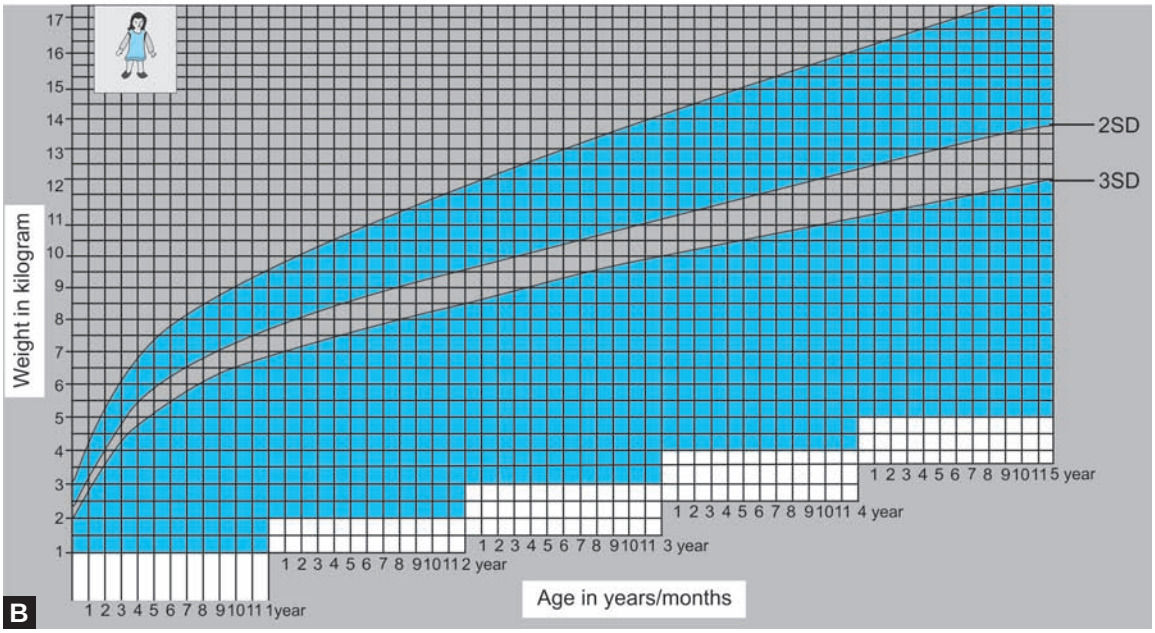


Fig. 22.16 Comparison of WHO with NCHS weight-for-age z-scores for girls

* fed with formula feed during





Figs 22.17A and B New growth chart used Indian *anganwadis*. (A) For boys; (B) For girls

Old Growth Charts Used in India

These are also called as 'Service charts', separate for boys and girls. There are many types of service charts, each with little modification. The one commonly used, has four reference curves. The top-most line corresponds to 50th percentile value of WHO chart, considering it as 100 percent standard. Accordingly, the lower lines correspond respectively to 80 percent, 70 percent and 60 percent of the first line **(Fig. 22.18)**.

The space between the first two lines is shaded and the lines are almost parallel. This is called 'Road to health'. The weight of the child is recorded periodically, once a month during infancy, once in two months during second year and once in three months subsequently up to 5 years and plotted on the chart as dots. Joining the dots constitutes the 'Growth line or growth curve'.

Normally, the growth curve of the child should run parallely and in-between the first two lines. That means the child is growing normally. If it goes between the second and third lines, it is 'First degree' malnutrition (Mild malnutrition-Grade I). That can be managed at home by the mother herself. If it is between the third and fourth line, it means 'Second degree' malnutrition (Moderately severe - Grade II). That requires doctors advice for correction. If it is below the fourth line, it means 'Third degree' malnutrition. (Severe - Grade III) and requires hospitalization, for investigations and treatment.

Thus, it is the direction of the growth-curve that is more important than the position of dots. Thus, an up going curve indicates a healthy child; a flat growth curve is a warning signal; and a down going curve calls for immediate action.

The objective of child care is to maintain the growth-line between the first-two lines.

Uses of road to health card

- To monitor the growth of the child (Growth monitoring)
- To make an early diagnosis or detection of malnutrition, much before the clinical signs or symptoms occur. (diagnostic tool)
- To educate the mother in taking care of her child. (educational tool)
- To refer the case by the health-worker (tool for action)
- To make policies and plans to provide nutritional services (tool for planning)
- To evaluate the nutritional services (tool for evaluation)
- To know the related information about the health status of the child such as birth-weight, immunization status, episodes of illness, etc. (tool of information).

Thus, the growth chart is a 'Passport' to child health care.

The other methods of growth monitoring are by recording the height periodically against the age (Height for age), weight against the standard height (Weight for height) and height against the midarm circumference.

The 'Weight for age' and 'Height for age' are age-dependent (i.e. when the age is known). The 'Weight for Height' and 'Height for midarm circumference' are age independent (i.e. when the age is not known) indicators.

UNDER FIVES CLINIC

Under Fives clinic is a center, where preventive, promotive, curative, referral and educational services are provided in a package manner to under five children under one roof. The services are made available through trained nurses, so that

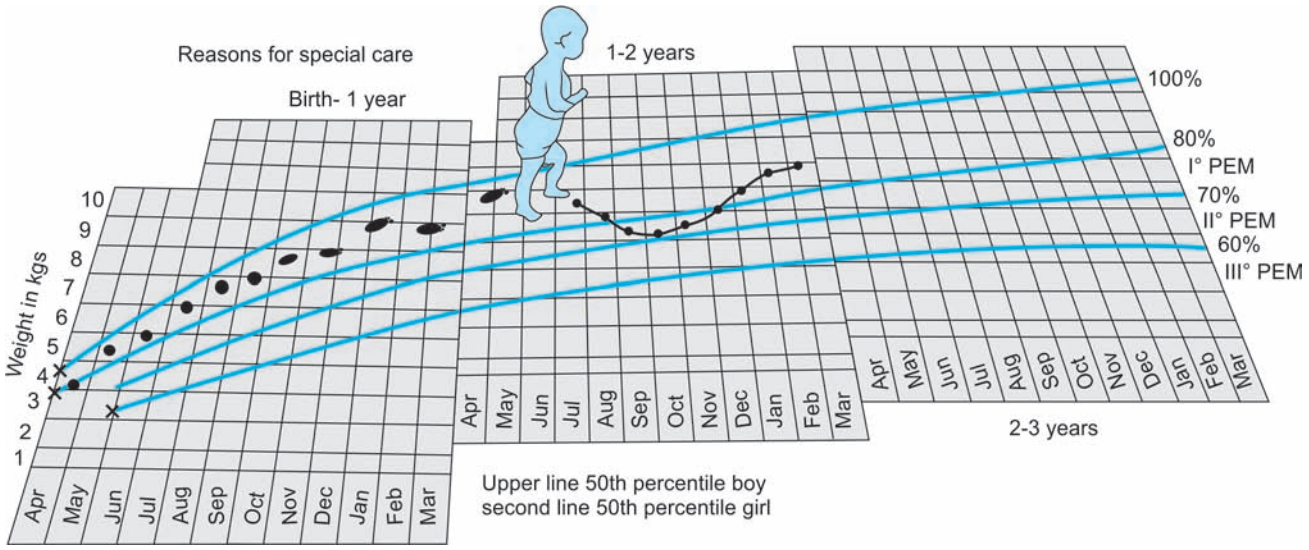


Fig. 22.18 The road to health chart

not only the services become economical but also becomes available to larger proportion of children population in the community. Since the services are provided by a nonmedical person, it constitutes an example of primary health care.

The subcenter, the primary health center function as under fives clinic one afternoon every week. The Pediatric Outpatient Department in the hospitals function as under fives clinic everyday.

Importance

The services are concentrated to under fives because of the following reasons:

- They constitute nearly 15 percent of total population
- They are nutritionally vulnerable
- They constitute human resource of the country in future
- They are responsible for the progress of the country.

Aim

The aim of the clinic is to provide comprehensive health care to under fives through nonmedical person, in an economical way.

Functions

The functions of an under fives clinic are shown diagrammatically as an 'Emblem' **(Fig. 22.19)**.

The emblem consists of 6 triangles, 2 large and 4 small ones. The apical small triangle represents 'Curative Services', i.e. care in illness. Since common health problems are diarrhea and respiratory symptoms like cough, the services provided in the early stage are distribution of ORS packets and pediatric cotrimoxazole tabs, to the parents. If the child does not improve, it is referred to the medical officer. Thus, the treatment of sick children is the mother's felt-need.

The left small triangle refers to 'Promotive services', such as 'Growth monitoring' and 'Health check-up'. The child is periodically weighed and recorded in the 'Road to health card' to make an early diagnosis of malnutrition and is corrected. The health worker will try to find the cause of growth failure such as defect in feeding practices and presence of infections, infestations, etc. The general health check-up is also done periodically.

The right small triangle represents 'Preventive services' such as routine immunization, Vitamin A prophylaxis and distribution of IFA tablets (Ped), each containing 20 mg elemental iron and 100 mcg of folic acid, one tablet a day for anemic children. 5 mega doses of Vitamin A syrup is given for children below 5 yrs and is even extended up to 5 years.

The central inverted small triangle, represents the symbol of 'Family planning' of India and its position touching the

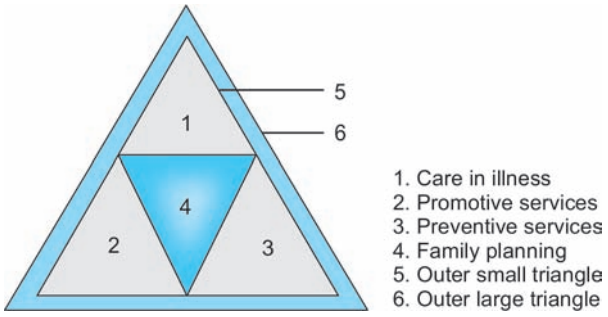


Fig. 22.19 Emblem of under fives clinic

three triangles is in correct context. It is the 'Center of concern' for the health and wellbeing of not only the child but also the entire family. So, the family welfare services are also provided to the mother. Thus, it is possible to conduct family planning program successfully through these clinics, because mothers accompany the children.

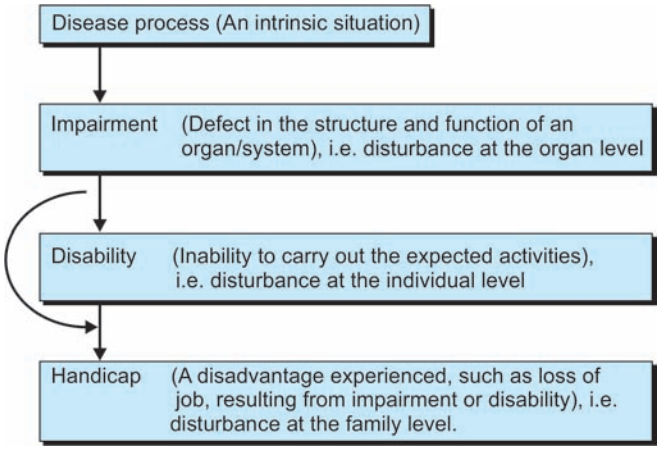
The outer small triangle constitutes the margin of all the four small triangles.

The outer large triangle represents 'Health education', which the mother automatically receives, regarding the care of the child, such as growth monitoring, oral rehydration therapy, breastfeeding, immunization, family planning, personal hygiene, female literacy, etc.

HANDICAPPED CHILDREN

A handicapped child is the one, who is experiencing a disadvantage physically, psychologically, (mentally) or socially in the life and is not able to carry out the normal activities (role) expected out of him/her, resulting from an impairment or disability.

The concept or evolution of handicap, as explained by WHO is as follows:



Handicap may also result from impairment without an intermediate state of disability.

Taking accident as an example, the evolution of handicap can be explained as in **Flow chart 22.2**.

Extent of the Problem

WHO (1976) estimated that 10 percent of the world's population is disabled, which is about 200 million (20 crores).

In India, about 2 percent of the population suffer from one or the other physical disability in the country at any given point of time, i.e. about 2 crores. Disabled children constitute about 3 percent of children population and usually they will have retarded growth and development (delayed milestones).

Problems of Having a Disability

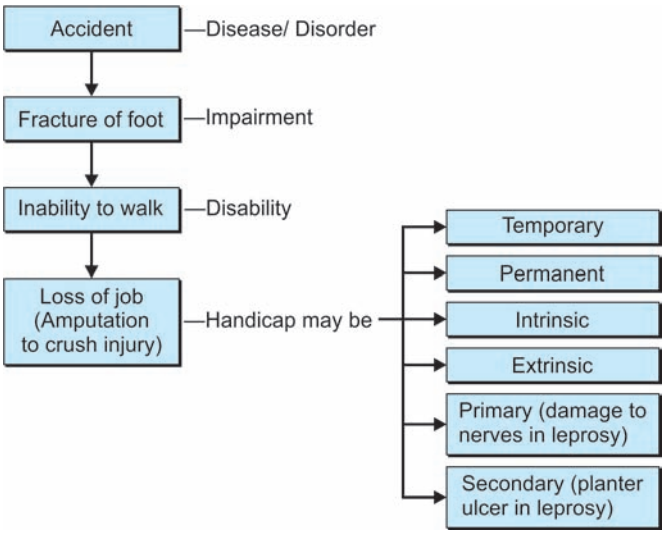
A disabled person faces many social disadvantages such as inferiority complex, inability to compete with normal persons, lack of self-confidence, fear of social ridicule that they are under some divine punishment. In addition, they are often not included in high positions in the administrative or political offices. They have poor representation in the community affairs.

Classification of Handicapped Children

Handicapped children are classified into three groups:

A. Physically handicapped
B. Mentally handicapped
C. Socially handicapped.

Flow chart 22.2 Evolution of handicap following accident



Physically Handicapped Children

These include handicaps resulting from either congenital defects (such as congenital heart disease, cleft lip, cleft palate, telipes, etc.) or acquired due to disease or accidents such as blindness, deafmutism, injuries, paralysis, etc. To a large extent, these are preventable.

Mentally Handicapped Children (Mentally Retarded)

These children have subaverage intellectual function combined with deficits in adoptive behavior.

Extent of the problem: Fifteen million children in India are mentally retarded.

Causes

- *Congenital (Genetic)*: Down's syndrome, Klinefelter's syndrome, phenylketonuria, galactosemia, microcephaly, congenital hypothyroidism, other chromosomal abnormalities.
- *Antenatal*: Erythroblastocis fetalis, rubella, syphilis, toxoplasmosis, teratogenic drugs, irradiation.
- *Perinatal*: Birth asphyxia, birth injury, cerebral palsy.
- *Postnatal*: Head injuries, accidents, encephalitis, lead or mercury poisoning, etc.
- *Miscellaneous*: Low birth weight, PEM, iodine deficiency, consaguineous marriages, late pregnancy beyond 35 yrs of age.

Diagnosis: By neurological examination, Binet's test for IQ, biochemical tests and cytogenetics (for chromosomes).

Degree of mental retardation (MR): A person is considered as mentally retarded if the IQ is less than 70 percent.

$$\text{Intelligent Quotient (IQ) (Binet's test)\%} = \frac{\text{Mental age}}{\text{Chronological age}} \times 100$$

Grading of mental retardation (WHO): Depending upon IQ.

Percentage of IQ	Degree of MR	% distribution among MR
< 20 34-20	Very severe Severe	5 to 10%
49-35	Moderate	20%
69-50	Mild MR	70%
70-100	Normal	
> 100	Genius	

Terms like moron, imbecile, idiot are now not used. Physically and mentally retarded children are taken care by rehabilitation.

Socially Handicapped Children

A socially handicapped child is the one whose opportunities for a healthy personality development are hampered, i.e. unfolding of potentials are hampered because of defect in the social environment such as death or divorce of parents, lack of learning process, negligence, exploitation or victimization of children, illegitimacy, delinquency, etc. A physically or mentally handicapped child also meets with social handicaps.

Socially handicapped children are taken care of by 'Child-placement' measures, such as adoption, borstals, certified schools (Juvenile home) remand homes, Foster homes and orphanages.

Prevention of Handicap

At primary, secondary and tertiary levels **(Flow chart 22.3)**.

Primary Prevention

This measure is adopted before the occurrence of the disease, by two modes—health promotion and specific protection.

Health promotion: These are the general measures, which will prevent an individual from getting the disease.

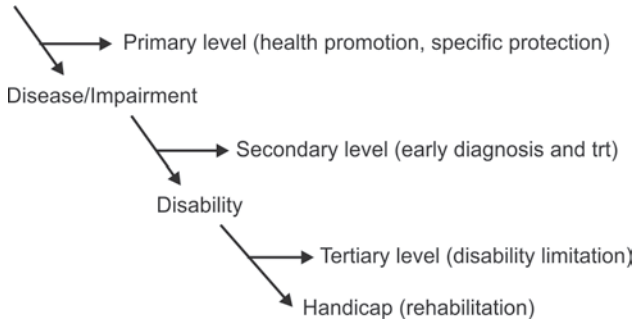
These general measures include good living conditions with safe environment, adequate nutrition, health education, personal hygiene, sex education, genetic counseling (to avoid late and consanguineous marriages), efficient antenatal care.

Specific protection: For example, immunization with oral polio vaccine—prevents polio-paralysis, Vitamin 'A' prophylaxis schedule—prevents nutritional blindness.

Immunization of all potential mothers with Rubella - vaccine prevents congenital rubella.

Immunization of Rh –ve mothers with Rh-antibody prevents erythroblastosis fetalis.

Flow chart 22.3 Implementation of preventive measures against handicap at various levels



Secondary Level of Prevention

This measure prevents the transition from impairment to disability. The intervention is early diagnosis (ED) prompt treatment of the disease. For example, During pregnancy ED and treatment for hypertension, diabetes, syphilis, Rh-status, tuberculosis, etc.

Among children for fractures and injuries, PEM, etc.

Application of traction, splints, braces to prevent deformities.

Tertiary Level of Prevention

This measure is taken once the disability has occurred and is found to be irreversible, by two modes:

Disability limitation: To limit the development of further disability by intensive or aggressive treatment, to prevent transition into handicap. For example, treatment of corneal xerosis prevents blindness.

Rehabilitation: This measure is applied when the individual has become already handicapped, so that he/she becomes useful to himself/herself, to family and to community at large, by training and retraining by medical, social, vocational and psychological measures.

Mentally handicapped children require tender care, love and affection. Their potentialities should be identified and the child must be helped to develop in that direction.

Socially handicapped children are taken care by child-placement measures.

Child Placement Measures

These are the measures by which the socially handicapped children are taken care. These measures are:

- *Adoption:* The children are legally adopted by the couples who do not have children. This confers upon both the child and the adoptive parents, the rights and responsibilities similar to that of natural parents. The law varies from country to country. The relevant law in India is 'Hindu Adoptions and Maintenance Act, 1976'.
- *Orphanages:* Orphans are those children who either do not have parent/s or who are not taken care by the parents. Such orphans are placed in orphanages. In such institutions, children do not experience the warmth and intimacy of family life. So, the chances to become good citizen is less.
- *Foster homes:* These are the places where facilities are provided to take care of the children, by the foster parents, who are paid. The children are provided with love, security and affection that is needed.
- *Remand homes (Juvenile homes; certified schools):* Here, the delinquent children are placed under the care of

doctor, psychiatrist and other trained personnel. Efforts are made to improve the physical and mental well-being of the child, by elementary school education, various arts and crafts, sports and recreational facilities.

- *Borstals:* It is an institution falls in a category between juvenile (a certified school) and an adult prison, where children above 16 years of age who are difficult to be handled in a juvenile home or misbehaved there are placed. A borstal sentence is usually for 3 years. Such children are not punished but trained and reformed. Borstals are governed by State Inspector General of Prisons.

JUVENILE DELINQUENCY

According to Children Act, 1960, it means an offence committed by a child, a boy below 16 years or a girl below 18 years of age. In a broad sense, delinquency not only includes a crime but also all deviations from normal behavior such as disobedience to parents, deserting their homes, mixing with immoral people or indulging in antisocial activities such as stealing, telling lies, gambling, burglary, cruelty, sexual offences, destructiveness, etc.

The incidence has been found to be high in our country, five times more among boys than among girls, and is on the increase due to industrialization and urbanization.

Causes

- *Genetic causes*: Recent studies have shown that chromosomal anomaly such as XYY might be associated with delinquency (i.e. extra Y chromosome).
- Usually, the social causes predispose for the occurrence of delinquency, such as broken homes, (e.g. death or divorce of the parents, step mother treatment) disturbed home conditions (e.g. poverty, alcoholism).
- Other causes include the influence of cinemas, television, immoral friends, etc.

Prevention

- Improvement of the family life, such as cardial relation among them, meeting the needs of the children by the parents, showering love and tender care on the children.
- Schooling helps in ordering the behavior of the children and also it helps in maintaining the decency and discipline in the life.
- Social welfare services like recreation facilities, parent counseling, child placement in juvenile homes, etc.

CHILD GUIDANCE CLINIC

It is a clinic meant for those children, who are not fully adjusted to their environment. They are guided and prevented from becoming psychotics and neurotics in later life. It was first started in Chicago in 1909.

The clinic consists of a team comprising of a psychiatrist, a clinical psychologist, psychiatric social workers, public health nurses, pediatrician, speech therapist, occupational therapist and a neurologist. Psychiatrist is the main person to take care by restoring positive feelings of security in the child by various measures such as play therapy, counseling, easing of parental tensions, reconstruction of parental attitudes, etc. this is based upon the philosophy that if sound foundations of mental health are laid in childhood, the same will continue into adulthood.

SCHOOL HEALTH SERVICES

Importance: The health services to school children (5-15 yrs) is an economical yet powerful means of raising the community health because of the following reasons:

- School-children constitute nearly 20 to 25 percent of our population (Large number).
- They are nutritionally vulnerable.
- School age is a period of rapid growth and development.
- School age is a 'formative period', physically, mentally, socially and intellectually, transforming the school-child into a promising adult (A child of today is the citizen of tomorrow).
- Health of the country, depends upon the health of the children.
- The health habits formed at this stage will be carried to the adult age, old age and even to the next generation.

Thus, school health service is a forum for the improvement of the health of the nation.

School is a temple of learning. It is a place where the child exposed to stress, strain and hazards of group life because different children come from different socioeconomic and cultural background with different immunity status. Since the growing children are vulnerable they become the easy victims of many communicable diseases, such as tuberculosis, tetanus, rheumatic fever, diarrheal diseases, etc. which can be prevented and they also suffer from many noncommunicable diseases such as malnutrition, dental, visual and hearing defects, congenital disease, etc. which make learning difficult and may even lead to changes in the personality and behavior. Most of these can be detected and corrected, so that they can cope-up with their education and become normal future promising adults.

Unfortunately school health services are not well organized in our country because of peculiar rural conditions, economic problems, nonavailability of medical personnel in villages, ever growing number of schools and such other conditions.

School Health Program is a comprehensive Health Program.

Objectives

- *Health promotion*: To keep child physically fit and mentally alert to receive the education
- *Health protection*: To protect the child from various communicable and noncommunicable disease
- *Health restoration*: By early diagnosis by periodical screening and prompt treatment of diseases and their follow-up
- *Health education*: To create health consciousness among children and also to inculcate healthy habits and practices.
- *Healthy living*: In a healthy environment of school.

Components of School Health Program

Components of School Health Program are health services, healthful living and health education.

Health Services

These are designed to provide comprehensive health care such as preventive, promotive and curative services. The main activities are:

i. *Health (appraisal):* This consists of periodical medical examinations, once in 4 years, starting from the time of admission. The initial examination must be thorough and should consist of correct history, thorough physical examination, anthropometric examination and routine laboratory examinations and the findings are recorded in the 'School health record'. This is done by the School medical officer, assisted by the School teacher.

The school teacher also will carry out 'Daily morning inspection' of the children by looking for the signs of illness such as dull face, runny nose, flushed face, red and watery eyes, rashes, etc.

Screening procedures are also carried out to detect visual defects (refractive errors), hearing defects and dental defects.

Any health problem detected must be recorded and informed to the parents through the class teachers. (i.e. Health counseling). The parents should be persuated to get the child treated. The school medical officer will manage at the clinic.

ii. *Immunization:* The routine immunization recommended for the school children are hepatitis B vaccine, typhoid vaccine, tetanus toxoid and rubella vaccine (specially for girls). These are also entered in the record. A planned immunization program is drawn up.

iii. *First-Aid:* Emergency care will be provided by the teachers to the children who become injured or sick in the school premises, such as injuries, fractures, unconsciousness, fits, vomiting and diarrhea, etc. The teachers should have received adequate training during their training program.

iv. *Screening procedures:* This includes evaluation of mental health, dental health and defects of vision and hearing, which are all hurdles in the learning process.

Mental health is assessed by their behavior, habits and intelligence. Behavioral disorders may lead on to juvenile delinquency. Such children are taken special care by giving more of assignments, homework, etc. Habits like smoking are also taken care of. Children with low IQ are referred to child guidance clinic. Thus, a better shape is given to the child.

Dental health is assessed by annual dental examinations. The common dental problems are caries tooth, mal-occlusion (nonalignment) and periodontal diseases (of gums and supporting tissues), which are all detected and corrected.

Vision: Since visual defects are serious obstacle to learning process, screening procedures are adapted by ophthalmologist to detect refractive errors using Snellen's chart. Treatment is also done for squint, amblyopia and eye infections.

Hearing: Since the hearing defect also interferes with the learning process, it is detected by audiometer and corrected.

v. *Referral services:* Referral of sick children or children with visual, dental, hearing or any other defect are referred to appropriate health agency (institutions) for better treatment for referrals, special clinics are conducted for school children at primary health centers in rural areas.

vi. *Follow-up:* It is necessary to ensure that the child complies with the referral service.

vii. *Examination of teachers and other staff:* All the staff members are also examined for any diseases, because they may be the source of infection to the children.

viii. *Maintaining records:* A cumulative record is maintained for every student. It gives cumulative information about the name, age, sex, date of birth, parent's name, address, past health status, present health status and the services provided. This record will also be useful in evaluation of school health program.

Healthful School Living (Healthful School Environment)

Since the school children spend most of their time in the school only, the environment must be healthy both inside

and outside the school, so that the children should remain healthy, physically, mentally, socially, emotionally and culturally. School should serve as a model center of good sanitation to the community.

The elements of healthful school living are:

i. School building with a playground and clean sanitation.
ii. Healthful teaching
iii. Mid-day meal
iv. Physical education procedures
v. Relation between the teacher and the students and among the students.

School Building

Location: School should be centrally located with proper approach roads and away from busy places, heavy traffic, factories, cinemas, market and railway tracks. It should have a compound. Preferably it should have an ample space and good ventilation and a play-ground for games and physical exercises.

Classrooms: The classrooms should have verandahs outside and be spacious inside. The minimum floor space per student should be 15 sq feet. The height should be minimum 12 feet. The floor surface should be so smooth as to facilitate easy cleaning and washing. The classrooms should have good lighting, ventilation and sitting arrangements. Blackboard should be such that there is no glaring.

Lighting: The class rooms should have sufficient natural light, preferably from the sides and not front, because it will be dazzling to the eyes. If lighting is from behind, the student's shadow falls on the desk.

Ventilation: The windows should be arranged in such a way that it should not only provide light evenly and sufficiently but also should facilitate cross ventilation in the room. Combined door and window area should be 40 percent of the floor area. Improper ventilation facilitates transmission of diseases.

Sitting arrangements: If the 'Desk-chair' arrangements are improper, it results not only in the development of orthopedic, postural and myopic defects, but also in the loss of interest in writing and reading, thus interfering with the learning process.

There are three types of 'Desk-chair' arrangements **(Fig. 22.20)**.

Zero desk: It is one wherein the vertical line from the margin of the desk, touches the edge of the chair.

Plus desk: It is one wherein there is a space between the edge of the chair and the vertical line from the desk.

Minus desk: It is one wherein the vertical line from the desk falls on the chair.

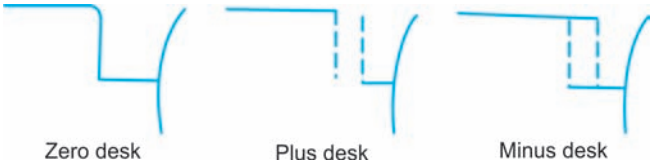


Fig. 22.20 Relation of seat to desk

Fig. 22.21 Correct position in a minus desk

From the point of view of health, desks should be of 'minus' type, so that the pupil should be able to read and write without leaning forward and will have a good back-rest which will in turn prevents postural defects **(Fig. 22.21)**. A plus type of desk, predisposes for the development of myopia, contracture of the chest, and spinal deformities.

Clean sanitation: Outside the school building and within the compound, the environment is kept sanitary by providing protected water supply, sanitary latrines and urinals and also by proper collection and sanitary disposal of refuse.

Water supply: There must be provision to supply clean and safe water, preferably from the independent source like tube-well and the supply should be continuous through taps. There must be a minimum of 'one drinking fountain' for every 100 students.

Latrines and urinals: There must be one urinal for every 50 students and one latrine for every 100 students, separately for boys and girls.

Refuse: All the wastes of classrooms, verandahs, and other rubbish collected from the dustbins and disposed off by burning. Here and there, there must be receptacles with carbolized saw dust and sand placed for spitting.

Healthful Teaching

The daily teaching routine in the class must be arranged in such a way the classes should be interspersed with rest pause, games and physical exercises. The teaching classes should not be didactic, depressing, discouraging and boring to the students. Monotony is avoided.

Mid-day Meal

Since the school children are nutritionally vulnerable, development of malnutrition not only makes the child physically and mentally weak (affecting the growth and development) but also interferes with learning process. Thus, malnutrition is a serious obstacle to take full advantage of schooling.

Since the nutritional disorders are widely prevalent among school children, in order to combat malnutrition, The School Health Committee (1961) recommended the provision of one nourishing meal in the middle of the day. (mid-day meal). This program has been in operation in many states of our country since 1962 to 63, after its first successful organization in Tamil Nadu in 1957.

In this mid-day meal program, efforts are directed to encourage the children to adopt and enjoy good food habits and hygienic measures. Today, this program has become an integral part of the educational system in many countries, because it not only improves the nutritional status of the children but also improves the educational performance.

The particulars of the mid-day meal are:

- It is a supplement and not a substitute for the home diet.
- It should provide at least 1/3 of the daily calorie requirement and about half of daily protein requirement.
- The cost of the meal should be reasonably low.
- The meal should not involve complicated cooking process.
- The menu is changed frequently to avoid monotony.
- The meal should be provided through their own cafeteria on a 'No profit no loss' basis. So the fund may be formed with contribution by students, by school authorities, assistance from Government and from charitable organizations, such as UNICEF, CARE, etc.

A model menu for a mid-day school meal is as follows:

Sl. No.	Food item	Quantity (g/day/child)
1.	Cereals and millets	75
2.	Pulses	30
3.	Leafy vegetables	30
4.	Non-leafy vegetables	30
5.	Milk	150 mL
6.	Oils and fats	8

The National Institute of Nutrition, Hyderabad is of the view that the number of feeding days in a year should be atleast 250 days to have a desired impact on the growing children. There should be one or two teachers earmarked for this special duty of school lunch.

Physical Education Procedures

This is carried out under the supervision of physical education teacher. This physical education not only helps in the growth and development of the children, but also promotes a sense of team-work and discipline. Some of them become sports men and women.

Pupil-pupil Relation and Pupil-teacher Relation

The healthy relation between the pupil and the pupil not only helps in the development of behavior pattern but also helps to retain the affection throughout the rest of the life. Teachers can foster this relation better by encouraging group discussions, by handling the conflict situations, etc.

The teacher–pupil relation is also important for a healthful school living. The teacher should be a model for the students in maintaining decency, discipline, decorum, punctuality, sincerity and honesty.

Health Education

This is another important component of School Health Program. The objective of the health education is to bring about changes in their knowledge, attitude and practice that promotes effective healthful living both at home and in the community.

The teacher is the key person to impart health education. It is directed at the health needs and interests of children. There are 13 areas of health education.

- Personal hygiene (Care of all parts of the body from head to toe including attention to posture)
- Prevention of diseases (Immunization)
- First-Aid
- Safety education (Recognition and avoidance of hazards causing death or disability)
- Mental health
- Nutrition education (about dietary habits by wise selection and use of feeds)
- Improvement of environmental sanitation
- Consumer health
- Adult health education (Health problems confronting adults)
- Family life education (about sex, successful marital relation, and family relation)
- Hazards of alcohol, tobacco, narcotics and such other drugs
- International health.

Since the students watch their teachers, they should practice good health habits. Since the parents are the first

teacher of the children, their habits, behavior and lifestyle has a great effect on their children. Health education at home should go hand in hand with school health education.

The School Health Committee recommended that the school health service should be an integral part of general health services, provided through primary health centers in the rural areas, i.e. through the Medical Officers.

One special kind of education given to school children is 'Child to Child Program' (CCP).

Under this program, some children are selected, educated in an interdisciplinary manner about selected subject of national or regional importance, e.g. pulse polio immunization. They are taught about the scientific background of the selected subject and informed about what to do and why to do. Thus, they become health messengers not only for other children of the school and members of the family but also to the community at large.

These selected children create awareness and spread the health message in the community by the following measures:

- Singing subject based folk songs set to the tune of popular film songs
- Telling stories or street plays
- Taking out a procession carrying placards describing the preventive action to be taken.

INDICATORS OF MCH CARE

The commonly used indicators are:

1. Maternal mortality rate (MMR)
2. Mortality occurring during infancy:
   - Perinatal mortality rate (PNMR)
   - Neonatal mortality rate (NNMR)
   - Postneonatal mortality rate (PNNMR)
   - Infant mortality rate (IMR)
3. Mortality occurring during childhood:
   - 1 to 4 year mortality rate
   - Under 5 mortality rate (0-5 yrs)
   - Child survival rate.

Maternal Mortality Rate

Maternal death is defined as, death of a woman while pregnant or during childbirth or within 42 days of termination of pregnancy, irrespective of site or duration of pregnancy, from any cause related to or aggravated by pregnancy or its management, but not from accidental or incidental causes.

In other words, death of a pregnant woman due to suicide or homicide or accident in the street, factory or home is not a maternal death. However, the death of woman during pregnancy due to worsening of a pre-existing disease or death resulting from anesthesia during cesarean section constitutes maternal death.

The maternal deaths of a given country, during a given year, is estimated per 1000 livebirths and is expressed as maternal mortality rate. Maternal mortality rate is defined as the number of maternal deaths per 1000 livebirths. Maternal mortality ratio is defined as the annual number of maternal deaths per 1000 deliveries. In developed countries, it is estimated per 1,00,000 livebirths because MMR is very low.

$$\text{MMR} = \frac{\text{No. of deaths of mothers during pregnancy, childbirth or within 42 days of delivery, in a given area, during a given year}}{\text{Total No. of livebirths in the same area and year}} \times 1000$$

'Late maternal death' is death of a woman from 43rd day of delivery to 1 year.

'Puerperium' is 42 days period, following the childbirth, (6 weeks) during which the uterus undergoes involution.

Magnitude

It is estimated that globally, nearly 5 lakhs maternal deaths occur every year. About 99 percent of this occurs in developing countries and hardly 1 percent in developed countries. Next to Africa (2.5 lakhs), South Asia has highest MMR in the world. It is shockingly high in India, nearly 150 maternal deaths per day, one evey ten minutes. For every maternal death, there are 14 perinatal deaths and many women experience serious complications. Most of these are preventable. It is one of the leading causes of death among women of reproductive age.

The current national MMR in India is 2.12/1000 live-births (2010).

Causes of Maternal Mortality

The causes are grouped into obstetric, medical and social causes.

Obstetric causes: These are subdivided into antenatal, intranatal and postnatal causes.

Antenatal: Toxemias (Pre-eclampsia; eclampsia); ante partum hemorrhage, placenta previa, abruptio placentae, multiple-prognancies, incomplete abortion followed by bleeding, ectopic pregnancy, criminal abortion.

Intranatal: Rupture of uterus, prolonged labor, obstructed labor, anesthetic shock during cesarean section, amniotic fluid embolism.

Postnatal: Puerperal sepsis, postpartum hemorrhage, thrombophlebitis.

Medical causes: Anemia, malnutrition, associated underlying systemic diseases, (cardiac, respiratory, renal, etc).

Social causes: These are not the cause of maternal death but they are the predisposing factors making the pregnancy

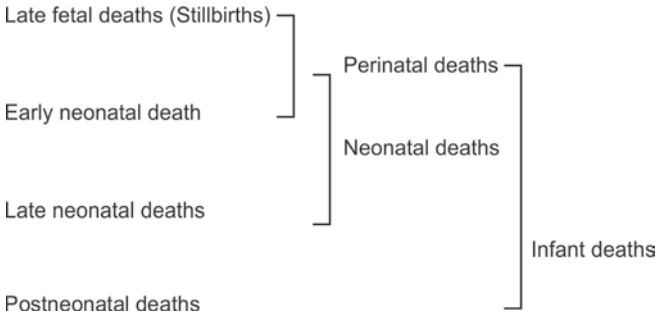
and child-birth a risky venture. These are poverty, illiteracy, ignorance, overcrowding, poor living conditions, lack of sanitation, illegitimacy, lack of health care services, other customs like early marriage and teenage pregnancies, too frequent and too many pregnancies (because of gender discrimination), etc.

Reduction of Maternal Mortality Rate

a. *Efficient antenatal care:* Such as early recognition and registration of expectant mothers, regular antenatal check-up, antenatal investigations, detection and referral of high-risk mothers, antenatal advice including warning signals, antenatal services like immunization and nutritional supplementation, distribution of IFA tabs.
b. *Efficient intranatal care:* Provision of safe delivery by a trained person observing 5 cleans, identification of danger signals and giving special attention, institutional deliveries for high-risk mothers.
c. *Efficient postnatal care:* Promotion of speedy recovery by regular postnatal check-up and postnatal advice, encouraging early ambulation, provision of emergency care by blood transfusion.
d. *Family welfare services:* Counseling of newly married couple not to conceive before 20 years and after 30 years of age; spacing for more than 3 years between the pregnancies, limiting the number of children, preferably to only one.
e. *Health education:* About nutrition, drugs, exercise, habits, personal hygiene, about taking treatment for the illness, etc.
f. *Other services:* Encouraging female literacy and socio-economic development of the community through active community involvement.
g. Lastly identification and investigations of every maternal death.

Mortality During Infancy

The different components of the mortality occurring in and around infancy are as follows:



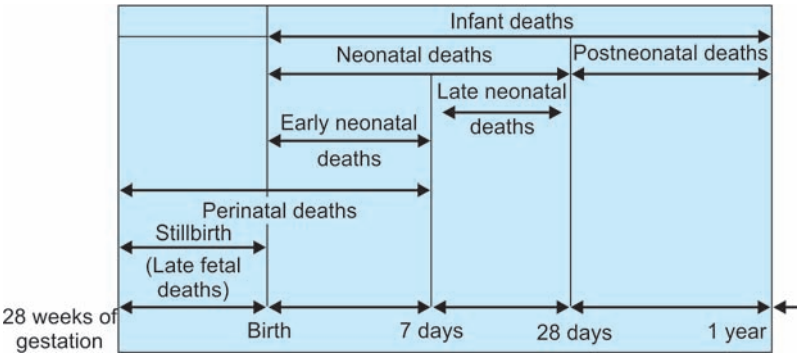
Represented diagrammatically as follows:
Accordingly, the different indicators are:

- Stillbirth rate
- Perinatal mortality rate
- Neonatal mortality rate
- Postneonatal mortality rate
- Infant mortality rate.

Stillbirth

Stillbirth or late fetal death is one in which the fetus is born dead, after completion of 28 weeks of gestation but before full term (40 wks). But for international comparison WHO has suggested that the weight of the fetus at 28 wks of gestation is taken as 1000 g. Stillbirth is expressed per 1000 total births.

Stillbirth rate is defined as 'Number of fetal deaths weighing more than 1000 g at birth in a given area, during a given year'. It is expressed per 1000 total births. (stillbirths + livebirths).



Formula

$$\text{SBR} = \frac{\text{No. of fetal deaths weighing over 1000 g at birth}}{\text{Total births (Total livebirths + stillbirths weighing more than 1000 g at birth)}} \times 1000$$

The current SBR in India 8 per 1000 total births (2008).

Causes

- *Maternal:* Toxemias, diabetes, infections, Rh-incompatibility, premature rupture of membranes. Antepartum hemorrhage.
- *Placental:* Anomalies of placenta, anomalies of cord.
- *Fetal:* Fetal malformations, twins, triplets, quadruplets, hydramnios.

Perinatal Mortality Rate

Perinatal mortality rate (PMR) is number of deaths of newborns occurring during perinatal period. Perinatal period is the period lasting from 28th week of gestation to 7th day after full-term. Therefore, perinatal deaths include late fetal deaths (Stillbirths) and early neo-natal deaths. (Deaths occurring within 7 days of the birth).

$$\text{PMR} = \frac{\text{No. of stillbirths + No. of early neonatal deaths weighing over 1000 g at birth}}{\text{Total no. of livebirths, weighing over 1000 g}} \times 1000$$

For international comparison, the denominator is total livebirths and not total live- and stillbirths. Early neonatal mortality is also called 'Hebdomadal mortality'.

PMR is a very sensitive indicator of obstetric and neonatal care, i.e. the quality of health care available to the mother and the newborn. The important reason of including both stillbirths and early neonatal deaths under one term as perinatal deaths is that the factors responsible for these two types of deaths are often similar. These factors when severe result in stillbirth and when mild result in early neonatal deaths.

Incidence

The PMR in India is 35/1000 livebirths. (2009). It is very high in Bangladesh (85) and Pakistan (70). It is very low in Japan (5) and Singapore (5). In India, Kerala with PMR 13 are the least performing state and Madhya Pradesh and Chhattisgarh (45) are the least performing states during 2009.

Causes of PMR

The causes of PMR are grouped into medical and social.

Medical causes are subgrouped into antenatal, intranatal, postnatal and miscellaneous (all causes of still-births + causes of neonatal deaths).

Antenatal causes: All 'high-risk' mothers.

Intranatal causes: Obstructed labor, prolonged labor, birth - injuries, (Birth injuries include cranial fractures, visceral rupture, massive subdural hematoma) birth-infections, birth-asphyxia.

Postnatal causes (Neonatal causes): Acute respiratory distress syndrome (due to the presence of hyaline membrane in the pulmonary alveoli) low birth weight, respiratory and alimentary disease, congenital anomalies, neonatal tetanus.

Miscellaneous causes: Include placental and fetal causes.

Placental causes: Placenta previa, placental insufficiency syndrome, placental anomalies, abruptio placenta.

Fetal causes: Fetal malformations, multiple pregnancies, hydramnios.

Social causes: There are all predisposing factors, same as for maternal mortality (See under MMR).

Prevention of PMR

See under infant mortality rate.

Neonatal Mortality Rate

Neonatal deaths are the deaths of the newborn occurring within first 28 days after birth. It is expressed in numbers per 1000 livebirths during a given year, in a given area.

Formula

$$\text{NNMR} = \frac{\text{No. of deaths of newborns within first 28 days of birth in a year}}{\text{Total no. of livebirths during the same year}} \times 1000$$

The current NNMR in India is 39/1000 livebirths (2007). It is more among baby boys than among baby-girls because baby boys are biologically more fragile than girls. About 50 percent of infant deaths occur in the neonatal period and about 50 percent of this occur in the early neonatal period (first 24 to 48 hours). NNMR was about 75/1000 LB during 1980-81. It is on the decline in our country. But it is not declining proportionately compared to the inputs of health services. It is lowest in Kerala state (7 per 1000 LB). Neonatal survival is a very sensitive indicator of population growth and socio economic development of the country.

Causes

See under infant mortality rate.

Neonatal mortality rate (NNMR) is inversely proportional to birthweight. Lower the birthweight, higher the NNMR and vice-versa. All causes resulting in LBW (endogenous factors) can result in NNMR.

Prevention of Neonatal Mortality Rate

See under infant mortality rate.

Postneonatal Mortality Rate

Postneonatal deaths are the deaths of infants occurring from 29th day till the end of one year. This is also expressed in number per 1000 livebirths, in a given area, during a given year.

Formula

$$\text{PNNMR} = \frac{\text{No. of deaths of infants (children) between 29 days and one year of age in a given year}}{\text{Total no. of livebirths in the same year}} \times 1000$$

The PNNMR in India is 16/1000 livebirths (2009).

Whereas NNMR is influenced by endogenous factors, (maternal factors) PNNMR is influenced by exogenous factors (environmental and social factors). This (PNNMR) is more among girls than among boys because of preferential care for male children (NNMR is more among boys).

Causes

See under 'Infant mortality rate.'

Infant Mortality Rate

Definition

Infant mortality rate is defined as the number of deaths of children below one year of age in a given area, during a given year, per 1000 livebirths.

Formula

$$\text{IMR} = \frac{\text{No. of deaths of infants, in a given area during a given year}}{\text{Total no. of livebirths in the same year}} \times 1000$$

Importance

Infant mortality rate is universally considered as the most sensitive indicator of health status of a country. It also reflects the cultural milieu and the socioeconomic development of the country. It reflects the quality of MCH care. Thus, it also reflects the peoples' attitude toward value of human life. No single indicator conveys so much as the infant mortality rate.

Among all the mortality rates, IMR deserves special mention because:

- It is the largest, single, age category mortality
- Deaths occurring during infancy are due to peculiar set of conditions, to which adult population are not exposed
- It is affected directly and quickly by the specific health programs.

Magnitude of the Problem

Infant mortality rate is a global problem. It is very low in developed countries and high in developing countries. It is maximum in Sierra Lieone (113.7/1000 LB) and is minimum in Iceland (1.6/1000 LB), Singapore (2.1/1000 LB) and Japan (2.4/1000 LB). Further reduction of IMR in developed countries is difficult because it depends upon preventing congenital abnormalities.

The decline of IMR in developed countries is mainly because of improvement in the quality of life. Improvement in the quality of health services has played a secondary role. This is reverse in developing countries. In India, IMR was very high in the beginning of the century (200/1000 LB). It started declining slowly and reached 120/1000 LB at the time of Independence (middle of the century) and 64/1000 LB during 2002 and 53/1000 LB during 2008 (SRS) and 47.57/1000 LB during 2010. Inspite of significant decline, it is still very-very high compared to developed countries. Rate of decline is very slow **(Fig. 22.22)**. That means social development is very slow in India. The Indian planning commission in the tenth plan has outlined that we should achieve IMR of 30 by the year 2012. We are nearer to it.

Within India, IMR shows variation from state to state. It is maximum in Orissa 98/1000 LB and minimum in Kerala 16/1000 LB (1998 data).

Kerala has lowest IMR (16/1000 LB), lowest Birth Rate (18.3/1000 MYP) and highest literacy rate (88%).

Causes of Infant Mortality

These are grouped into causes of neonatal mortality and causes of postneonatal mortality.

a. *Causes of neonatal mortality:* Low birth weight, hypothermia, birth injury, obstructed labor, birth asphyxia, congenital anomalies, neonatal tetanus, acute respiratory distress syndrome, diarrheal diseases.
b. *Causes of postneonatal mortality:* Acute infections (Respiratory and diarrheal disease), malnutrition, congenital anomalies, accidents.

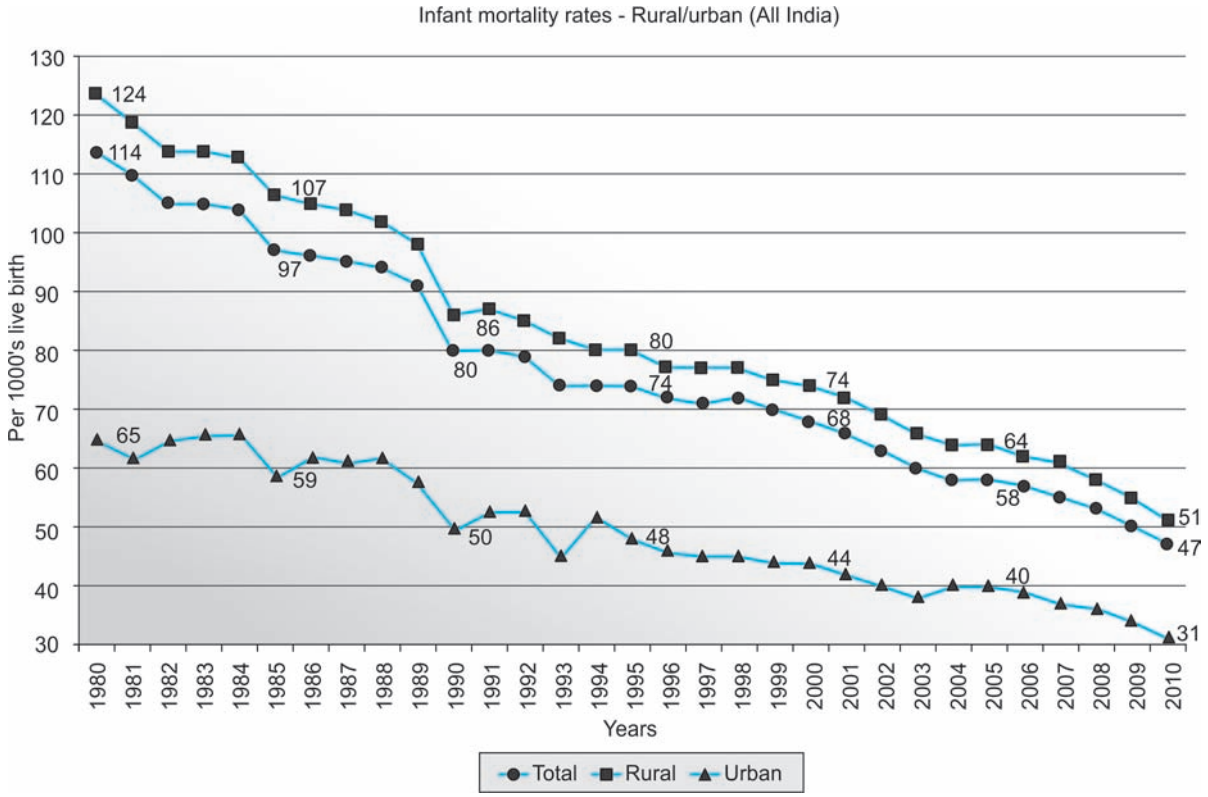


Fig. 22.22 Infant mortality rate
Source: Government of India. MOHFW. Family Welfare Statistics in India. 2011.

Predisposing Factors

These are grouped into biological, social and cultural.

a. *Biological factors*:
- *Birth weight:* Lower the birth weight, higher the infant mortality.
- *Age of the mother:* Younger the age of the mother (teenage pregnancy) higher the infant mortality. Infant mortality becomes again high, when mother is relatively older (above 35 yrs).
- *Birth order:* Infant mortality is highest among first born and lowest among second born. Again the risk increase after third birth. It is highest after 5th birth.
- *Birth interval:* Shorter the birth interval, higher the infant mortality.
- *Multiple births (Twins, triplets):* This is associated with high infant mortality because of LBW newborns.
- *Fertility:* Higher the fertility, higher the infant mortality.
- *Family size:* Higher the family size, higher the infant mortality.

b. *Social factors*:
- *Economic status:* Poorer the economic status, higher the infant mortality.
- *Literacy level:* This is inversely proportional. Higher the literacy level among mothers, lower the infant mortality (as in Kerala) because a literate mother can take better care of the infant.
- *Living condition:* Better the living condition, lower the infant mortality.
- *Broken families:* Infant mortality is higher among those families, where mother or father is dead or divorced.
- *Illegitimacy:* A child born out of wedlock is at a higher risk of death.
- *Lack of sanitation:* Such as lack of safe water supply, poor living condition, overcrowding, presence of insect breeding places, etc. is associated with increased infant mortality.
- *Sex of the child:* In most parts of India, birth of a female child is unwelcome. Infant mortality is high among female children, because of preferential care for male children.
- *Quality of health care:* Infant mortality is directly related to quality of services such as immunization, nutritional services, family welfare services and maternal care. Better the quality of service, lower the infant mortality.

c. *Cultural factors:*
- *Feeding practices:* Correct feeding practices with exclusive breastfeeding during first six months followed by proper weaning has considerably reduced infant mortality. Malpractices in breastfeeding increases infant mortality.
- *Customs:* Of early marriages and teenage pregnancies is associated with increased infant mortality.
- *Brutal habits:* Such as cutting the umbilical cord with knife, application of cowdung to umbilical stump, etc. increases infant mortality.

Prevention of Infant Mortality Rate

Since infant mortality is multifactorial in causation, preventive measures are also multiple. Under ideal conditions no infant should die except those who are born with congenital irrepairable anomalies.

The various measures of preventing infant mortality are grouped into two broad groups namely, general measures and specific measures.

General measures: These consist of improvement in the socioeconomic development of the community such as:
- Improvement in female literacy
- Improvement in the living conditions and
- Improvement in the sanitation, with a special emphasis on provision of safe water supply
- Avoiding early marriages for girls
- Health education of the mothers regarding feeding practices, weaning practices and child rearing practices.

Specific measures: These are subgrouped into:
a. Measures related to mother
b. Measures related to infant.
a. *Related to mother*:
- *Efficient antenatal care:* Minimum 3 visits to antenatal clinic, with a special emphasis to nutrition and IFA tabs to prevent LBW
- Two doses of tetanus toxoid during pregnancy to prevent tetanus neonatorum
- To detect 'high-risk' mothers and to provide special care
- Efficient intranatal care by thorough asepsis
- Prompt management of complications occurring during delivery.

b. *Related to infant*:
- Essential care of the newborn babies
- Special care of 'at risk' newborns including LBW babies.
- *Growth monitoring:* To detect and correct malnutrition early.
- *Oral rehydration therapy:* To prevent dehydration following diarrhea.
- *Breastfeeding:* To encourage correct breastfeeding practices
- *Immunization:* Of the infants against all vaccine preventable diseases
- *Family planning:* Measures to be adopted by parents, so that they can take better care of the infant.

Mortality Occurring during Childhood

One to Four Year Child Mortality Rate

Definition: It is the number of deaths of children between 1 to 4 years of age in a given area during a given year. It is expressed per 1000 mid year population of the same age. It is the probablity of a child dying between 1st and 4th birth day

Formula:

$$\text{1-4 yrs Mortality rate} = \frac{\text{No. of deaths of children between 1–4 yrs of age in a given area, during a given year}}{\text{MYP of children between 1–4 yrs of age}} \times 1000$$

1-4 yrs mortality rate is a refined indicator of the social situation of a country than infant mortality rate.

In India, for the year 1999, it was 24/1000 MYP of 1 to 4 yrs of age. It was about 5 percent of total deaths (2006). During 2009, it was 14.1. Kerala with child mortality rate 2.6 is the best performing state.

Causes: Diarrheal diseases, respiratory infections, malnutrition, accidents and congenital anomalies. Four groups of home accidents have been identified. They are fall from staircase/balconies, suffocation, burns and poisoning.

Child Survival Index (Child Survival Rate)

Child survival rate (CSR) is the percentage of children surviving up to the age of 5 years.

Formula:

$$\text{CSR} = \frac{1000 - \text{Under 5 mortality rate}}{10}$$

CSR is 90.4 in India, 98.1 in Sri Lanka, 99.4 in China, 99.2 in USA, 89 in Pakistan during the year 2000. This indicates the quality of health care services for children.

RIGHTS OF THE CHILD

The parliament approved the National Policy for Children on 22nd August, 1974. The policy recognizes children as the 'nation's' supremely important asset and declares that the nation is responsible for their nurture and solicitude.

The major issues which need urgent attention are child labor and primary education.

In the constitution:

- Article 24 prohibits employment of children below the age of 14 in factories
- Article 39 stresses prevention of abuse of children of tender age
- Article 45 stresses provision of free and compulsory education for all children until they complete the age of 14 years.

According to United Nations declaration, for which Government of India is signatory, the Rights of the Child are:

- Right to develop in the atmosphere of love, affection and security of the parents
- Right to enjoy the benefits of social security such is housing, medical care, etc.
- Right to free education
- Right for play and recreation
- Right to a name and nationality
- Right to special care if handicapped
- Right to receive protection and relief in times of disaster
- Right to develop in a healthy manner in conditions of freedom and dignity
- Right to be brought up in a spirit friendship among people
- Right to enjoy these rights irrespective of race, color, sex, religion, national or social origin.

The Current Level and Goals of MCH Care

Sl. No.	Indicators	Current level (SRS Bulletin 2009)	Goal for the year 2010
1.	Family planning indicators		
	Crude birth rate (CBR)	22.8 (2008)	21.0
	Total fertility rate (TFR)	2.9 (2006)	2.1
	Couple protection rate (CPR)	46.6% (2005)	> 60%
2.	Mortality Indicators per 1000 live-births		
	Infant mortality rate (IMR)	53.0 (2008)	< 30
	Neonatal mortality rate	39 (2004)	–
	Maternal mortality rate	3.01 (2008)	1
	Underfive mortality rate	17 (2007)	–
3.	MCH services (% coverage)		
	Immunization of infants (Fully)	56.0 (2000)	100
	Tetanus toxoid immunization of antenatal mothers	66.8	100
	Antenatal care	82.0	100
	Institutional deliveries	34.0 (1999)	80
	Deliveries of trained *dai*	50.0	100

National Programs for the Welfare of Mothers and Children

1. *Related to communicable diseases*
   a. National Acute Respiratory Infections Control Program
   b. National Diarrheal Diseases Control Program
   c. National Polio Eradication Program
   d. Universal Immunization Program.
2. *Related to noncommunicable diseases*
   a. National Iodine Deficiency Disorders Control Program
   b. National Program for the Control of Blindness.
3. *Related to nutrition*
   a. Vitamin A Prophylaxis Program
   b. National Anemia Control Program
   c. Mid-day School Meal Program
   d. Integrated Child Development Services Scheme (ICDS).
   ICDS-Scheme incorporates:
   – Balwadi Nutrition Program
   – Special Nutrition Program
   – Supplementary Feeding Program.
4. *Other programs*
   a. Reproductive and Child Health Program
   RCH Program incorporates:
   – National Family Welfare Program
   – Child Survival and Safe Motherhood Program
   b. All India Hospital Postpartum Program.

Organization of MCH and FP Services

The MCH and family planning services are now integrated, in the Fourth Five Year Plan, as an integral part of primary health care. This integration is based on the fact that it is inconvenient for the mother to go to one place to receive care for herself and to another for care of her children and for another place for family planning. The integrated approach not only promotes the continuity of the care, but also improves the quality of MCH care.

a. In the rural areas, the services are provided by the primary health centers (PHC) supported by a network of infrastructures called subcenters, at the rate of one PHC for every 30,000 population and one subcenter for every 3000 to 5000 population. The front line staff concerned with the delivery of MCH and FP services are Health Worker Male and Female, supervised by Health Assistants.

   Subcenter is the nucleus for the delivery of these services and the key person is Health Worker Female.

   Two schemes are being implemented at the village level to improve the outreach of services and to encourage community participation.

   i. This Village Health Guide Scheme, underwhich one person preferably a woman for each village or for every 1000 population, is trained to spread the knowledge

to the eligible couples on Health and Family planning methods and also to distribute *Nirodh* and oral pills. About 3.23 lakhs of VH Guides are functioning in the country now.

ii. Training of local *Dais*, at the rate of one per 1000 population to conduct safe deliveries by observing 5 cleans. So far, since 1974, about 7 lakhs of *dais* have been trained. They also act as family planning counselers and motivators.

Another scheme which deserves special mention in this connection is ICDS-Scheme, underwhich the services provided are supplementary nutrition, growth monitoring, immunization, health check-up, medical referral services, nutrition and health education for women and nonformal education of children below 6 yrs of age. The key person who delivers all these services is *Anganwadi* Worker (Teacher). The place where these are provided is '*Anganwadi* Center' (School). As of date nearly 6 lakhs of *Anganwadi* Workers are working in India.

b. In the urban areas, the trend is toward institutional deliveries. In larger cities, majority of the people go to nursing homes for deliveries. In corporation cities, maternity hospitals are run by municipal corporation and district head quarters, district hospitals provide the maternity services.

CHILD WELFARE AGENCIES

These are:

- Indian Council for Child Welfare
- Central Social Welfare Board
- Kasturba Gandhi Memorial Trust
- Indian Red Cross Society.

Activities

- *Day care services:* To take care of mainly infants and toddlers of working mothers.
- *Nursery schools, balwadis and creches:* To take care of underfives of working mothers
- *Holiday homes:* For older children (12 to 16 yrs) at hill stations and sea resorts.
- *Recreation facilities:* Such as play centers, Bal Bhavans, libraries, childrens' films, museums, hobby classes, etc.

INTEGRATED MOTHER AND CHILD DEVELOPMENT SERVICES SCHEME (IMCDS SCHEME)

Since the growing children are nutritionally vulnerable, and they are the future citizens of the country, the strength and pride of the nation depends upon their health. They also constitute greatest resource of the nation and the national asset. Therefore, Government of India adapted a resolution on 'National Policy for Children' on 22nd August 1974, for the welfare of the children and set up a Board as 'National Childrens' Board' with late Prime Minister Mrs Indira Gandhi, as the President of the Board on 3rd Dec 1974.

In pursuance of the 'National Policy for Children', Government of India launched a scheme called 'Integrated Child Development Services Scheme' on 2nd Oct 1975 (Gandhi Jayanthi Day) in order to improve the health status of not only children but also mothers. It was started on an experimental basis, in 33 Community Development Blocks (Projects) each Block (project) covering a population of about one lakh, with the intention of expanding the services in subsequent Five Year Plans, to the rest of the country. By 1998, 4750 such projects were functioning in the country. This scheme is only complimentary to the on-going PHC activities. It is a program for child development and child protection. As of date, about 6284 such ICDS projects are functioning in the country and 792 additional projects have been sanctioned in 2008 to 2009. (Total = 7076 = 12.42 lakhs *Anganwadi* centers).

Aim

The aim of this scheme is to provide a package of basic health services (preventive, promotive, curative, educational, supportive and referral services) in an integrated manner to the vulnerable group, i.e. mothers and children, through nonmedical personnel, at the grass-root level, so that it not only becomes economical but also helps to cover a larger proportion of the population. Thus it is a classical example of primary health care.

Objectives

- To promote total development of children (physical, psychological and social)
- To promote the nutritional status of mothers and growth of children
- To prevent malnutrition among mothers and children
- To reduce the incidence of low birth weight babies
- To enhance the capacity of mothers to provide care for their children
- To give health education to the mothers
- To give nonformal education to the children
- To achieve effective co-ordination among various health related departments like education, communication, family welfare for the success of the program
- To reduce the morbidity and mortality among mothers and children.

Beneficiaries

- Children of 0 to 6 yrs age group
- Expectant mothers
- Lactating mothers (during first 6 months)
- Other mothers of reproductive age group (15–45 yrs)

Eventhough this scheme is mainly a child welfare program, mothers are also included as beneficiaries because they play 'KEY' role in the growth and development of the children. Thus, mothers constitute an integral part of the program.

Services

Different services like preventive, promotive, curative, supportive, referral and educational services are provided as a comprehensive health care package, under one roof, in an integrated manner as follows **(Fig. 22.23)**:

- Nutritional services (Promotive services)
  - Nutritional supplementation,
  - Vitamin A syrup and IFA (P) tablets distribution
  - Nutrition education
  - Growth monitoring
- Immunization services (Preventive services)
  - For example, routine immunization
- Health care services
  - Periodical health check-up
  - Treatment of minor ailments
- Educational services
  - Health education to mothers
  - Nonformal preschool education to children.
- Referral services
  - Referring ill children to medical officer
- Supportive services
  - Like family welfare, adult literacy, improvement of sanitation, women's empowerment program, etc.

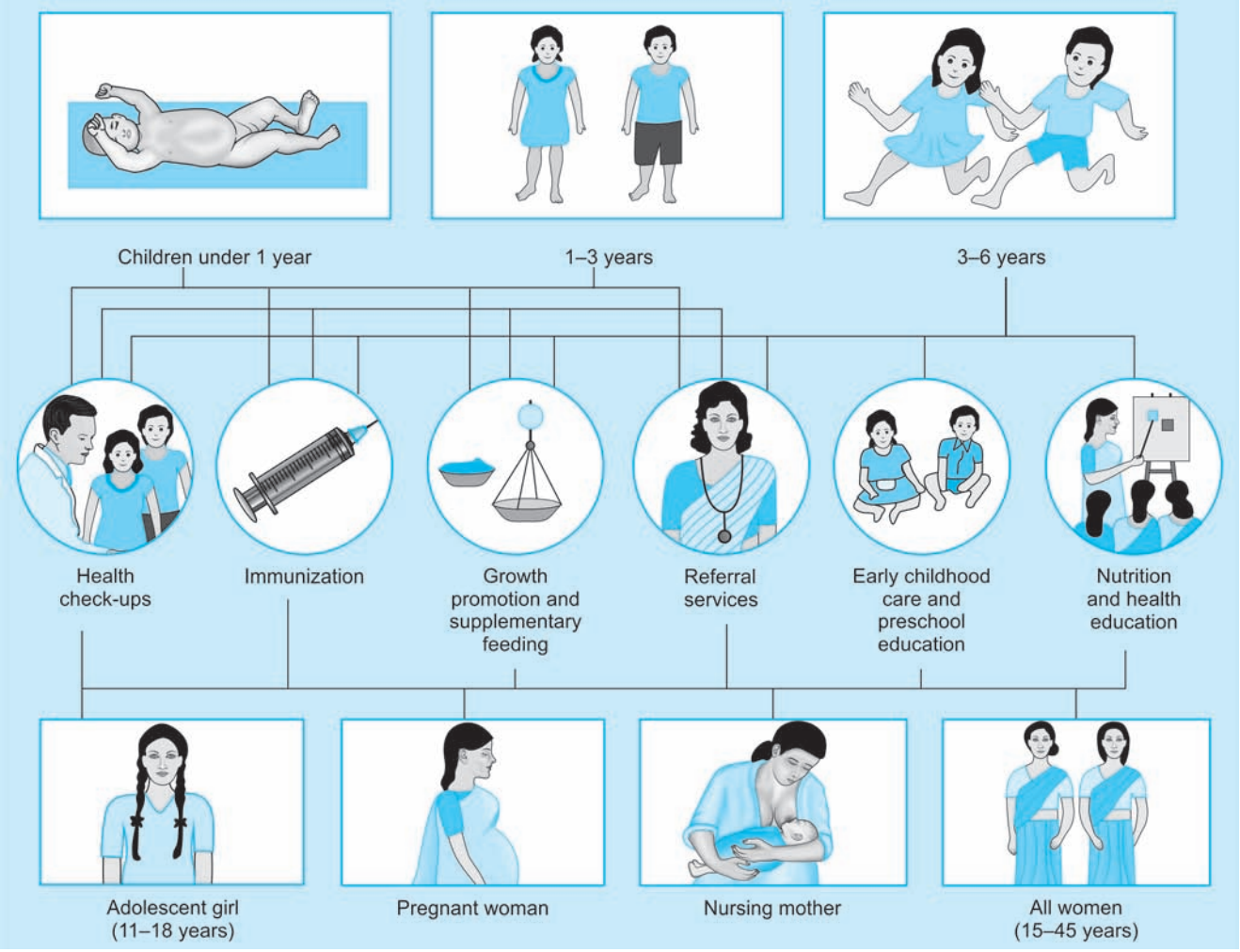


Fig. 22.23 Services and beneficiaries of ICDS

Source: UNICEF. Integrated Child Development Services. Regional Office, New Delhi 1984.

Nucleus

The focal point for the delivery of these services is '*Anganwadi* Center', located in the rural, tribal and urban slums, at the rate of one center for every 1000 rural and urban slum population and 750 tribal population (Angan means courtyard).

Key Person

To deliver these services, a local woman, studied up to SSLC is trained. She is called '*Anganwadi* teacher' (*Anganwadi* worker) (AWW). She is assisted by a helper, who is also a local woman. Both are paid.

Functions

The health check-up, immunization, treatment of minor ailments and referral services are provided by Health Worker Female (HWF) and supervised by Lady Health Visitor (LHV) (Mukhya Sevika) of that area. The AWW assists HWF in carrying out her activities and also does all other remaining work such as preparing the food and distributing everyday to the beneficiaries. She also monitors the growth of all children by recording their weight once in a month and plots in Road to Health Card, maintained one for each child and recognizes malnutrition early. She manages the I° malnutrition there only by educating the mother to give little more food at home and if she detects II°, III° malnutrition, refers to the Medical Officer.

AWW also gives vitamin A syrup periodically as per the vitamin A prophylaxis schedule and distributes (Ped) iron and folic tabs (IFA) to anemic children.

The revised supplementary nutritional norms is as follows (*Source*: Fact Sheet icds. http://pib.nic.in/archieve/others/2009/jul/ R2009071301.pdf):

Sl.No.	Category	kcals/day	Protein (g/day)
1.	Children (6–72 months)	500	12–15
2.	Pregnant and nursing mothers	600	18–20
3.	Severely malnourished children (6–72 months)	800	20–25

Severely malnourished children are given double the daily supplement.

Everyday there is change in menu to avoid monotony. The benefits are given for 300 days in a year. Sixty-five days are vacation days.

Nonformal education is given to the children between 3 to 6 years, daily for 3 hours, in the form of play, toys, games, songs, pictures, etc. There is no rigid curriculum of learning. This prepares the child for future school and prevents future school dropouts.

Health education is given to mothers about personnel hygiene, child feeding and rearing practices.

Supportive services like family planning, female literacy, improvement of sanitation are all encouraged.

Organization, Structure of ICDS Project

Each project consists of 100 *Anganwadi* centers, each center covering a population of 1000 in rural and urban slum area and 750 in tribal area, thus covering nearly 1 lakh population. Each ICDS project consists of 3 levels (caders) of staff members, namely *Anganwadi* workers, *Mukhya Sevika* (Supervisor) and Child Development Project Officer (CDPO).

Anganwadi Worker/Teacher (AWW)

Usually a local woman, studied at least up to Xth standard, is trained in Primary Health Center in various aspects of health, nutrition, immunization, family planning, child development, record keeping, community work and survey techniques. She is paid an honorarium of ₹ 250/- per month as stipend for the training period of 3 months. At the end, she is given a certificate and posted to *Anganwadi* center. She is provided with a helper. AWW prepares the food daily and distributes among the beneficiaries. She records the weight of every child once a month and thus monitors the growth of the children, gives health education to mothers and nonformal education to children, assists her Supervisor and Health Worker Female in carrying out their work. She maintains the record of all her activities. She attends the monthly meeting and submits the progress report to CDPO. Thus, she works at the grass root level and constitutes the link between the community and the health system. She will also have a rapport with the community leaders, school teachers, *mahila mandals* and such other organizations and seeks their help in carrying out her activities.

Thus, *Anganwadi* worker provides primary health care and constitutes an example of community participation in providing primary health care.

Supervisor (Mukhya Sevika)

Supervisor (*Mukhya Sevika*) is a graduate lady, who has undergone training for 3 months, in the Department of Social Welfare in the University College. She supervises and guides 20 to 25 AWWs. She assists CDPO and medial officer of PHC in organizing health services.

Child Development Project Officer

He is a qualified medical graduate, trained for 2 months, at National Institute for Public Cooperation and Child Development (NIPCCD) at Delhi, in child development, accounting, finance management, survey technique and

community organization. He is in charge of one ICDS project including 4 to 5 *Mukhya Sevikas* and about 100 *Anganwadi* teachers. He guides, supervises, directs and monitors the program. He submits the report periodically to District Co-ordinator. Thus, he is over all in charge of the project. He is the chief administrative officer. Government of India has now proposed that CDPO should be a woman.

Monitoring and Evaluation

This is done by the Department of Social Welfare, under the Ministry of Human Resources and Development, All India Institute of Medical Sciences, New Delhi and National Institute of Public Cooperation and Child Development, New Delhi.

Assistance

This is being provided by various International Organizations like:

- World Food Program (WFP).
- Cooperative American Relief Everywhere (CARE)
- Norwegian Agency for Development (NORAD)
- United States Agency for International Development (USAID)

UNICEF was assisting this program till 1982 and after 1982, the above organizations have been assisting. In India, the Ministry of Social Welfare has been supported substantially by various other ministries. The convergence of services is shown in **Figure 22.24**.

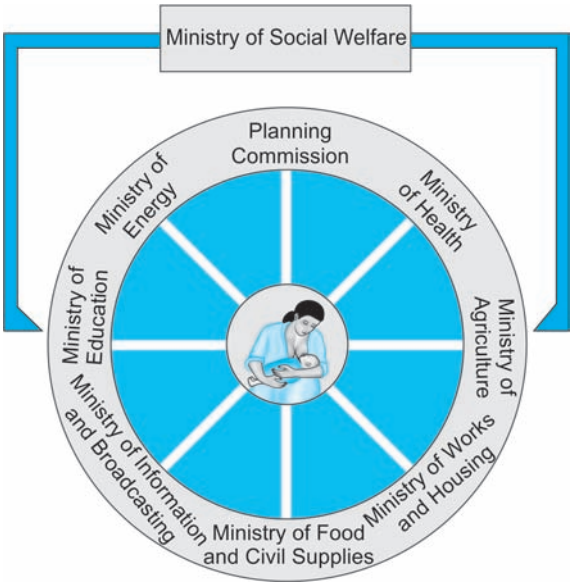


Fig. 22.24 Convergence of services

Source: UNICEF. Integrated Child Development Services. Regional Office, New Delhi 1984.

Kishori Shakti Yojana

Kishori Shakti Yojana (KSY) is a new initiative, launched under ICDS Scheme, during 1991 to 1992, exclusively for adolescent girls, with the following objectives:

- To improve the nutritional and health status of girls in the age group of 11 to 18 years.
- To provide nonformal education to improve their decision making capabilities
- To promote their vocational skills
- To sensitize about family welfare, home management and child care
- To marry only after 18 years of age
- To make them useful and productive members of the society.

Interventions

- These adolescent girls are provided with supplementary nutrition, providing 500 calories including 20 g of protein for six days in a week.
- Nonformal education covers the areas of personal hygiene, environmental sanitation, first aid immunization, child care and family welfare.
- Participation in creative activities and recreation.
- Training in home-based and vocational skills.

Anganwadi workers act as role models for training these girls. The training is spread over a period of about six months.

Administrative Set-up of ICDS (Table 22.3)

Thus, ICDS Scheme is an unique, single, largest, multisectoral (involving various departments), outreach, national program in the world, for the welfare of the mothers and children of our country, with an in-built monitoring system by the Ministry of Women and Child Development.

Reproductive and Child Health (RCH) Program: Described under National Programs.

Introduction of WHO Growth Standards in ICDS

Based on the results of an intensive study initiated in 1997 in six countries including India, WHO has developed New International Standards for assessing physical growth, nutritional status and motor development of children from birth to 5 years of age. This has been adopted in India on 15th August 2008.

Table 22.3 Administrative set-up of ICDS

Sl.No.	Level	Personnel	Designation/Function
1.	National	Secretary to Department of Social Welfare (Ministry of Women and Child Development)	National Coordinator
2.	State	Director of Health Services (DHS)	State Coordinator
3.	District	District Health Officer (DHO)	Chief Program Officer (District Coordinator)
4.	Block	Child Development Project Officer (CDPO)	Chief Administrative Officer in charge of 100 Anganwadi centers.
5.	Primary health center	Medical Officer (MO)	Coordinator for PHC
6.	Sector	Mukhya Sevika (Lady Health Assistant)	Supervisor of about 20–25 Anganwadi centers
7.	Village (Grass root level)	Anganwadi Worker (AWW)	Delivers the package of services.

This would now help us in comparing the growth of our children within projects, districts, states and also other countries.

STREET CHILDREN

These are the children below 18 years of age, boys or girls, who are experiencing homeless and primarily reside on the streets of the city, including unoccupied dwellings and wasteland and who live entirely in public spaces. Thus they are roofless, rootless and alienated from the society. The place of their abode is the street, railway station, bus station, bridges, beneath the flyover, temples and dargahs. They grow up on the margins of the society without love, care, protection, supervision or direction by responsible adults. Streets are the sources of their livelihood. They take the full responsibility of caring for themselves and protecting themselves. They are deprived of their basic rights of survival, protection, development and participation. They toil for their survival. Though street children band together for greater security, they are often exploited by employers and the police. Since most of them are involved in antisocial activities (juvenile delinquency) they constitute a socioeconomic issue of the country.

Magnitude of the problem: Street children are visible in the great majority of the world's urban centres. UNICEF has estimated that about 100 to 150 million children are growing up on the streets around the world. In India, it is about 8 lakhs. Pakistan has one of the world's largest street children population i.e., 1.2 to 1.5 million. It is on the increase.

UNICEF has defined three types of street children. Street living children, Street working children and Street family children.

- *Street living children:* Children who ran away from their families and live alone in the streets. They are homeless street children. Most of them are boys. They leave home because of broken homes or problem families.
- *Street working children:* Children who spend most of their time on the streets, fending for themselves but return home on a regular basis.
- *Street family children:* Children who live on the streets with their families. The last two groups are called "Market children".

Causes: These are often related to domestic, economic or social disruption, including, but not limited to, poverty, death of parents, broken homes, political unrest or acculturation. Owing to unemployment, increased rural – urban migration, the attraction of city life and lack of political will, India has developed one of the largest child labor forces in the world.

Importance: Street children are dirty, scared, bitter, wornout and helpless. They are neglected by the society and government; They are deprived of education, nutrition and medical care. Police overwhelmingly view and treat them as sub human; unworthy of basic human rights. They are exceptionally vulnerable and often exploited and made outcasts of the society. They grow up much too soon and die much too young. They are assaulted, tortured and killed every day.

Most of them form groups with other street children to protect themselves. These groups normally have a leader and specific territory. They are often used by the leader to do illegal activities such as stealing. They spend much of their free time with other friends, often going with them to movies. Some of them form connections with the families that live on the streets or in slums and see these families as their substitute families. Many of these children find a "mother figure" that cares for them when they are ill and is interested in their well being.

Abuse: They are abused through exploitative child labor and prostitution. They are often abused by police as reported by

street children. Police will beat them in order to coerce them into giving them a "cut" for working in certain areas. Police often arrest them under "Vagrany Act" and these children should work in police station until the "debt" has been paid. Street children have reported all types of abuse-general health, verbal, physical, psychological and sexual.

Child labor: They are often self employed and their common job is rag picking. They sift through the garbage in order to collect recyclable materials like paper, plastic and metals. Other common jobs are collecting firewood, tending to animals, street vending, dyeing cloth, begging, prostitution and domestic labor.

They are illegally employed in hotels, restaurants, canteens, tea shops and eating places. Other jobs include cleaning cars, selling vegetables/ sweets, newspapers, flowers, shoe cleaning etc. Sometimes older children are engaged in antisocial activities like stealing gambling, pickpocketing, drug peddling, prostitution, etc. Thus becoming the victims of subculture of the streets (Juveline delinquency). They work for 8 to 10 hours per day for their earning.

Gender discrimination: Girls carry the liability of dowry. Many parents consider education for girls to be a waste of money and time. Child marriage is another way. A girl under 15, if five times more likely to die during pregnancy than a women in her twenties; her child is also more likely to die.

Health and nutrition: Street children are deprived of sanitation, proper nutrition and medical care. Malnutrition and hunger is widespread among them. Poor health is a chronic problem of street children. More than 50 percent of them are malnourished. Not only they are underweight, their growth has often been stunted.

Civic amenities like latrine and bathing facilities are beyond their reach.

They live and work amidst trash, animals and open sewers. They are not vaccinated. Since they are highly vulnerable, they are at high risk of communicable diseases including STIs and HIV/AIDS. They are often habituated to smoking, alcoholism, chewing tobacco, drug abuse, etc. They grow up much too soon and die much too young. Thus their problems are multifaceted. Ninety percent of them are addicted to inhalants such as shoe glue and paint thinner, which cause kidney failure, brain damage and even death.

Most of them suffer from exhaustion, injury, exposure to dangerous chemicals and muscle and bone afflictions.

- *Homelessness:* Street children are deprived of shelter, food, love, care, education and life security. This is because of poverty or migration or because they have been abandoned, orphaned or have runaway.
- *Poverty:* This is their main crisis. Poverty dumps a crowd of problems onto a street child and keeps the child poor throughout the life.

Government and Non-Government Responses

Street children desperately need programs and services. Unfortunately there are very few shelters or outreach programs anywhere in the world. Government need stronger enforcement measures. Police must be made accountable for their crimes against homeless poor children.

Government of India has set in place various forms of public policy concerning street children over the past two decades, but they have been largely ineffective because they are uniformed by sociological, anthropological and geographical research on street children.

In 1996, Mumbai launched "CHILD LINE", the country's first toll free tele help line for street children in distress. It operates in 255 cities in 30 states and UTs through its network of 415 partner organizations across India. As of March 2011, a total of 211 million calls, since its inception, have been serviced by CHILD LINE service.

The objective is to ensure that no child should live on the street and that every child has an inherent right to dignity and respect. The organization "HAMARA FOUNDATION" believes in working towards creating the environment, in which every child enjoys rights to survival, development, protection, participation and a happy childhood. It provides need based services for their growth and development.

BIBLIOGRAPHY

1. Anand RK, Nigam GK, Potdar RD, Surekha PR. Maternity Home Practices and Breastfeeding. 1st edn, 1990.
2. Anand RK. Helping Mothers to Breastfeed. Felicity Savage King. Revised edn, 2001.
3. Aptekar L. (1994). Street Children in the Developing World; A review of their condition. Cross Cultural Resources. 28:195-244.
4. Available at http://www.childlineindia.org.in/1098/1098htm
5. Available at http://www.mscen.org/hamara-foundation
6. Breastfeeding Promotion Network of India. The Infant Milk Substitutes. Feeding Bottles and Infant Foods Act 1992. Gazette of India, Delhi 1992, 1993.
7. Chatterjee A. (1992) India. The Forgotten Children of the Cities. Florence. Italy, UNICEF. Retrieved. February 20, 2012.
8. Elisabet Helsing, Savage King F. Breastfeeding in Practice. Oxford University Press, Delhi, 1984.
9. Evgenia Bevezina (1997). Victimization and Abuse of Street Children Worldwide (PDF). Youth Advocate Program International Resource Paper Yapi Retrieved. 30.11.2012
10. Fact Sheet icds. http://pib.nic.in/archieve/others/2009/jul/R2009071301.pdf
11. Ghosh BN. A Treatise on Hygiene and Public Health, 15th edn, 1969.
12. GOI. MOHFW. Family Welfare Statistics in India. 2011.

13. Government of India. National Child Survival and Safe Motherhood Programme. Programme interventions. MCH Division, Ministry of Health and Family Welfare, New Delhi, 1994.
14. http://www.babycentre.in
15. Kishori Shakti Yojana. http://wcd.nic.in/KSY/ksyguidelines.htm.
16. Miriam Stoppard. New Pregnancy and Birth. Revised edn. Published by Dorling Kindersley, London, 2009.
17. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.
18. Rekha H Udani, Ruchi N Nanavathi. Training Manual on Kangaroo Mother Care 1st edn, 2004.
19. Singh A, Puroht B. (2011). "Street Children as a Public Health Fiasco". Peace Review 23:102-109.
20. Thomas de Benitez, Sarah (2007). "State of the World's Street Children", Consortium for Street Children. Retrieved February 20, 2012.
21. UNICEF. Integrated Child Development Services. Regional Office, New Delhi 1984.
22. WHO. New WHO Child Growth Standards. Report of a Regional Workshop. Bangkok, Thailand, June 2006.

CHAPTER 23

Demography

Demos = Population; Graphy = Study

Demography is that branch of community medicine, which deals with the study of human population in a given area, usually a country, during a given year, with reference to size, composition, behavior and distribution.

'Size' of the population means the total number of persons residing in the country, which can be determined or enumerated by 'census'. Thus, size refers to the quantity of the population.

'Composition' of the population means breakdown of the population according to age, sex, literacy level, occupation, income, marital status, language spoken, religion, etc. Thus, composition refers to quality of the population.

'Behavior' of the population means 'growth' of the population over a period of decades (i.e. Positive growth, zero growth or negative growth). The behavior of the population (or the trend) can be estimated through population projection (Growth rate of the population is the difference between the birth rate and the death rate. Growth Rate when expressed as a number, it is called 'Demographic gap' **(Fig. 23.1)**).

'Distribution' of the population means density of the population per km^2, rural-urban population ratio and location of the dense or sparse pockets of the population.

The processes which influence the size, composition, behavior and distribution of the population are marriages, births, deaths, migration and social mobilization, which are all continuously at work. The study of all the processes which result in the mode of change of population is called 'Population dynamics'.

The statistical study of all the components of the population and the factors related to it is called 'Demographic statistics'.

The term 'Vital statistics' refers to the study of vital events like births, deaths, diseases, marriages and divorces.

DEMOGRAPHIC CYCLE (DEMOGRAPHIC STAGES)

It has been observed by demographers that the trend of the population growth in a country undergoes changes or variations in a stepwise manner. These variations are called as 'Stages of demographic cycle'. There are five stages in a demographic cycle. They occur sequentially and each stage lasts for several decades. Thus, it requires several centuries to undergo each cycle. Strictly speaking, a country does not pass through stage one once again, in a cyclic fashion, after the fifth stage is over. So, the word 'Cycle' is a misnomer, but still used by usage.

The occurrence of changes in the growth of the population in various stages is called 'Theory of vital revolution' or 'Theory of demographic transition' or 'Theory of demographic cycle'.

The different stages of demographic cycle with its characteristics are shown in **Table 23.1**.

Stages of Demographic Cycle

The stages of demographic cycle is shown in **Fig. 23.1**.

Table 23.1 The different stages of demographic cycle with its characteristics

Sl. No.	Stage	Characteristics	Annual growth rate with example
1.	First stage (High stationary)	High birth rate, high death rate Cancel each other. Population remains stationary at high level	In India before 1920, BR = 49.2/1000 popln DR = 48.6/1000 popln GR = 00.6/1000 popln (= 0.06%) (GR was less than 1%)
2.	Second stage (Early expanding)	Death rate begins to decline Birth rate remains unchanged Population grows slowly	India experienced between 1921–1930, BR = 49/1000 popln DR = 36/1000 popln GR = 13/1000 popln (= 1.3%) (GR became between 1 to 2%) Many countries of Africa and South America are in this phase
3.	Third stage (Late expanding)	Death rate decline further precipitously Birth rate starts declining Population grows rapidly	India has now entered this phase [Current GR in India is 1.34% (2011)]
4.	Fourth stage* (Low stationary)	Birth rate falls rapidly and becomes equal to death rate. Low birth rate and low death rate cancel each other. Popln remains stationary at low level. GR 0 percent	India must enter this stage at the earliest. Countries like Australia, UK, Belgium, Denmark, Sweden were in this phase during 1980s
5.	Fifth stage (Stage of decline)	Death rate is higher than the birth rate So, popln goes on declining (GR = < 0% (minus)	Germany and Hungary are in this stage. This is the after-effects of second World war

*During the fourth stage, population becomes stationary at low level. Thus, stabilization of population is a 'National priority' in India. With the onset of this stage as in UK, Australia, Belgium etc, the country is said to have undergone 'Demographic transition', shifting from the stage of high BR and high D.R to a stage of low BR and low DR In this phase, people will have a good quality of life, comfortable living, peaceful life and the country will progress very fast. This is required to deal with the hazards of population explosion.

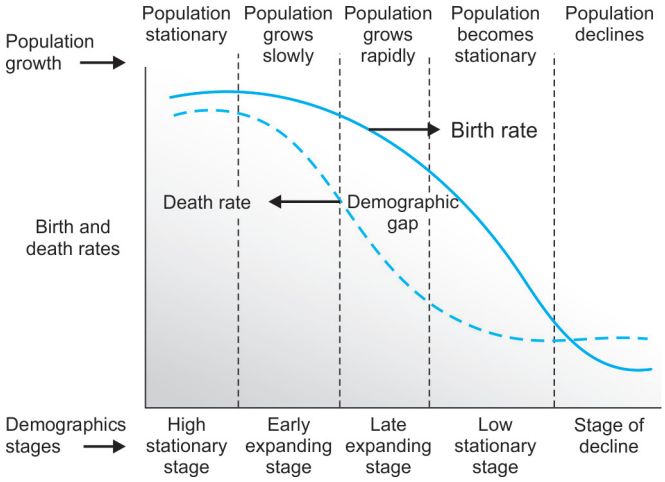


Fig. 23.1 Stages of demographic cycle

SIZE OF THE POPULATION (MAGNITUDE OF THE POPULATION)

Census

It means the total number of persons, living in a country, during a given year. This is estimated or enumerated by counting all the persons in that area. When the persons are counted, other data is also collected such as religion, caste, language spoken, age, sex, living condition, literary level, Occupation, Socioeconomic status, etc. thus the collection, compilation and publication of Social, Economic and Demographic data of all the individuals of a country, during a particular time/period, is called 'Census'.

Since the enumeration of the population is very difficult, massive and stupendous task, it is carried out once in 10 years. In India, census is conducted in the first quarter of first year of each decade, i.e. on 1st March of each decade. The first census was conducted in India in 1881 (1.3.1881 and the last was held in 2011 (1.3.2011), regularly once in 10 years (i.e. Decennially).

If enumeration is done based on the place, where the individual is found, it is called '*De facto*' system and if done based on the place of the permanent residence, it is called '*De Jure*' system of census estimation. *De facto* system was followed till 1931 and *De Jure* system was followed subsequently since 1941, because most people are found in their homes during Feb-March.

Since it is not possible to count the population on 1st March, the process is started several weeks before March, as early as January and completed by February. Then, from 1st March to 5th March, the enumerator will go back to respective house and asks two questions:

1. Whether any births have taken place since his last visit, up to 1st March, and if 'yes', he notes down the sex

2. Whether any deaths have taken place since his last visit up to 1st March and if 'yes' that name is deleted from the list.

Births and deaths occurring between 2nd to 5th March are ignored.

The supreme officer, who directs, guides, operates and is in overall charge of the process of conducting the census, is the 'Census Commissioner' of India.

Errors (Limitations) of Census

- Infants are generally under enumerated
- Many persons do not know their exact age
- Old persons tend to add years to their actual age
- Information about handicapped persons is incomplete
- Information about work status is distorted.

Uses of Census

- It provides demographic, social and economic data of the country
- It provides information on the composition (age and sex wise), size (total population) and distribution (density) of the population
- It helps to estimate the 'Mid year population', which constitutes the important denominator to calculate morbidity, mortality and fertility rates
- It helps to assess the trend (behavior) of the population, through population projection, by comparing with that of previous decades
- It helps to formulate the population policies
- It helps to plan health and welfare measures (like schools, colleges, hospitals, industries, etc.)
- It helps to compare with that of other countries
- It helps to formulate social security measures like Life Insurance, etc.
- It helps to assess and evaluate population control programs
- It also helps to know the quality of life of people.

POPULATION TREND IN THE WORLD

The time required for the population to get doubled is called 'Doubling time'. Higher the growth rate of the population, shorter is the doubling time. Thus, population doubling time is determined by the growth rate.

It is observed that at the beginning of christian era, about 2000 years ago, the population of the world was hardly 250 million. It required 1800 years to reach 1.0 billion. It required 130 years to reach 2 billions, then 30 years to reach 3 billions, 15 years to reach 4 billions, 12 years to reach 5 billions and another 12 years to reach 6.0 billions. At this growth rate, it is expected to reach 8.0 billions by 2025 AD **(Table 23.2)**.

Thus, the population of the world is growing at the rate of about 200 births per minute or 10,000 per hour or 2.5 lakhs per day or 10 crores per year. This growth of the population is the single, greatest obstacle for the development and progress of the country.

Table 23.2 Population trend in the world

Years	Population (in billions)	Annual growth rate (%)	Doubling
1800	1.0	0.4	
1850	1.3	0.5	
1900	1.6	0.6	130 years
1930	2.0	0.8	
1950	2.5	1.1	
1960	3.0	1.8	45 years
1975	4.1	1.9	
1987	5.0	1.6	40 years
2000	6.1	1.4	

Note: 1 billion = 1000 millions.

The three most populous countries of the world today are China, India and USA with populations of 1.3, 1.03 and 0.3 billions (2001) respectively. Four-fifths of the world population lives in the developing countries of Asia, Africa and Latin American.

POPULATION TREND IN INDIA

India is the second most populous country in the world today, next to China.

The first census was estimated in India in 1881, when the population was about 20 crores. In the beginning of this century, in 1901, it was about 23 crores. It was almost stationary between 1911 to 1921, about 24 to 25 crores. After 1921, there was sudden increase in the population. So the year 1921 is called the 'Year of big divide' **(Fig. 23.2)**.

At the time of independence, in 1947, the population was about 34 crores. Within a span of 34 years, by 1981, it became 68 crores, adding 'Second India'. In 1991, it was 91 crores. Since then almost 2 crores of population is being added every year. By 2001, it crossed 100 crores (= 1 billion). Thus, it is observed that during 20th century, first doubling took place after 60 years and next doubling took place in just 30 years. As on 1st March 2011, India's population stood at 1210 million. The population growth in India is shown in **Figure 23.3**. It is also estimated that it would reach 1400 million by 2026 **(Fig. 23.4)**.

COMPOSITION OF THE POPULATION

While the size of the population defines the quantity of the population, the composition defines the quality of the

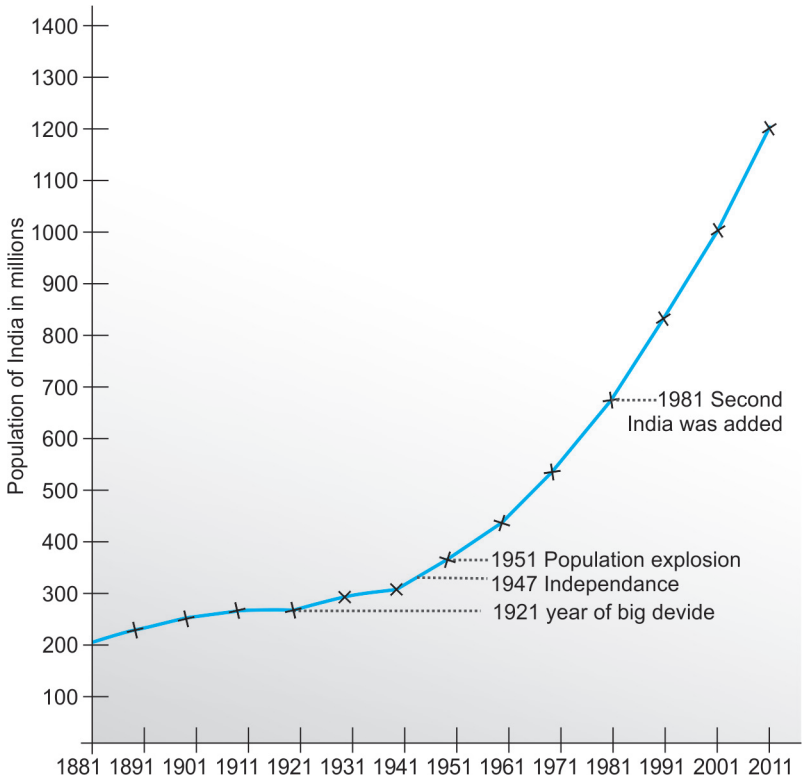


Fig. 23.2 Population growth in India (1881–2011)

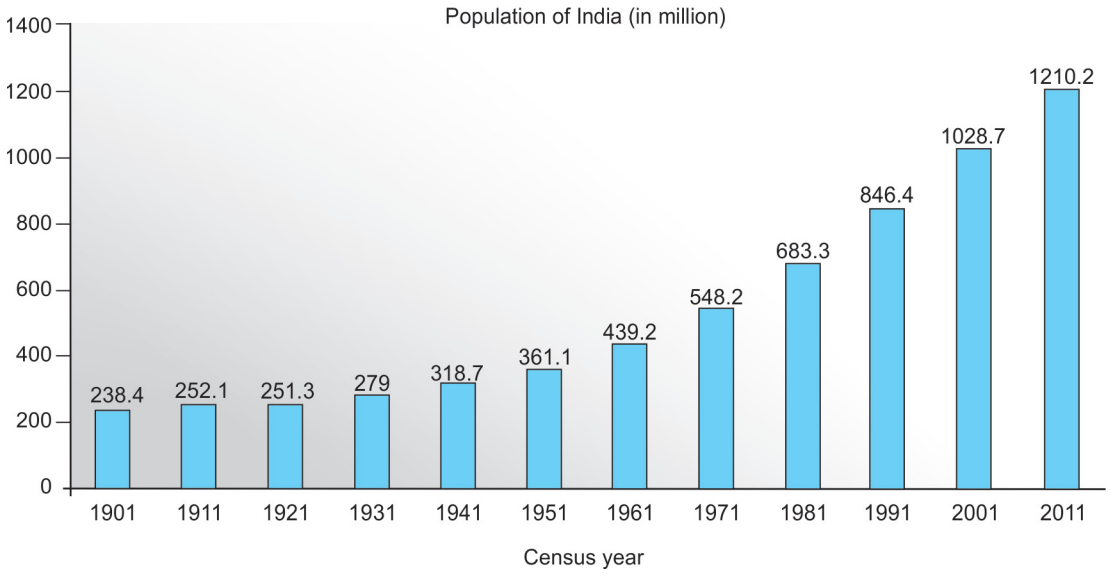


Fig. 23.3 Population growth in India (1901–2011)
Source: GOI. MOHFW. Family Welfare Statistics in India 2011

population, i.e. breakdown of the population according to different parameters like age, sex, literacy level, dependency ratio, occupation, socioeconomic status, living conditions, marital status, languages spoken, religion, etc.

This indepth information about the quality of the population is useful for understanding the needs of the population and the priority needs.

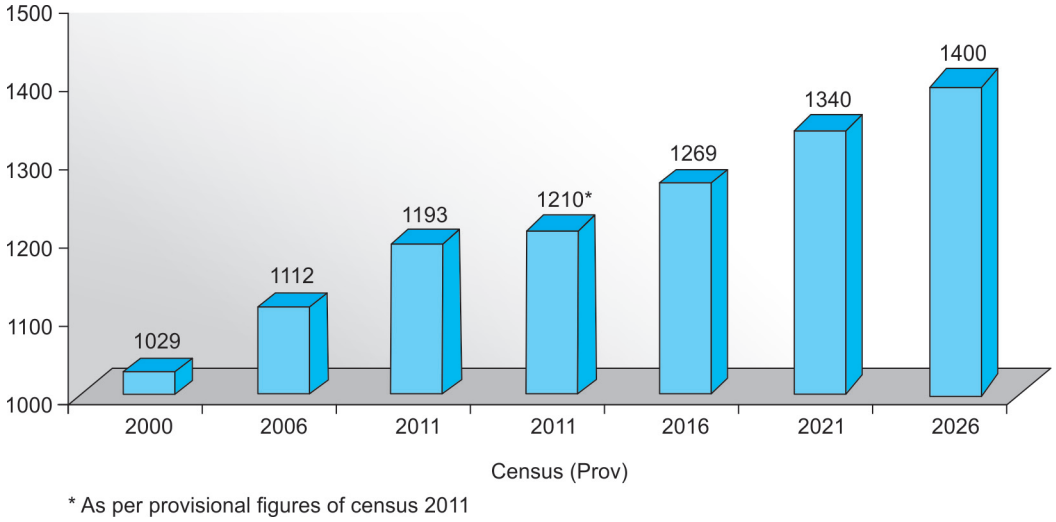


Fig. 23.4 Projected population of India (in millions)
Source: GOI. MOHFW. Family Welfare Statistics in India 2011.

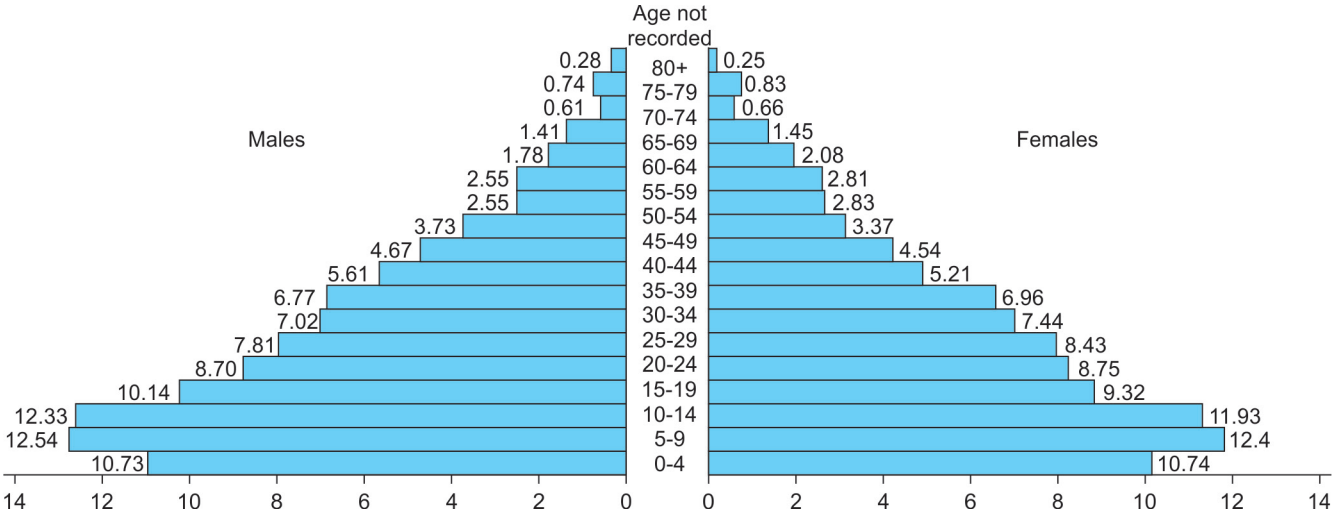


Fig. 23.5 Age and sex pyramid of India 2001 (Population pyramid)
Source: Sunderlal, Adarsh, Pankaj. Textbook of Community Medicine 1st edn, 2007.

Age and Sex Composition (Population Pyramid)

When the breakdown of the population is represented either as numbers or age percentages, according to different ages and sexes, in the form of a horizontal bar diagram, horizontal axis referring to sex (men on the right side and women on left side) and vertical axis to age, it takes the shape of a 'Pyramid', which is called 'Population pyramid' (or 'Age-sex pyramid') **(Fig. 23.5)**.

This is necessary for the calculation of the following:

- Age-sex specific death rate
- Age specific sex ratio
- Standardization of death rate.

The Population pyramid of a developing and developed country as shown in **Figure 23.6**. The differences between the population pyramids of developing and developed countries are shown in the **Table 23.3**.

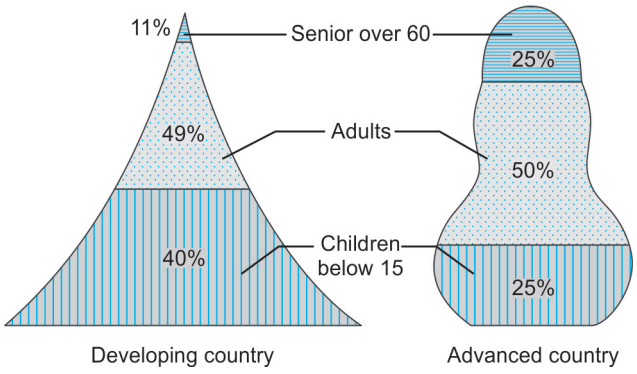


Fig. 23.6 Population pyramids of developing and advanced country

Table 23.3 Differences between the population pyramids of developing and developed countries

Developing country	Developed country
Broad base (indicating high birth rate)	Narrow base (low birth rate)
Concave border (concavity facing outwards)	Convex border (facing outwards)
Acute apex (indicating less number of elderly people)	Obtuse apex (more of elderly people)

Sex ratio is defined as the number of women for every 1,000 men. In 1901, it was 972:1000 and in 2001; it became 933:1000 and 940:1000 during 2011. The sex ratio was reduced because of preference for male children, infanticides, illegal abortions, etc. In Kerala, it is 1084:1000 (2011). It is the only state in India with a sex ratio preferable to women.

Literacy Level

Literacy means ability to read and write any language with understanding. Ability to read and not to write is not literacy. The average literacy level of our country is 65 percent as per 1991 census. (Men 76% women 54%). During independence, it was 18 percent. Kerala state has attained 94 percent literacy level (2011). It is lowest in Bihar (49%). Female literacy is more important for better use of health care services. Literacy level in general is a most crucial element in determining the progress and development of the country. Govt of India has made education compulsory up to the age of 14 years in the country. During 2011 census, the literacy rate of India increased to 74 percent (82% male and 65.5% female literacy). The female literacy has gone up from 54 percent (2001) to 65.5 percent during 2011 and male literacy from 75 percent to 82 percent.

Dependency Ratio

It is the ratio between the adults, (who are in the age of the economically productive life) and the dependents (such as children below 15 yrs and the elderly above 65 years). It is also called as 'Dependency load'. It is expressed per 100 adults. In 1995, it was 65.5. Projected figure for 2005 was 56. It is on the decline. If only children (0–14 years) are taken into consideration, it is called 'Young age dependency ratio' and if old people are taken into consideration, it is called 'Old age dependency ratio'. However, it is a crude ratio because it does not take into consideration young children and elderly people who are employed and adults who are not employed.

Total dependency ratio =

$$\frac{\text{Children 0–14 years + population > 65 years}}{\text{Population of 16 to 65 years}} \times 100$$

An increase in the dependency ratio will affect the economic and social progress of the country.

Occupational Composition

Depending upon the nature of the work, occupations have been grouped into professional, managerial, clerical, skilled, semiskilled, unskilled and unemployed groups.

Socioeconomic Status

Depending upon the per capita monthly income, BG Prasad modified his classification of SE status considering consumer price index Rs. 949 in April 2012, as follows:

Modified BG Prasad's classification (April 2012)

Rs. 4700 and above	–	Class I
Rs. 4699 to Rs. 2350	–	Class II
Rs. 2349 to Rs. 1410	–	Class III
Rs. 12409 to Rs. 705	–	Class IV
< Rs. 704	–	Class V

Per capita monthly income =

$$\frac{\text{Total monthly income of the family}}{\text{Total members of the family}}$$

Other socioeconomic classification are Kuppuswamy's classification, Pareek's classification (Discussed under Social Science)

Nearly 26.1 percent of the population are below poverty line.

Housing (Living Condition)

Whether the living condition is good, satisfactory or poor, is assessed by scoring method, considering the construction, lighting, ventilation, overcrowding, drainage facilities, source of water, presence of latrine, breeding places, live-stocks, etc. Housing standards are raised by allotting free sites to the poor, sanction of loans for building houses. Indira Awas Yojana is active in this direction.

Marital Status

Whether the individual is married, unmarried, divorced, widow or widower is known in order to implement certain welfare measures such as 'Tali-Bhagya', 'Pension to widows', etc.

Religion

Various religions are also known, such as Hindus, Muslims, Christians, Sikhs, Jain, etc. This data is also collected, when census is estimated. People belonging to scheduled caste and tribe deserve special mention.

Languages Spoken

This data is also collected.

Life Expectancy (Expectation of Life)

It is the average number of years a person is expected to live, according to the mortality pattern existing in that country. This is considered as one of the indicators of health of the country. Unless otherwise specified it always refers to life expectancy at birth (LE_0). This includes the risk of infant mortality. The life rxpectancy at age 1, is the average number of years a one year old child is expected to live. This excludes the risk of infant mortality.

The combined LE_0 for both the sexes in India, during independence was 46 years. At the end of century it increased to 63 years. This indicates the country's development. This information is necessary for the health policy makers to implement disease control measures in the country.

LE_0 is least in Nepal 58 years, and 78 years in UK, USA, Sweden and Switzerland and the highest in Japan 80 year as per 2000 years. It is least in Zambia 33 years.

Family Size

It actually means the 'total number of children' a woman has borne at a given point of time.

This depends upon the factors like age at marriage, duration of married life, literacy level of the couple, availability of family welfare services, preference for male children, etc.

The country's family size was 3.9 in 1990 and declined to 3.1 by 2000 years. It is 4.7 in Nepal, 2 in USA, 1.8 in China and 1.4 in Japan.

If the couples adopt 'one child norm', it can still be reduced. Large family size has not only socioeconomic consequences, but also results in poor health status of its members.

Demographic profile of India is shown in the **Table 23.4**.

Table 23.4 Demographic profile of India

	1991	2001	2011
1. Population (in million)	846	1028	1211
2. Crude birth rate (per 1,000 MYP)	29.5	25.4	20.97
3. Crude death rate (per 1,000 MYP)	9.8	8.4	7.48
4. Growth rate (BR – DR)	19.7	17.0	13.49
5. Infant mortality rate (per 1,000 LB)	80	66	47.5
6. Maternal mortality rate (per 1,000 LB)	3.98	3.01	2.12
7. Literacy rate female (percent)	-	53	65.5
8. Sex ratio (females per 1,000 males)	927	933	940
9. Couple protection rate (percent)	44.1	45.6	40.4
10. Expectation of life at birth (years)			
Male	60.6	61.8	63
Female	61.7	63.5	64.2

Source: GOI. MOHFW. Family Welfare Statistics in India 2011.

DISTRIBUTION OF THE POPULATION

This consists of the distribution with reference to geographical areas, urban-rural-tribal-slum areas, density per square km, etc. This is necessary because the population has not spread uniformly.

If the people are living together as in cities, it is called 'Concentration' of the population. If they are living together due to certain activities like industrialization, plantation, it is called 'Centralization'. If they are living together due to same sociocultural habits, it is called 'Segregation'. Such information about the distribution of population helps to provide health care services.

The socioeconomic development, educational opportunities, industries, natural calamities like famine, floods, etc. are the determining factors of population distribution.

The important indicator of the population concentration is 'Density of the population', i.e. number of persons living per square kilometer area. It was 77/sq. km in 1901 and it is 324/sq. km during 2001. Most important factor which determines the density of the population is 'Growth rate' and to some extent migration.

Urbanization

This is a recent phenomena taking place in India. The proportion of urban: rural population was 11 percent and 89 percent during 1901 and during 2001, it has increased to 31:69 percent.

A community is called an urban if its population is more than 5000, at least 75 percent of male population is working in

non-agricultural occupation and the population density is at least 400/sq.km. The increase in urban population is not only because of increased births, but also because of migration of village population which in turn is because of employment opportunities, attraction of living conditions, educational, health, transport, entertainment and such other facilities. This has been causing a social crisis in the rural areas.

A megacity is a one with a population of 10 million or more (Kolkata, Delhi and Mumbai in India at present. By 2015 Hyderabad will be added to the list).

Hazards of Urbanization

Described as hazards of population explosion, under the title 'population explosion.'

POPULATION DYNAMICS

It is the study of factors responsible for the changes (Size, composition, distribution) of the population. These factors are marriages, births (Fertility), deaths, migration and social mobilization.

Marriages

These are starting point of the family. It is an important event because fertility starts from it. Marriage is the right of procreation which is legally and socially accepted.

Marriage Rate

It is the number of marriages during a given year per 1,000 mid year population (MYP).

$$\text{Marriage (Crude) rate} = \frac{\text{Number of marriages in the year}}{\text{Mid year population}} \times 1{,}000$$

This is a crude rate because the denominator consists of those, who are not eligible for marriage, such as children and those, who are already married. Therefore, a refined indicator is general marriage rate.

$$\text{General marriage rate} = \frac{\text{Number of marriages in the year}}{\text{Number of unmarried persons of marriageable age}} \times 1{,}000$$

Fertility

Fertility means actual bearing of children and fecundity means capacity to bear children. Fertility encompasses fecundity.

The factors which determine or influence fertility are age at marriage, duration of married life, birth-interval, literacy level, economic status, religion, nutritional status, family-welfare services, etc.

- *Age at marriage:* Earlier the marriage, more will be the number of children. Therefore, there are legislations governing the age of marriage, such as Child Marriage Restraint Act, 1978, Hindu Marriage Act, 1925. The minimum age prescribed for marriage in India is 18 years for girls and 21 years for boys. If the marriages are post-poned for 4 to 5 years, number of births would decrease by about 25 percent.
- *Duration of married life*: Longer the duration of married life, more will be the fertility.
- *Birth interval*: Longer the birth interval between the pregnancies, lesser will be the fertility rate.
- *Literacy level*: Higher the literacy level among the parents, lower will be the fertility and vice versa.
- *Economic status*: Similarly, there is an inverse association between the economic status and the fertility. Higher the economic status, poorer is the fertility and vice versa.
- *Religion*: Fertility is more among Muslims, medium among Hindus and lower among Christians. Again it is observed that in these religions, fertility is higher among lower castes than higher castes.
- *Nutritional status*: Better the nutritional status, lower is the fertility and vice versa.
- Other factors, which influence fertility are industrialization, urbanization, place of women in the society, customs, beliefs, child rearing practices, socioeconomic development of the country, etc. The World Population Conference at Bucharest stressed that economic development is the best contraceptive and brings about reduction in fertility.

MEASUREMENT OF FERTILITY (FERTILITY INDICATORS)

Crude Birth Rate

Crude birth rate (CBR) is simply called birth rate. It is the number of livebirths per 1000 MYP, in a given area, during a given year. Number of births can be obtained from the register of births. Higher the CBR of a country, higher is the fertility.

$$\text{Birth rate} = \frac{\text{Number of livebirths}}{\text{MYP}} \times 1{,}000$$

Since the denominator includes population not exposed to childbearing such as children and the elderly people, who are incapable of procreation, it is called crude birth rate. So the refined indicator is general fertility rate.

The BR in India, is 20.97/1000 MYP (2011). CBR has been declining in India, since 1981, as shown in **Figure 23.7**.

General Fertility Rate

Definition: General fertility rate (GFR) is defined as number of livebirths per 1000 women of reproductive age (childbearing age), irrespective of their marital status.

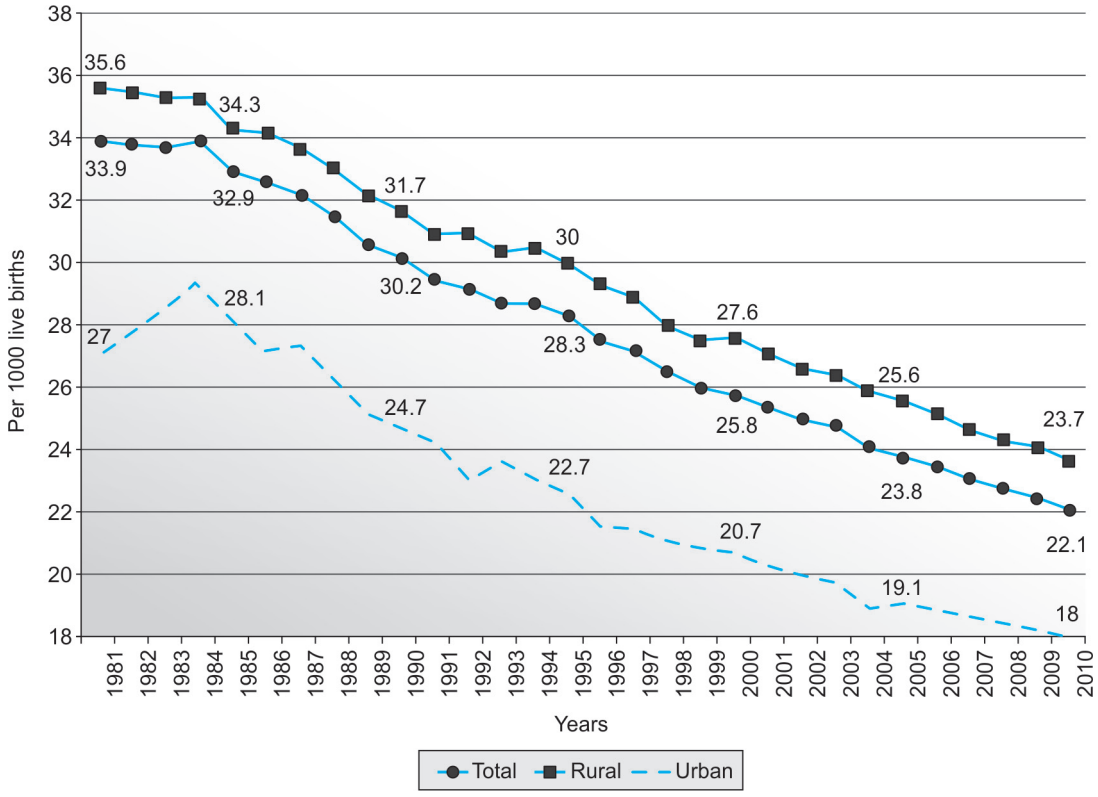


Fig. 23.7 Trend of crude birth rate in India (Rural, urban and total)
Source: GOI. MOHFW. Family Welfare Statistics in India 2011.

This is a better indicator than CBR because the denominator is restricted to only those women of childbearing age (15 to 44). But one limitation of this indicator is that not all women in reproductive age group are exposed to the risk of childbirth. It includes unmarried women also. It is expressed per 1,000 women of reproductive age during a given year.

$$\text{GFR} = \frac{\text{Number of livebirths}}{\text{MYP of women in the childbearing age}} \times 1000$$

This is directly proportional to the capacity of women to bear the children and the number of marriages performed.

In India GFR is 86.5 (2009).

General Marital Fertility Rate

General marital fertility rate (GMFR) is still a better indicator because the denominator consists of only married women in the reproductive age, during a given year.

$$\text{GMFR} = \frac{\text{Number of livebirths}}{\text{MYP of married women in the reproductive age}} \times 1000$$

In India, GMFR is 120.3 (2009).

Age Specific Fertility Rate

Age specific fertility rate (ASFR) is still more a precise indicator because the denominator consists of women in any specified age group. It is also expressed per 1,000 women of specific age group.

$$\text{ASFR} = \frac{\text{Number of livebirths during a year at a specified age of mother}}{\text{MYP of women in the same specified reproductive age}} \times 1000$$

(15-19 yrs or 20-24 yrs or 25-29 yrs or 30-34 yrs or 35-39 yrs or 40-44 yrs)

Thus, ASFR is the number of livebirths in a year per 1000 women of a specified age group. It increased to 227 during 2009 from 218 during 2008, for the age group of 20 to 24.

It is higher below 30 years of age. In practice five yearly age groups from 15 to 44 are considered (as 15 to 19; 20 to 24; 25 to 29; 30 to 34; 35 to 39 and 40 to 44) in 6 groups, out of 30 years

of reproductive age. This gives an information, in which age group the fertility is more so that the family welfare services can be concentrated. Thus, it is an indicator to evaluate the family welfare services also.

Age Specific Marital Fertility Rate

It is the number of children born to married women in the said age group per 1,000 women in the same age group. This differs from ASFR in that the denominator is married women of the specified age. Age specific marital fertility rate (ASMFR) is usually higher than ASFR, because ASMFR covers only married women. It increased to 326 (2009) from 303 (2008) for the age group of 20-24 (rural).

$$\text{ASMFR} = \frac{\text{Number of livebirths at a specified age of married mother}}{\text{MYP of married women in the specified age}} \times 1000$$

Total Fertility Rate

Total fertility rate (TFR) is sum of all age specific fertility rate (of all 6 groups) for all ages and is expressed per woman. Thus, it is the average number of children a woman would have during her reproductive age if she passes through the current fertility rate. It is 2.6 (2009) in India.

Total Marital Fertility Rate

Total marital fertility rate (TMFR) is the sum of all age specific marital fertility rate for each year. Here, the denominator is the married woman. So it is the average number of children a married woman would have during her reproductive age, if she passes through the current fertility rate. In India it is 4.4 (2009.)

Gross Reproduction Rate

Gross reproduction rate (GRR) is the average number of girls that would be born to a woman, during her reproductive age, if she experiences the current fertility rate, without dying.

$$\text{GRR} = \frac{\text{Number of female livebirths}}{\text{Total number of livebirths}} \times 1000$$

In India, GRR is 1.2 (2009).

Net Reproduction Rate

Net reproduction rate (NRR) is the average number of female children a newborn girl will bear during her reproductive age, assuming fixed age specific fertility and mortality rates. This is a measure of the extent to which mothers produce female infants who survive to replace them. If NRR is 1, it means the female population is maintained exactly and population remains almost constant. If NRR is less than 1, the population will decrease and if more than 1, the population will increase.

Net reproduction rate is a demographic indicator. The current level in India is 1.4. NRR of 1 can be achieved (a goal for the year 2006) only if 60 percent of the eligible couples practice one or the other method of family planning (i.e. couple protection rate = CPR).

Couple protection rate is defined as the percentage of eligible couples adopting one or the other method of family planning and effectively protected against childbirth.

This is based on the observation that 50 to 60 percent of births in a year are of birth order 3 or more. Thus, attaining a 60 percent of CPR will be equivalent to cutting off almost all third or higher order of births, leaving 2 or less than 2 surviving children per couple.

Thus, CPR is a dominant factor in the reduction of NRR. NRR is a demographic indicator. The present level in India is 1.4 (2001). The goal of NRR for 2006 is 1 and this can be achieved only if CPR is 60 percent, and above, which is equivalent to attain 2 child norm per couple.

Child Woman Ratio

It is the number of children between 0 to 4 years of age per 1000 women of reproductive age group (15 to 44 or 49 year) during a given year.

$$\text{CW Ratio} = \frac{\text{Number of children between 0-4 year}}{\text{Number of women of reproductive age}} \times 1000$$

This measure of fertility is useful in those areas where birth registration is poor. This data is obtained from census report.

Pregnancy Rate

Pregnancy rate (PR) is the number of pregnancies occurring, irrespective of the outcome such as abortions, stillbirths or livebirths, per 1000 married women of reproductive age group, during a given year.

$$\text{PR} = \frac{\text{Number of pregnancies occurring during a year}}{\text{Number of married women of reproductive age}} \times 1000$$

The pregnancy rate is also employed to assess the failure rate of contraception. It is expressed per 100 women years (or 100 × 12 months = 1200 months) of exposure.

$$\text{Pregnancy rate (failure rate of contraception)} = \frac{\text{Number of pregnancies occurring during a year}}{\text{Total months of exposure}} \times 1{,}000$$

When a woman conceives during the period of observation, she becomes the numerator and not further exposed to the risk of pregnancy. Therefore, the remaining months of exposure of gestation period in the denominator must

be deducted respectively 9, 8 and 3 months for full term pregnancy, still-birth and abortions. For pregnancy, ending with live born child, lactational amenorrhea of average six months needs to be deducted.

Abortion Rate

It is the number of abortions occurring during a given year per 1000 women of reproductive age.

Abortion Ratio

It is the ratio between the number of abortions occurring in a given year and the number of live-births.

MEASUREMENT OF MORTALITY

Demographically important death rates are crude death rate and infant mortality rate.

Death Rate

Crude death rate is defined as number of deaths occurring per 1000 MYP of a given area during a given year.

Increase in the size of the population (or growth of the population) is because of increased birth rate and decreased death rate.

The decline in the death rate is attributed to the following factors:

- Absence or decrease of natural checks like epidemics and famines
- Control of communicable diseases by immunization procedures
- Advancement in the medical science
- Improvement in the health consciousness among people
- Availability of better health care facilities through primary health centers
- Launching of various National Health Programs
- International Aid, etc.

The current death rate in India is 7.4/1000 MYP (2011). The goal was to reduce the death rate to 7/1000 MYP by 2007. The death rate has to be declined because higher the death rate, higher is the birth rate and the population is maintained at a higher level consistently. India has to enter low stationary phase.

International Death Certificate

According to registration of Births and Deaths Act, 1969, the medical practitioner, who has attended the deceased during his last illness, should certify the death. This constitutes the basis of mortality data.

This certificate provides information not only about the direct cause, immediate and antecedent cause and contributory cause of death but also about the interval between the onset of each cause and the occurence of death.

The format of international death certificate is shown in **Table 23.5**.

Table 23.5 Format of international death certificate

	Cause of death	Interval between the onset and death
I. Direct cause	a. Immediate cause (e.g. myocardial infarction) b. Antecedent cause (e.g. hypertension)	_____ _____
II. Contributory	(e.g. obesity)	_____

Note:

a. The immediate cause may be a condition, an injury or poisoning directly leading to death.
b. The antecedent or intervening cause is the one which starts the fatal course leading to the above cause.
c. The contributory cause is the one, which contributes to the death but not related to the disease causing death.

Examples:

1. Myocardial infarction — Hypertension — Obesity.
2. Shock — Dehydration following diarrhea — Malnutrition
3. Fat embolism — Fracture of femur following accident — Epilepsy

Infant Mortality Rate

Higher the infant mortality rate (IMR), higher will be the fertility, because couples want to have at least one male child who will survive to adulthood. So, the couples procreate without restraint, resulting in increased fertility. With all the health and family welfare services in India, IMR has declined from 114/1,000 LB during 1980 to 47.5 per 1,000 LB during 2011.

Migration

It is the movement of population form their regular area of residence either temporarily or permanently, into another territorial area. It may be in-migration (immigrants) or out-migration (emigrants). Intercountry migration is usually legal. It is illegal as in Indo-Pakistan border or Indo-Bangladesh border. The inter-country migration changes the population size, its composition and its distribution. Migration from rural to urban area decreases fertility rate and vice versa.

Net migration = Difference between immigration and emmigration.

$$\text{Migration rate} = \frac{\text{Number of migrants}}{\text{Total population}} \times 1{,}000$$

POPULATION EXPLOSION (POPULATION BOMB)

An increase in the population in an area from one year to another year is called 'Population growth,' which is expressed as 'Annual growth rate'. Growth rate is computed by subtracting crude death rate from crude birth rate. But in reality GR = (CBR – CDR) + Immigration - emmigration).

The current GR in India = 20.97 – 7.48 = 13.49 per 1000 MYP. = 1.35 percent (CSA World fact book 2011). The difference between the Birth rate and Death rate in a graph is marked as 'Demographic gap' **(see Fig. 23.1)**.

As long as the natural resources of a country (such as water, soil, minerals, forests) are able to support and sustain the population by providing basic needs, such as food, cloth and shelter, so long, the increase in population is called as 'Population growth'.

But when the growth of the population is so much that the natural resources are unable to support and provide the basic needs, it is described as 'Population explosion' or 'Population Bomb'. It is a sad state of affairs.

In India, depending upon the growth rate, the population increase is graded as shown in **Table 23.6**.

Table 23.6 Grading of the population increase as per the growth rate

Growth rate (%)	Grading of population increase
'0' (Zero)	Stationary growth (No growth)
0 to 0.5	Slow growth
0.5 to 1	Moderate growth
1 to 1.5	Rapid growth
1.5 to 2.0	Very rapid growth
> 2	'Explosive' growth (Population explosion)

It is said that population growth rate, like a railway train, is subjected to momentum. It starts slowly and gains momentum. Once it is in full speed, takes a long time to bring the momentum under control. The controlling factors for growth rate is mainly the birth-rate and the related factors.

The world population is currently growing at the rate of 3 per second, 180 per minute, 10,800 per hour, 2,59,200 per day and 9.2 crores per year.

As the growth rate increases, the doubling time becomes shorter.

In India, during 20th century, first doubling occurred in 60 years and second doubling occurred within just 30 years.

The rampant population growth is the greatest obstacle to the social and economic development of a country.

Reasons for Population Explosion

- High birth rate
- Low death rate.

Causes of High Birth Rate

- Early onset of puberty (between 11 and 13 years among girls)
- Universality of marriage (Every one must and should get marry and prove their fertility)
- Early age at marriage (60% of girls in India get marry before 19 years of age. Early marriage results in too early pregnancy, too many pregnancies and too frequent pregnancies)
- High proportion of young adults (potential parents)
- Social and cultural factors, such as poverty, illiteracy, ignorance, poor standard of living, lack of knowledge about family planning, religious fetters against birth control (children are God's gift), belief to have a son, etc.

Causes of Low Death Rate

- Decreased frequency of natural calamities like earthquakes, floods, famines, epidemics and pandemics.
- Advancement in the medical science.
- Development of health consciousness among people.
- Availability of better health care facilities through PHCs.
- Launching of various National Health Programs.
- International aid, etc.

Hazards of Population Explosion

- *Physical hazards*
  - Housing (Eruption of slums with poor living conditions)
  - Environmental pollution (Air, soil, water, etc.)
  - Vector problems.
- *Psychological hazards*
  - Behavioral disorders.
  - Mental illness (Neuroses and psychoses)
  - Anxiety (Due to stress and strain)
  - Tension, worries.
- *Social hazards*
  - Alcoholism
  - Broken homes
  - Corruption
  - Divorces
  - Drug abuse
  - Gambling, Unemployment problem.
- *Antisocial activities*
  - Theft, murder, sex-crimes (rape, prostitution), robbery, child abuse, juvenile delinquency.
- *Miscellaneous hazards*
  - Malnutrition
  - Infections
  - STDs including AIDS
  - Accidents
  - Epidemics
  - Hypertension due to stress and strain, etc.

Thus, population explosion is not only a health problem but also a social problem, economic problem and a demographic problem.

POPULATION STABILIZATION

Because of these hazards, there is an urgent need to control and stabilize the population. Since it is not possible to reduce the population to preindependence level, at least it can be stabilized and kept stationary. Stabilization of population is a national priority.

To stabilize the population either the birth-rate has to be decreased or death rate has to be increased. Since death rate cannot be increased, the one and the only way to stabilize the population is by reducing the birthrate and to bring it down to that of death rate, so that low birth rate and low death rate will cancel each other resulting in low stationary phase (India is in late expanding stage of the demographic cycle). It must enter low stationery stage.

Reduction of Birth Rate

There are two strategies:
1. Nonbirth control measures (Social welfare measures)
2. Birth control measures (Family planning methods).

Nonbirth Control Measures

- *Raising age at marriage*: Under the Child Marriage Restraint Act, 1978, the minimum age at marriage has been fixed to 18 years for girls and 21 years for boys. Still this is not strictly implemented. There is a need for educating the people about the dangers of early marriage. Raising the age at marriage stabilizes the population by lengthening the generation gap and increasing the doubling time. If all girls get married at 15 years of age, the population doubles every 16 years, but if they get marry at 25 years, it doubles once in 26 years, all other things being equal.
- *Eradicating illiteracy (Raising the literacy level)*: It has been observed that the fertility rates and family size are lower among literate women compared to illiterate women. Therefore, there is a need to increase the female literacy.

Different measures undertaken to increase the literacy are:
- Establishment of *Anganwadi* and *Balwadi*-centers,
- Enrolment of all children, specially female children for primary education,
- Retention of enroled children (Reducing the drop-out rate from the schools by continuous promotion up to SSLC)
- Establishment of primary schools at the rate of 1 for every 200 children
- Encouraging adult literacy.

Improvement of economic status
- By sanctioning loans (for education, for agricultural activities, for home industries, etc.)
- By encouraging self-employment programs.
- By encouraging job oriented training courses (Jawahar Rozgar Yojana).

Raising the housing standards
- By allotment of free sites to the poor
- By sanctioning of house-loans, (Indira Awas Yojana).

Improving the status of women
- By giving equal opportunities and equal salary to women
- By Information, Education and Communication (IEC) activities.

Adopting one child-norm (be it a boy or girl): By massive educational campaign.

Improving the quality of health services: Specially, maternal and child health services.

If all these measures are taken to reduce IMR, child mortality rate to a very low level, people will be sure that their child does not die prematurely. Only then they will come forward to adopt one child-norm.

Birth Control Measures (Family Planning Methods)

Explained in the next Chapter.

BIBLIOGRAPHY

1. GOI. MOHFW. Annual Report; 2009-10. Mar 2010.
2. GOI. MOHFW. Family Welfare Statistics in India 2011.
3. Last JM. Dictionary of Epidemiology 1983.
4. Registrar General and Census Commissioner of India. Census of India 1991.
5. Registrar General of India. Physician's Manual on Medical Certification of Causes of Death. Vital Statistics Division. New Delhi 1992.
6. Sunderlal, Adarsh, Pankaj. Textbook of Community Medicine 1st edn, 2007.

CHAPTER 24

Family Planning

Family planning means planning the size of the family in a manner, compatible with the physical and socioeconomic resources of the parents and conducive to the health and welfare of all members of the family.

WHO defined family planning as, 'A way of living and thinking, that is adopted voluntarily upon the basis of scientific knowledge, attitude and responsible decisions by individuals and couples, in order to promote the health and welfare of the family groups and thus contribute effectively to the social and economic development of a country.'

Another definition refers to the 'practices' that help the individuals or couples to attain the following objectives:

- To avoid unwanted births
- To bring about wanted births
- To regulate the interval between the pregnancies
- To control the time at which births occur in relation to the age of the parents
- To determine the number of children in the family.

NEED FOR FAMILY PLANNING

The necessity of family planning (FP) is on the following grounds:

1. Demographic
2. Socioeconomic
3. Health.

Demographic Grounds

The unchecked and unregulated fertility specially in the developing countries has the following demographic consequences, such as:

- Population explosion due to high growth rate of more than 2 percent
- Broad based population pyramid, indicating high proportion of children and adolescents
- Decline in the sex ratio (i.e. decline in the number of females per 1000 males)
- Increase in the population density (i.e. number of persons per sq. km area)
- Increased urbanization.

Other demographic indicators which are characteristic of high growth rate are low literacy (especially in females), large family size, low level of life expectancy and high values of fertility indicators, such as total fertility rate, gross and net reproduction rate, age-specific rates, etc.

If the size of the family is reduced, proportionately the birth rate will also come down as in **Table 24.1**:

Table 24.1 Reduction of birth rate as per the size of the family

Size of the family	Birth rate
4.3	28.5
3	25
2	17
1	09

Thus, the BR will then become equal to death rate, resulting in stationary growth or stabilization of the population (i.e. low stationary phase, i.e. demographic transition).

Socioeconomic Grounds

Good socioeconomic condition is conducive for better acceptance of small family-norm resulting in low fertility and viceversa, i.e. a better performance in family planning and low fertility results in better socioeconomic condition, thus one influencing the other. The indicators of socioeconomic

development are per capita GNP, adult literacy rate and life expectancy at birth. The indicators for the performance in family planning services are percentage of eligible women using contraception, total fertility rate and crude birth rate. Social consequences of not adopting FP would be poverty, illiteracy, unemployment problem, living problems, prostitution, antisocial activities like theft, murder, juvenile delinquency, etc.

Health Grounds

The health of the family and family planning are related in such a way that one gives boost to the other. The components of family health are:

- Women's health
- Fetal health
- Child health.

Women's Health

Eventhough pregnancy is a normal physiological process, it is associated with a great pathological potential, resulting in increased maternal morbidity and mortality. MMR in developing countries is 15 to 20 times higher than that of developed countries. Adopting FP directly reduces MMR, by improving women's health (By having only one or two children with spacing, it prevents the depletion of maternal reserve, thus promoting her health).

Fetal Health

An association between advanced age of the mother and some congenital anomalies like Down's Syndrome has been well documented. Similarly, the incidence of abortion and still-birth is more among teenage pregnancies. Thus, adopting FP and conceiving in the right age of the mother, improves fetal health.

Child Health

Adopting FP for spacing between the births and reducing the number of births has been shown to be associated with better health and better growth and development of the children.

SCOPE OF FAMILY PLANNING SERVICES

The aim of the FP is not just preventing the births. It is more than mere birth control. The aim is to have children by choice and not by chance.

FP includes services to the following groups of individuals.

- To potential parents
- To couples after marriage
- To infertile couples
- To those who conceive out of wedlock.

Services to the potential parents (to individuals before marriage)

- Sex education (anatomy and physiology of reproductive system)
- Parent craft education
- Genetic counseling
- Premarital consultation and examination.

Services to couples after marriage (to fertile couples)

- Marriage counseling
- Genetic counseling
- Screening for diseases of reproductive organs
- Supply of contraceptives
- Sterilization facilities
- Termination of pregnancy, if needed.

Services to infertile couples

- Investigations on sterility
- Treatment for sterility
- Artificial insemination
- Adoption services.

Services to those women who conceive out of wedlock

- Care of such pregnant women
- Termination of pregnancy, if it is caused by rape
- Services to unmarried women.

Concept of Family Welfare

Till 1977, the concept was Family Planning. During emergency period 1976-77, there were all forms of compulsions for tubectomy and vasectomy. Targets were fixed for these services. During 1977, the new government ruled out all forms of compulsions and renamed the program as 'Family Welfare Program', with the objective of improving the quality of life of the people by adopting small family norm and by stabilizing the country's population to 150 crores by 2050 AD.

The Family Welfare Program not only includes Family planning services but also Universal immunization.

A significant achievement of FW program in India has been the decline in the fertility rate from 6.4 in 1950s to 3.1 in 2000.

Eligible Couple

Eligible couple (EC) is a couple wherein the wife is in the reproductive age (15 to 45 yr), who is eligible and in need of FP services. They are about 150 to 180 such couples per 1,000 population. They are documented in 'eligible couple register'. Each of such couple has to be identified and motivated to accept FP services in the interest of the health and welfare of the family and to overcome the hazards of population explosion. In the rural areas, the FP services are rendered at their doors by female health worker. She maintains EC register, which is a basic document for organizing FP work.

Couple Protection Rate

The percentage of eligible couples effectively protected against childbirth by one or the other methods of contraception. This indicates the prevalence of contraceptive practice in the community. The current couple protection rate (CPR) is 46 percent. The target fixed for 2000 AD was 60 percent, based on the observation that 50 to 60 percent of births in a year, are of the birth order 3 or more. By attaining CPR 60 percent, it is almost equivalent to cut off almost all third or higher order of births, leaving 2 or less than 2 children per couple, so that it is possible to achieve NRR (net reproduction rate) of 1.

Target Couples

It means those couples who have had 2 or 3 living children thus constituting priority group. They are directed to undergo tubectomy or vasectomy. Since the scope is broadened to include families with one child or even newly married couples to accept FP services, the term target couple has lost its original meaning and is outdated.

Unmet Need for Family Planning

Currently married women who are not using any contraceptive method, but who do not want any more children or want to wait for two or more years, before having another child, are defined as having an unmet need for family planning. Current contraceptive users are said to have a met need for family planning. The total demand for family planning is the sum of the met need and the unmet need.

CONTRACEPTIVE METHODS (FERTILITY REGULATING METHODS; TECHNIQUES OF BIRTH CONTROL)

A contraceptive method is the one which helps the woman to avoid unwanted pregnancy resulting from coitus. There are many methods of contraception. Each has got its own merits and demerits.

An ideal contraceptive method is the one, which is safe, effective, acceptable, inexpensive, reliable, reversible, simple, long lasting, independent of coitus and requires less medical supervision.

A method suitable for one group may not be suitable for another group because of different cultural background, religious beliefs and socioeconomic status. Thus, there can never be an ideal contraceptive method. Therefore, the present approach is to allow the couple to select any method of their choice to promote FP. This is called 'Cafeteria choice.'

The term conventional contraceptive method denotes the method, which requires action at the time of sexual intercourse, e.g. condoms, spermicides, diaphragm, etc.

Broadly the contraceptive methods have been classified into two groups namely temporary and terminal methods.

Temporary (Nonterminal Methods; Spacing Methods)

These are subclassified into five groups:
1. Barrier methods
2. Intrauterine devices
3. Hormonal methods
4. Postconceptional methods
5. Miscellaneous methods.

Terminal (Permanent Methods; Sterilization Methods)

1. Vasectomy
2. Tubectomy.

TEMPORARY METHODS

Barrier Methods

These are the methods, which act as barrier between the sperms and the ovum. They are of three types:
1. Physical methods
2. Chemical methods
3. Combined methods.

Physical Methods

The devices employed for physical barrier methods are condom, diaphragm, cervical cap, vault cap and vimule cap.

Condom: There are two types, male condom and female condom.

Male condom (Latin 'Condus' means receptacle): It is named after the inventor Dr. Condum, who recommended it to King Charles II to prevent illegal offspring. It is a sheath made up of latex, a kind of plastic. It is cylindrical shaped measuring 15 to 20 cm length, 3 cm diameter, and 0.003 cm thick. It is closed at one end with a teat-end and open at the other end, with an integral rim. It is used by the male partner to cover erect penis during coitus **(Fig. 24.1)**.

Before wearing, the air from the teat-end is expelled to make room for the collection of semen, by pressing it. Keeping the teat-end pressed, it is rolled over the erect penis up to the base. After climax and before losing his erection, the

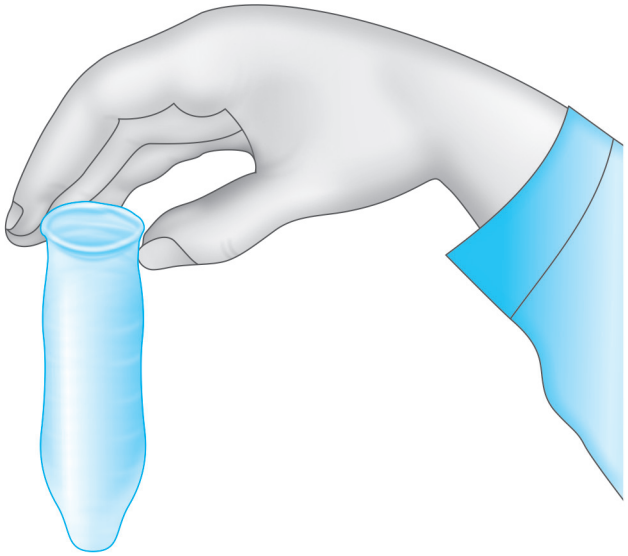


Fig. 24.1 Condom

person should hold the rim of the condom against penis and he should withdraw, so that the condom does not slip and the semen is not spilled.

If air from the teat-end is not removed, it may tear due to force of ejaculation. Promoting proper use of condom is an important measure of prevention of STDs/AIDS and pregnancy **(Fig. 24.2)**.

After use, it should be wrapped in a piece of paper and thrown in dustbin and not in commode of the latrine. A new condom must be used for each sexual act. It is electronically pretested and presterilized by gamma-radiation and made available in packs.

There are three varieties of condoms marketed with the following trade names:

Dry types (Non lubricated): Nirodh, Durapac, Kohinoor ('Nirodh' is a sanskrit word, meaning prevention) Lubricants can be applied over this, such as glycerine, spermicide and even water. Oil based lubricants should never be applied such as cooking oil, coconut oil, mineral oil, petroleum jelly, Vaseline, cream, lotion, butter, etc. because they weaken the latex rubber very quickly.

Deluxe types (lubricated): Adams, Fiesta, Kamasutra, Durex, Kohinoor-pink, etc.

Super deluxe types: They are colored, thinner varieties lubricated with spermicides, i.e. share, rakshak, etc.

Storage over three years can weaken latex and increase chances of breakage.

Merits: It is simple, safe, effective, cheap, easily available, spacing method of contraception without side effects and contraindications. If used properly, it protects against not only pregnancy, but also against STDs including AIDS. It is easy to use and does not require medical supervision. It is light, disposable, available without prescription and harmless. It often prevents premature ejaculation and help the man last longer during sex-play.

Demerits:

- If not properly used, it may slip off or tear during sex-play
- It interferes with sex sensation but many get used to it
- Rarely allergic reaction can occur to latex
- It becomes weak when stored for long time
- It cannot be used more than once
- It causes little embarrassment to buy, to put on, to take off and throw away
- Allergy to condom is the only contraindication.

Failure rate: It is about 15 to 20 per 100 women years of exposure (WYE). This can be decreased by using it in conjunction with a spermicidal jelly, inserted into the vagina before intercourse.

Condoms are manufactured in India by Hindustan Latex Ltd, Trivandrum and London Rubber Institute in Chennai.

Female condom: Female condom (FEMIDOM) is also a sheath made up of thin, transparent, soft plastic, closed at smaller end and opened at the wider end. There are stiff and flexible rings at both the ends. The inner ring at the closed end, is used to insert the device inside the vagina and held it in place and the outer ring which remain outside the vagina, covers the external genitalia. Before sex, the woman places the closed end of the sheath high-up in vagina and larger open end stays outside the vulva. During sex, the man's penis goes inside the female condom. Effectiveness is similar to male condoms. It is meant for one time use only **(Fig. 24.3)**.

Merits: Controlled by woman, prevents both pregnancy and STDs, including AIDS, no apparent side effects, no allergy and no contraindications. It can be used even during menstruation. More comfortable to men. Offers greater protection as it covers both internal and external genitalia.

Demerits: Expensive, not impressive, woman must touch her genitals. It is now available in India, but widely available in Europe and USA. It is costly in India. Improvements are being worked out for universal acceptability.

Diaphragm (vaginal diaphragm, dutch diaphragm): It is also known as Dutch cap. It is named so after a German physician Dutch Neo Mathusians, who first published it in 1882.

It is a shallow, soft rubber cup, with a stiff but flexible rim, made up of coiled spring, which helps in retention **(Fig. 24.4)**.

Size varies from 5 to 10 cm in diameter. The required size for a woman can be determined by inserting two fingers in the posterior fornix and noting how far on the finger the symphisis pubis comes. The distance indicates the approximate diameter of the diaphragm, required for that woman.

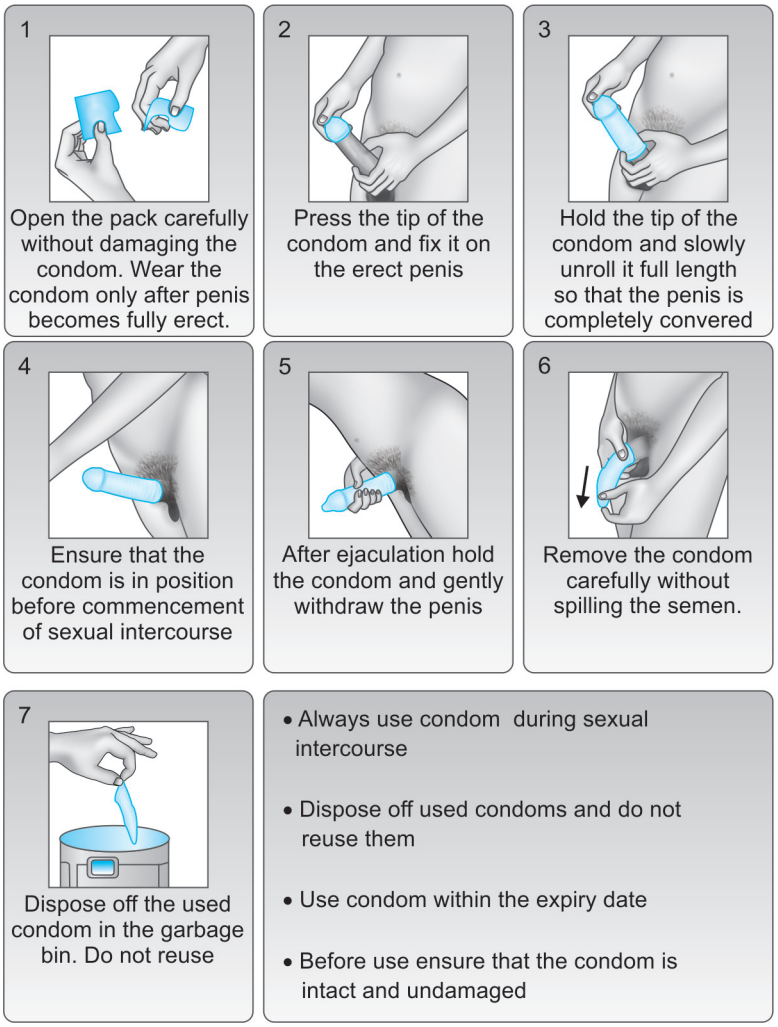


Fig. 24.2 Condom promotion regarding how to use

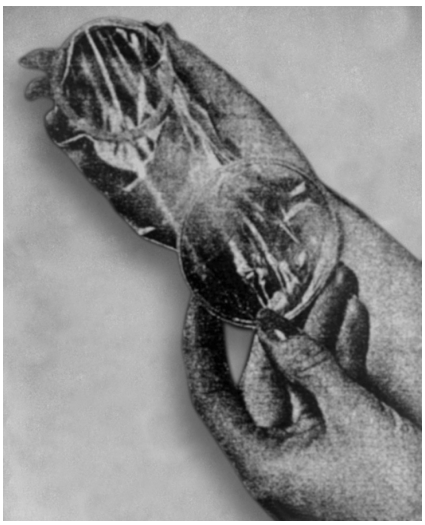


Fig. 24.3 Female condom

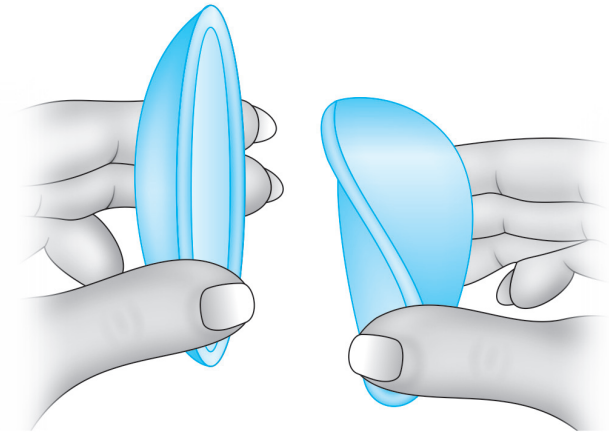


Fig. 24.4 Diaphragm

Method of insertion
She holds the diaphragm with the dome down, like a cup, with a tablespoonful of jelly into the cup. She then presses the opposite sides of the rim together and pushes the diaphragm into the vagina as far as it goes and makes sure that it covers the cervix with her fingers.

When it is inserted, it lies snugly between the sacrum and the pubic symphisis. It is held in position partly by the tension of the spring and partly by the tone of the vaginal muscles.

It is to be inserted just before the intercourse. It must remain there at least for 6 hours after the act. For each additional act of intercourse during these 6 hours, she must use spermicide to be more effective. It should not be retained for more than 24 hours.

She should not douche for at least 6 hours after sex.

Method of removal
She should hook the rim from behind the pubic symphisis and pull out carefully. After removal, it should be washed with soap and water.

Meanwhile she checks for holes either by filling it with water or by holding against light. After drying, it should be stored in a cool, dark and clear place.

Merits
Simple, safe, effective and easy to use.

Demerits
It requires the services of a medical or paramedical person for the demonstration of using it.

It may tear while removing, if not careful. There are some contraindications such as prolapse of uterus, cystocoele, too long or too short cervix.

If left in the vagina for a long time, it may result in 'Toxic shock syndrome', caused by *Staphylococcus pyogenes*, proliferating in the upper vagina, characterized by fever, myalgia, rashes, dizziness, vomiting and diarrhea. It is rare but serious.

Failure Rate
Failure rate is 10 to 20 per 100 women years of exposure (HWYE). It can be reduced to 2 per HWYE by using alongwith the spermicidal jelly.

Because of many limitations, its use is outdated. Variations in Dutch cap are cervical cap, vault cap and vimule cap.

Cervical Cap
It is thimble shaped. It is like diaphragm but smaller. It covers the vaginal portion of the cervix, thus acting as a barrier **(Fig. 24.5A)**.

The woman inserts the cervical cap with spermicide, in the proper position in the vagina before having sexual intercourse.

She fills the dome of the cap 1/3 full with spermicidal jelly or cream. She squeezes the rim of the cap between thumb and index finger and with the dome side towards the plam of the hand, slides the cap into the vagina and presses the rim around the cervix.

She leaves the cap for at least 6 hours after the act. She should not douche for at least 6 hours after the sex. Leaving *in situ* for more than 48 hours can cause bad odor and may increase the risk of toxic shock syndrome.

She presses the cap rim and tilts. Then hooks a finger around the rim and pulls it. She washes the cap with soap and water after each use, then, cheeks for holes as in diaphragm. She then dries the cap and stores in a clean, cool and dark place.

It is not widely available outside North America, Europe, Australia and New Zealand.

Vault cap (dumas cap): It fits into the vault of the vagina and occludes the cervix **(Fig. 24.5B)**.

This is indicated when neither diaphragm nor cervical cap is suited to the woman.

Vimule cap: It is a small, deep, cup like device with a flanged base, because of which it fits firmly on the cervix **(Fig. 24.5C)**.

It can be used by a woman, whose vaginal walls are lax and cannot use diaphragm.

Chemical Methods

These are the contraceptives that a woman places in her vagina shortly before sex. These are all spermicides **(Fig. 24.6)**.
These methods are grouped as follows:

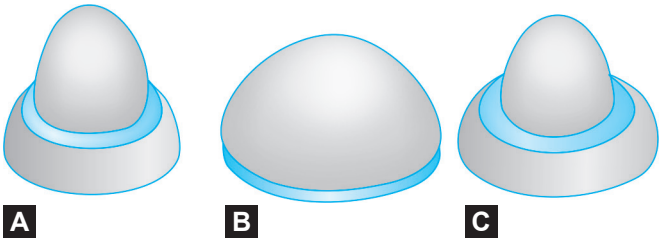
a. Foams
b. Creams, jellies, pastes
c. Suppositories
d. Soluble films

All these devices are impregnated with spermicides. They are surface active agents. They have to be inserted high up in the vagina. They attach themselves to sperms, inhibit oxygen uptake and kill them.

Foams: The foam tablets contain the spermicide 'Chloramine-T' or Phenyl mercuric acetate. A few drops of water are poured on it and then introduced high up in the vagina. Foam is produced and spreads to all parts of vagina.

The commercial name is 'Today'. This contains Nonoxynol-9 spermicide, which paralyses the sperm. The effect lasts for about 1 hour.

Foam aerosols are better than foam tablets because they dissolve better than tablets.



Figs 24.5A to C Cervical caps

Fig. 24.6 Spermicides

Cream and paste: These have a soapy base.

Jelly: This has an acqueous base. They are supplied alongwith the applicator, which is like a syringe with screw. They also contain Chloramine T or Phenyl mercuric acetate. For example Delfen cream, volper cream, orthogynol jelly, perception jelly, etc.

Merits

- They are simple, safe and easy to use
- They offer contraception just when needed
- Do not require medical assistance
- They are free from systemic toxicity.

Demerits: Some women complain of burning or irritation and messiness. They often cause local allergic reaction and urinary tract infection. They have to be used at each act of sex.

Failure rate: It is quite high, i.e. 25 pregnancy per 100 WYE. This can be reduced by using it in conjunction with physical barriers.

All physical methods, except male condom and all chemical methods are vaginal methods. All these vaginal methods were widely used before 1960s. With the introduction of IUDs and oral pills, the vaginal methods have become outdated.

Combined Methods

This consists of combination of both physical and chemical methods, i.e. condom and cream; diaphragm and jelly.

Intrauterine Devices

Intrauterine devices (IUDs) are the devices, which when placed inside the uterus, prevent the birth of the child, by acting as a foreign body. This principle was known to Arabs, who were controlling conception in camels by introducing a small spherical stone into each horn of the uterus.

In 1929, Grafenberg, a German gynecologist used a core of silkworm gut encircled by German silver ring successfully in preventing conception. However, because of injudicious use, Grafenberg ring fell into disrepute.

In 1934, Mr. Ota in Japan introduced a new device, a gold plated silver ring, with a disk in the center, attached by three spokes (Ota ring) **(Fig. 24.7)**.

In 1959, Openheimer of Israel and Ishihama of Japan published the excellent results of IUDs, discovered by Grafenberg and Ota.

In 1960, Margulies spiral was launched, a plastic device, impregnated with barium sulphate, a radio opaque substance.

In 1962, Dr Jack Lippe of US introduced a device, named after him as Lippe's loop, which was very popular for two decades in India **(Fig. 24.8)**.

During 1970s, it was modified by adding copper to IUDs, which was found to have strong antiferlility effect. Copper-T has now been widely used under National Family Welfare Program.

During 1990s, it was further modified and improved by impregnating the IUDs with slow releasing hormones, Hormonal IUDs.

An IUD is a small, stiff but flexible, nontoxic, polyethylene plastic frame, incorporated with Barium sulphate, to make it radio opaque and prevents conception by acting as a foreign body when inserted into the uterus of the woman, through vagina. The IUD has two strings, made up of nylon, which hang through the opening of the cervix into the vagina, to

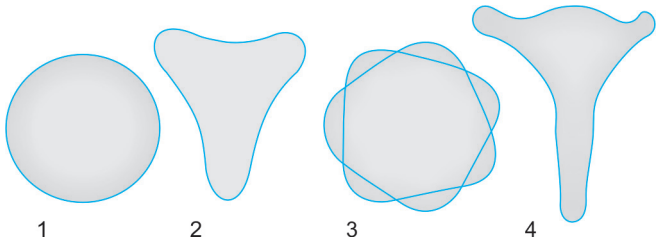


Fig. 24.7 Intrauterine ring devices

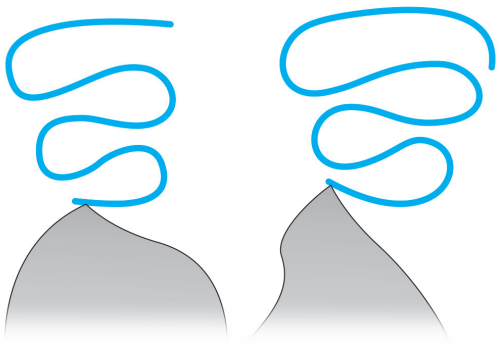


Fig. 24.8 Lippe's loop

check by the user to know whether it is *in situ* and also to remove it by pulling when pregnancy is desired.

Introduction of IUD has opened a new avenue in the control of population growth.

Types of IUDs

A. First generation IUDs
B. Second generation IUDs
C. Third generation IUDs.

First generation IUDs: These are inert, nonmedicated devices, i.e. Lippe's loop. It is a double S-shaped, serpentine device, made up of poly-ethylene, nontoxic, nontissue reactive material, incorporated with barium sulphate. It has two nylon transcervical threads, attached to lower end of the loop. It is available in four sizes, A, B, C and D, latter being the largest, recommended for multiparous women.

In India, it is available in two sizes, 27.5 and 30 mm. For purposes of identification, smaller one has black thread and bigger one yellow threads **(Fig. 24.8)**.

Because of side effects and more expulsion rates, (19/100 WYE) with the introduction of copper IUDs, it became outdated and not used at all.

Second generation IUDs: During 1970s, it was found that metallic copper has a strong antifertility effect. Addition of copper to IUD has made it possible to develop smaller and safer devices than Lippe's loop, thereby minimizing the side effects and expulsion rates; Thus, copper IUDs became more popular.

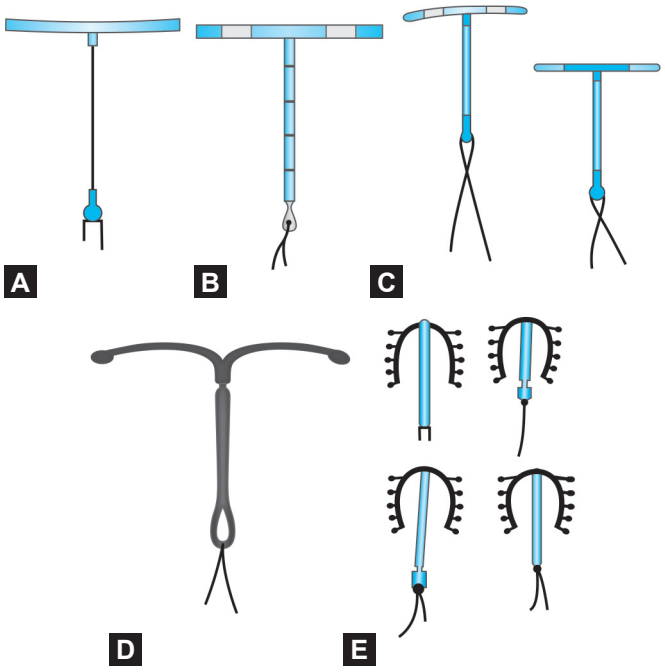
The different copper bearing IUDs are:

- *Earlier devices*—T Cu 200, T Cu 200 B, **(Fig. 24.9A)** Copper 7, Shangai-V-Cu-200.
- *Newer devices*—T Cu-220 C, **(Fig. 24.9B)**
  T Cu—380 A, T Cu 380 S (Slim line) **(Fig. 24.9C)**
  Cu Nova—T 200 **(Fig. 24.9D)**. Cu Nova T 380
- *Multiload devices*—mL - Cu - 250, mL - Cu - 375 **(Fig. 24.9E)**.

The number indicates the surface area of the copper in square mm, on the device. Nova T and Copper T 380 Ag are distinguished by a silver core overwhich is wrapped the copper wire. All copper T and multiload devices are effective for at least 5 years, except T Cu 380 A, which is much more effective for prevention of pregnancy up to 10 years.

Third generation IUDs (medicated IUDs): These were first pioneered by Scommegna et al. These are also 'T' shaped devices, made up of permeable, polymer membrane, incorporated with a slow releasing progesterone hormone, which prevents pregnancy, i.e. Progestasert, LNG-20.

Progestasert: This contains natural progesterone hormone, released in the uterus slowly over a period of one year, at the rate of 65 mcg daily. As the hormone is depleted, regular replacement is necessary, every year **(Fig. 24.10A)**.



Figs 24.9A to E (A) T Cu 200 B, (B) T Cu 220 C, (C) T Cu 380 A and T Cu 380 S, (D) Cu Nova T 200, (E) ML Cu 250 and 375

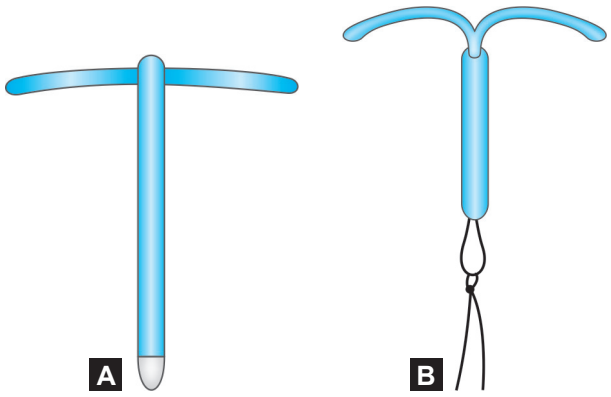
LNG-20: This device contains potent synthetic hormone, i.e. levonorgestrel, releasing 20 mcg daily. This is effective for 3 to 5 years **(Fig. 24.10B)**.

Compared to copper devices, hormonal devices are still better in that the expulsion rate and the incidence of side effects are lesser. But more expensive.

Mechanism of Action

IUDs cause foreign body reaction resulting in cellular and biochemical changes. The cellular or morphological changes are increased vascular permeability (hyperemia), edema and infiltration of leukocytes (giant cells, macrophages and polymorphs) in the endometrium of uterus. Certain biochemical changes also occur in the uterine fluid, thereby the viability of the ovum is impaired, thus reducing the chances of fertilization. Even if fertilization occur, because of the increased tubal motility by the foreign body, the fertilized ovum moves to the uterus much before the bed is prepared for implantation and dies, thus preventing pregnancy.

In addition, copper ions are released from the copper IUDs, which has strong antifertility effect, by enchancing the cellular changes in the endometrium, biochemical changes in the uterine fluid and cervical mucus and also by affecting the motility, viability and capacity of the sperms. Further, Cu-T also causes the release of prostaglandin which increases the contractility of uterus and makes it uncongenial for the nidation of zygote.



Figs 24.10A and B (A) Progestasert; (B) LNG 20

The hormone releasing devices release the progesterone hormone, which increases the viscosity of cervical mucus and prevent the sperms from entering the cervix. They also maintain a high level of progesterone in the endometrium, making it unfavorable for implantation of zygote.

Advantages

- Simple to insert, safe to use.
- Visit to the clinic is only once.
- Effective to the tune of 97 percent (i.e. High success rate) thus reliable.
- High continuation rate (Stays in place for several years).
- Reversible contraceptive method (IUD can be removed easily).
- Free from systemic, metabolic side effects, unlike oral pills.
- Does not interfere with sexual intercourse (so increased sexual enjoyment).
- Does not interfere with lactation.
- Collateral benefit is thorough pelvic examination of the woman, before IUD insertion.
- Effective as 'postcoital emergency contraceptives', if inserted within 3 to 5 days of unprotected intercourse.
- Less risk of ectopic pregnancy.

IUD Insertion

The placement of IUD is done by using a plastic syringe called 'IUD—inserter', which is presterilized by gamma radiation. The device is thus made available in a presterilized packet.

Hands to be washed, sterile gloves to be worn, thorough pelvic examination to be done to exclude any pathology, the genitalia (vagina and cervix) is cleaned with iodine, working slowly and gently, the provider inserts the IUD by opening the new, presterilized packet.

After insertion, if the woman feels dizzy, she should lie down quietly for 5 to 10 minutes.

Indications for Removal of IUD

- Development of side effects such as severe pain and heavy bleeding
- Occurrence of pregnancy
- Development of pelvic inflammatory disease (PID)
- Perforation of uterus
- Partial expulsion of IUD
- When the lifespan of IUD has passed
- When the woman reaches menopause

Using aseptic precautions, the IUD strings are pulled slowly and gently with forceps.

An Ideal IUD Candidate

It is a woman in the reproductive age, given birth to a child, not having any pelvic inflammatory disease and not having multiple sexual partners (because polygamy favors the development of PID which in turn can lead to infertility).

Eventhough smaller IUDs can be fitted in nulliparous woman, she is not an ideal candidate because of side effects and more expulsions, compared to multiparous woman. However, IUD can be preferred for nulliparous women, if they cannot use or accept alternative methods of contraception.

Contraindications for IUD Insertion

- *Absolute contraindications* are pregnancy, STDs, previous ectopic pregnancy, any pelvic pathology such as infections, tumors, bleeding disorder, congenital defects in the uterus and cancer of cervix, uterus or adnexa.
- *Relative contraindications* are multiple sexual partners and anemia; Wilson's disease is a contraindication for copper IUDs only.

Time of Insertion

The IUD can be inserted to a woman of reproductive years, at any time during the menstrual cycle, if it is reasonably sure that she is not pregnant. However, the ideal time is after the 5th day and before 10th day of menstrual period. This is called 'Intermenstrual insertion.'

Thus, depending upon the timing of IUD insertion, it is named as follows:

- *Postplacental insertion:* This means insertion of IUD immediately following delivery of the placenta. This can be done at any time between 10 minutes and 48 hours after childbirth. This is also called as 'immediate postpartum insertion.' But the disadvantage is high expulsion rate and high-risk of infection and perforation of uterus.
- *Postpartum insertion:* This means insertion of IUD about 6 to 8 weeks after delivery. This is also called as 'post puerperal insertion.' The expulsion rate is almost half of postplacental insertion.
- *Postabortum insertion:* This means insertion of IUD about 12 weeks after an abortion. However, following

spontaneous abortion, IUD can be inserted after the first menstrual period.

- *Postcesarean section insertion:* This means insertion of IUD, about 6 to 8 weeks after cesarean section. The risk of infection is high.
- *Postcoital insertion:* This means insertion of IUD within 3 to 5 days of unprotected or forced intercourse, to provide post coital contraception. This is called 'emergency contraception.'

Instructions Following IUD Insertion

- She must feel for the filaments in the vagina, every month.
- She must report if it is not felt or expelled out or if it causes any problem.
- In the absence of any complaints, she must report for the examination 1 year and 2 years after insertion.
- Depending upon the types of IUD, it has to be removed after its lifespan is over.
- In case she becomes pregnant and if she desires that pregnancy, it is better to remove the IUD to avoid infection and spontaneous abortion. If she does not want that pregnancy, medical termination of pregnancy is done.

Disadvantages (Side Effects and Complications)

- *Menstrual changes (bleeding):* These changes are common during the first-three months. Bleeding can occur in any of the following forms:

  Spotting between the periods, longer and heavier menstrual periods (menorrhagia). More cramps or pain (dysmenorrhea) during periods. Removal of IUD restores the normal pattern of the cycle.
- *Pain:* This occurs in nearly 30 to 40 percent of the users. Pain is experienced as low back ache, abdominal cramps or pain down the thighs. Usually, pain disappears by third month. If pain is intolerable, IUD has to be removed. If pain is severe during insertion, it indicates that either the IUD is large or incorrectly placed inside the uterus.
- *Pelvic infection:* PID (Pelvic inflammatory disease) is a collective term including acute, subacute or chronic inflammatory conditions of pelvic organs such as ovaries, fallopian tubes, uterus, the related connective tissues and the pelvic peritoneum.

  PID can occur if aseptic precautions are not adopted, while placing the IUD. Recent hypothesis is that the nylon threads of IUD may act as a vehicle of infection for ascending infection from, lower genital tract to uterus and tubes and it is more so among those who are at a high-risk of STDs because of polyandry habits.

  PID is clinically characterized by fever, intermenstrual bleeding, leucorrhea, dysuria, pelvic pain and tenderness and palpable painful adnexal swelling (indicating tubo-ovarian abscess). One or two such episodes can result in blocking of fallopian tubes and infertility. Thus, PID is a threat to woman's fertility. When PID is diagnosed, IUD has to be removed.

  PID can be prevented by proper selection of cases, thorough examination of pelvis before IUD insertion and by following aseptic precautions while inserting IUD and by avoiding multiple sexual partners.
- *Uterine perforation:* It is rare but potentially a serious complication following IUD insertion. It is used to be more with Lippe's loop than with copper IUDs. It is more common following postplacental insertion than post-partum insertion. It is also more when inserted by an untrained person.

  Perforation of uterus results in migration of the device into the peritoneal cavity causing obstruction of bowel, and peritoneal adhesions. Often it could be asymptomatic also. Uterine perforation is suspected when a search is made for a missing IUD and diagnosis is made by pelvic X-ray or ultrasound examination. IUD is removed by laprotomy.
- *Expulsions:* Nonmedicated devices like Lippe's loop have higher expulsion rates (6-13/100 WY) than copper devices which have 1-8/100 WY. Nulliparous women have higher expulsion rate than the parous women. Among the parous women, it is more among lactating mothers than nonlactating mothers. Nearly 20 percent of the expulsions go unnoticed. Most expulsions take place within 3 months of IUD insertion and frequently occur during menstruation. Unnoticed expulsion may lead to unwanted pregnancy.
- *Ectopic pregnancy:* Pregnancy itself is rare among IUD users. But when pregnancy occurs, 1 in every 30 is ectopic (3%). It is life threatening and requires immediate treatment.

  Ectopic pregnancy is characterized by History of amenorrhea, lower abdominal pain and tenderness, scanty or dark vaginal bleeding, anemia and fainting. It is confirmed by pelvic ultrasonography. It may result in rupture of fallopian tubes. Treatment is lapratomy and removal of trophoblast, fetal parts and tubes.

  History of previous ectopic pregnancy is associated with an increased risk of ectopic pregnancy. So, such women should not use IUD.

Failure Rate

It is 2 to 3 per 100 WY.

Restoration of Fertility after Removal

Fertility is not impaired after removal of IUD, provided there is no episode of PID. Seventy percent of IUD users conceive within one year of removal.

Hormonal Contraceptive Methods (Steroidal contraceptives)

These are the contraceptives containing gonadal steroids, i.e. synthetic estrogens (ethinyl estradiol; mestranal and/or synthetic progestogens (mederoxy progesterone acetate; norethisterone acetate; lynestrenol; norethinodrel; levonorgestrel). All these methods are for women **(Flow chart 24.1)**.

Combined Oral Contraceptive Pills (COC Pills; Birth Control Pills)

They are so called because each pill has got a combination of synthetic estrogen and progestogen in low dose as to be safe and effective, i.e. 30 to 35 microgram of ethynyl estradiol (estrogen) and 0.5 mgm (i.e. 500 micrograms) of norethisterone (progestogen). Therefore, they are also called as 'Low dose combined oral contraceptives'. They are marketed as Mala-D. Mala-N are the standard dose pills, containing 50 micrograms of ethinyl estradiol and 500 microgram of norethisterone.

In this type, all pills have the same composition of estrogen and progesterone.

Monophasic Pills

They are available in two types of pill packets. One type containing 21 active (hormonal) pills and another type containing 28 pills (21 active + 7 placebos, i.e. reminder pills). The purpose of reminder pills of different color is to make the women to have a continuity in taking the pills. All the 21 active (hormonal) pills have the same composition of estrogen and progesterone.

Mechanism of action: Estrogen mainly inhibits ovulation and progestogen mainly causes the atrophy of endometrium and makes the cervical mucus thick, viscid and impenetrable to sperms, thereby preventing the pregnancy. Pills do not work by disrupting the existing pregnancy.

Instructions: The woman is instructed to swallow one pill daily, preferably at bedtime, starting from the 5th day of the menstrual cycle, daily one, for 21 days, in the direction of the arrow over the packet, followed by a break of 7 days in case of 21 pills packet or continue one placebo daily in case of 28 pills packets, during which the woman will have menstruation. The bleeding occurs within 2 to 3 days after the last hormonal pill.

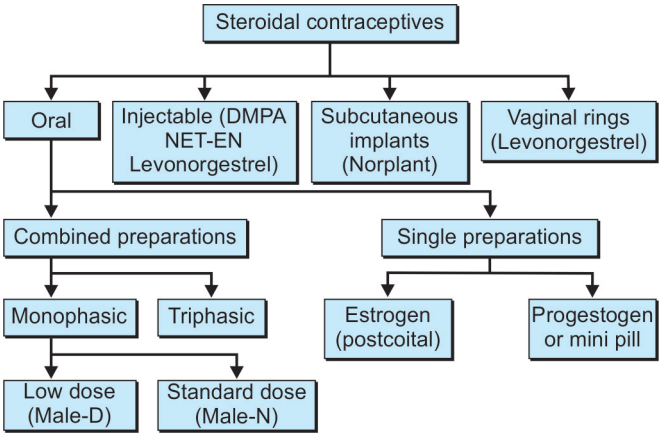
When bleeding occurs, it is considered as the first day of the next cycle. It is called withdrawal bleeding because bleeding is not like normal menstruation but an episode of uterine bleeding from an incompletely formed endometrium caused by the withdrawal of the exogenous hormones. Further, the quantity lost is half of that occurring in the natural menstruation. Thus, it is an anovular menstruation.

Whether bleeding occurs or not, she is instructed to start the next packet of the pills, the very next day of the previous 28 pill packet or from the 5th day of the cycle in case of 21 pill packet. Usually, she will have her cycles at the end of second course/packet. She must not wait for more than 7 days between cycles of 21 pill packets. She must continue to take packets after packets, as long as she does not desire pregnancy.

Missed pills **(Fig. 24.11)**: Pills should be taken every day to be most effective. If not taken correctly there will be a risk of becoming pregnant. Most common mistake is missing the pill or starting new packets late.

- *Missed 1 pill*: She should take it as soon as she remembers and take the rest as usual.
- Missed 2 pills or more, in the first two rows (i.e. the first 14 pills) **(Fig. 24.11)**. She should take one pill as soon as she remembers and the rest as usual. Meanwhile, she must also use another method such as condoms or spermicides for 7 days or avoid sex for 1 week.
- *Missed 2 pills or more in the third row:* She should take the pill as soon as she remembers and takes a rest as usual meanwhile she must also use another method such as condoms for 7 days or avoid sex for one week and she should start a new pack the next day after the completion of 3rd row. She should throw the last row of this pack away.
- *Missed any pill in the fourth row:* She should throw the missed pill away and take the rest as usual. Start a new packet as usual on the next day. Thus, forgetting to take placebos, she is still protected from pregnancy.

Flow chart 24.1 Different steroidal contraceptives



Triphasic Pills

This is based upon the concept of administration of the pills of varying strengths of estrogen and progesterone in three phases, so that the regimen parallels more closely the normal hormonal cycle of the menstruating woman, as shown in the diagram (marketed as 'Triquilar') **(Fig. 24.12)**.

- Missed 1 pill? Take 1 now. Take the rest as usual.
- Missed 2 or more in a row? Which ones? (See below)

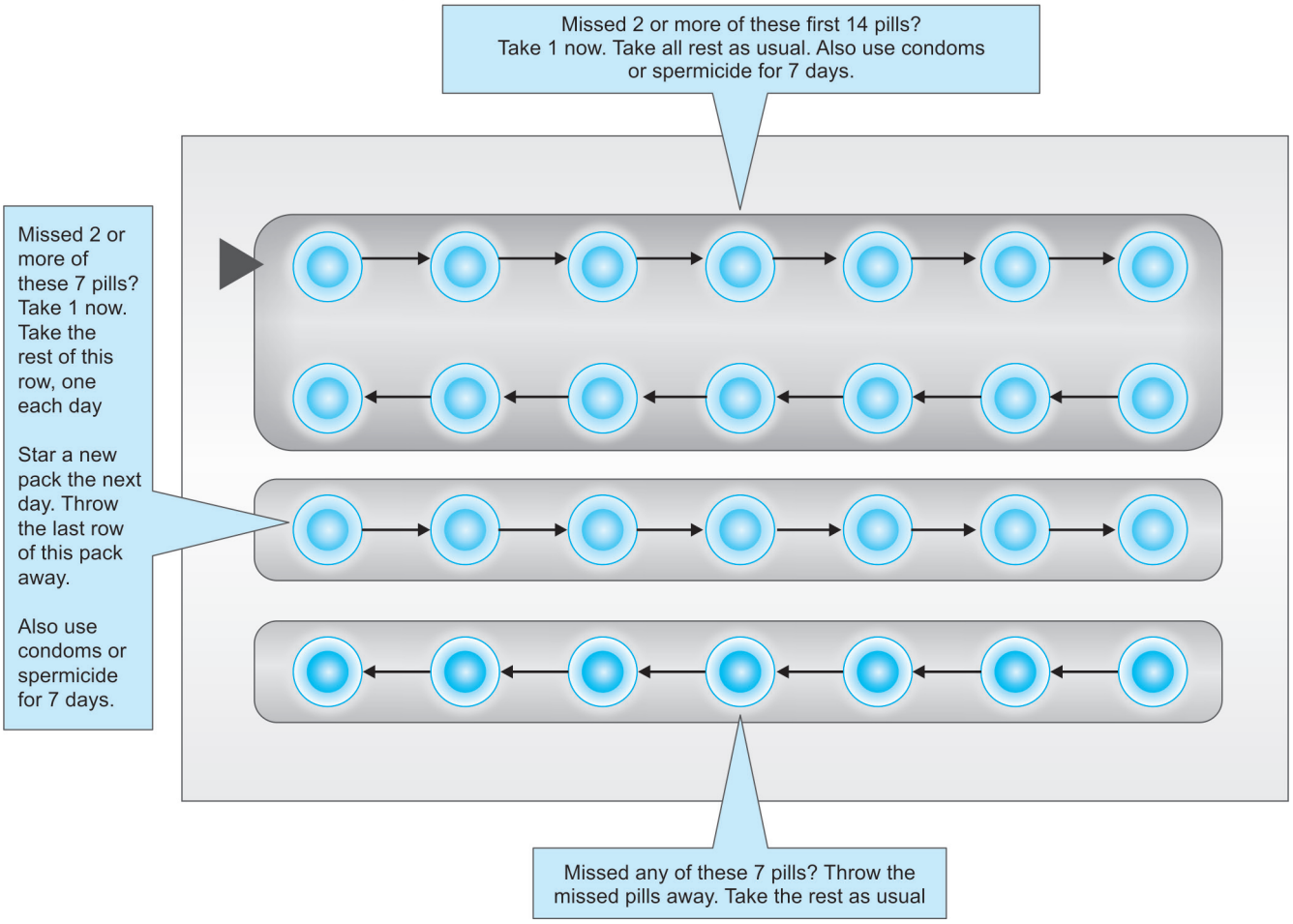


Fig. 24.11 Missed pills—what to be done?

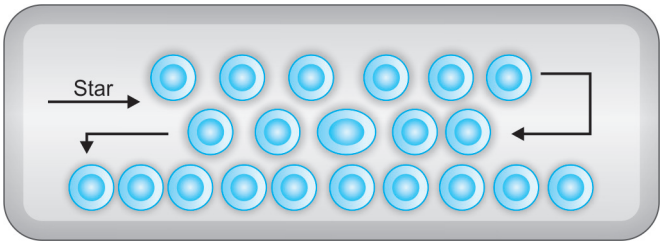


Fig. 24.12 Triphasic pills

Ethynyl estradiol (µg)		Levonorgestrel (µg)		
30	+	50	–	6 days
40	+	75	–	5 days
30	+	125	–	10 days

Effectiveness: Low dose combined, either monophasic or triphasic, oral pills are very effective when used correctly and consistently. Failure rate is 0.1 pregnancies per 100 women users (i.e. 1 in every 1000).

Merits

- Highly effective (almost 100%)
- Easy to use
- Nothing to do at the time of sex play unlike in barrier methods.
- Increased sexual enjoyment because of no worry about pregnancy.

- Can be used at any age during reproductive age, preferably by newly married woman to postpone for the first issue.
- Can be used as long as she does not want pregnancy.
- Fertility returns soon after stopping (Reversible).
- Can be used as an emergency contraceptive after unprotected sex.
- Periods become regular, painless, and fewer days of bleeding with minimal cramps.
- Relieves premenstrual tension and acne.
- Prevents anemia and malnutrition by preventing pregnancy.
- Helps in preventing
  - Ectopic pregnancies
  - Ovarian cysts
  - Endometrial cancer
  - Pelvic inflammatory disease
  - Ovarian cancer
  - Benign breast tumor.
- Thus, it is safe for almost all women of any age whether or not they have had children.
- Can be started any time, it is reasonably certain a woman is not pregnant.

Demerits

- Nausea (common during first 2 to 3 months)
- Spotting or bleeding between menstrual periods specially if she forgets to take pills regularly.
- Mild headache
- Breast tenderness
- Slight weight gain (often considered as a merit)
- Suppresses the quality and quantity of the breastmilk if she is lactating mother (because of estrogen content)
- May cause mood changes including depression, less interest in sex.
- Very rarely can cause cardiovascular effects such as hypertension, myocardial infarction, cerebral thrombosis and thrombosis in the deep veins of the legs. These risks are high among women with hypertension, aged above 35 years, and heavy smokers.
- It does not protect against STDs including AIDS.
- Worsens diabetic condition calling for more insulin.

All these side effects, except thromboembolic and cardiovascular effects, are not dangerous and generally stops in a few months.

Contraindications

Absolute contraindications are women beyond 35 years of age, or with hypertension or history of thromboembolism or cardiovascular diseases, cancer of breast and genitals, liver diseases and bleeding disorders.

Relative contraindications are pregnancy, lactation, epilepsy and migraine.

These conditions have to be looked for before prescribing the pills and women should not take for more than 2 to 3 years.

Progestin Only Pills

Progestin only pills (POP) is also called as 'Mini pill' or 'Micro pill'. These contain very small amounts of only one kind of hormone, i.e. progestin (one half to one tenth of progestin present in oral contraceptives). They do not contain estrogen.

They are available in pack of 28 or 35 pills, all of the same color and there are no placebos **(Fig. 24.13)**.

This is a good choice for breastfeeding women who want an oral contraceptive, because these pills do not suppress milk production.

Mechanism of action: Progestin thickens the cervical mucus, making it difficult for sperms to pass through.

It induces a thin, unfavorable, atrophic endometrium.

It also stops ovulation in about 50 percent of cases (just like exclusive breastfeeding prevents pregnancy).

It does not work by disrupting the existing pregnancy.

When to start?: The women can start at any time after childbirth or miscarriage and no need to wait for the menstrual periods to return. If periods have returned in a lactating woman, she can start POP at any time it is reasonably certain that she is not pregnant. The first day of the bleeding is the best time to start if periods have returned.

She should take one pill everyday, preferably at the same time. Delay by few hours increases the risk of pregnancy and missing two or more pills, greatly increases the risk.

When she finishes one packet, she should take the first pill from the next packet on the very next day. There is no wait between packets.

Missed pills: If the lactating mother forgets to take one or more pills, she should take 1 as soon as she remembers and then keep taking one pill each day as usual.

If more than 3 hours late taking a pill by a woman who is not breastfeeding or who is breastfeeding but her menses have returned should also use condoms or spermicide or else

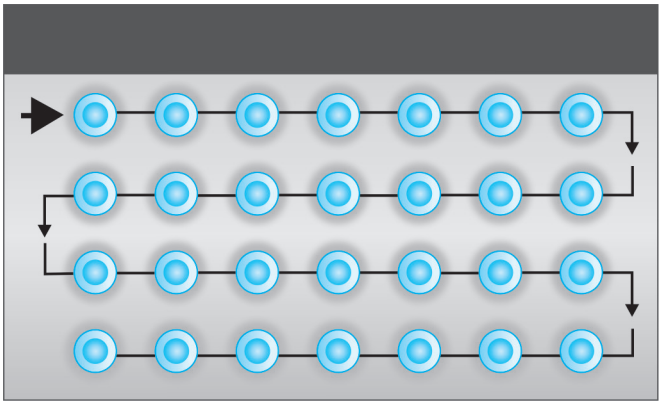


Fig. 24.13 28 or 35 pills of the same color: These are progestin-only oral contraceptives

avoid sex for two days. She should take the missed pill as soon as she can. Then keep taking one pill each day as usual.

Effectiveness: For breastfeeding women—POP is very effective, much more than COC because breastfeeding itself provides protection against pregnancy. Failure rate is 1 pregnancy per 100 women users.

Merits
- Good choice for a lactating mother, because it does not suppress lactation
- Free from the side effects of estrogen
- May help prevent benign breast disease, pelvic inflammatory disease, endometrial and ovarian cancer
- May lengthen period of lactational amenorrhea
- It can also be used as an emergency contraception after unprotected sex.

Demerits
- Among nonlactating women, POP causes irregularities in bleeding such as irregular periods, intermenstrual bleeding, spotting, etc.
- Less frequently headache and breast tenderness.
- Should be taken daily at the same time. Delay by even a few hours increases the risk of pregnancy.
- Does not prevent ectopic pregnancy.

Since POP does not contain estrogen, many conditions that restrict the use of COC, do not apply to POPs, such as hypertension, lactation, smoking, thromboembolic disorder etc. So, it is indicated for such women who cannot tolerate combined pills or in whom it is contraindicated.

Limitations: Eventhough POP is better than COCs, it has not gained widespread use because of menstrual irregularities, higher rate of ectopic pregnancy, and prolonged infertility.

Estrogen, Postcoital Pills (Emergency Oral Contraception)

Emergency oral contraception can prevent pregnancy. Therefore, often it is called 'Morning after' contraception. This method should not be used in place of family planning methods. Any woman can adopt this method if she is not already pregnant, to prevent unplanned pregnancy, only as an emergency under the following circumstances:
- Unprotected intercourse
- Rape, sexual assault, incest
- Failure of contraceptive method such as rupture of condom, displacement of IUD, missing two or more mini pills
- Premature ejaculation among couples practicing coitus interruptus.

Therefore, it has been rightly referred to as 'The casualty in family planning', as it offers a last chance, secondary method of contraception to prevent an unplanned pregnancy. This method can save the lady from agony and embarrassment of resorting to illegal abortion and even suicide.

Nearly four million abortions are induced every year in our country. This method has reduced MMR by reducing the abortion rates.

This emergency method is recommended within 48 to 72 hours of unprotected intercourse. They act by stopping ovulation or by interfering with implantation of the ovum. Different methods are as follows:
- High dose progesterone
- High dose estrogens
- Estrogen—progesterone combination.

High Dose Progesterone

Each of these contains 1.5 mg levonorgestrel. One pill to be taken orally, preferably within 12 hours and not later than 72 hours of unprotected sex. It prevents ovulation. If ovulation has already occured, it prevents fertilization of ovum. If fertilization has already occured, it prevents implantation in the endometrium. It is ineffective, if the pregnancy has already occured. It is marketted as 'i-pill'. It does not protect from STD/HIV. Nausea, vomiting, headache, breast tenderness are common side effects. It will stop after 1 or 2 days.

High Dose Estrogens

These are:
- Diethylstilbestrol (DES) 50 mgm a day for 5 days.
- Ethinyl estradiol 05 mgm a day for 5 days.
- Estradiol benzoate 12.5 mgms combined with estradiol phenyl propionate 10.0 mgm.

Failure rate is less than 1 percent.

Side effects are high and severe because of high doses of estrogen. Therefore, this old method is replaced by a safer and new method, i.e. Yuzpe method.

Estrogen—Progesterone Combination (Yuzpe Method)

In 1977, Yuzpe and Lancee showed that a combination of 100 mgm of estrogen and 1 mgm of progestogen, in a single dose rendered the endometrium out of phase.

This method consisting of consuming either 8 low dose combined oral contraceptive pills (Mala-D) (4 as soon as possible followed by another 4 after 12 hours) or 4 standard dose combined pills (Mala-N) (2 pills followed by another 2-pills after 12 hours).

Merits: Simple, safe, cheap and readily available method.

Demerits: Due to high doses of estrogen. This method is ineffective, if the implantation of ovum has already occurred.

Failure rate is 0.2 to 2.0 percent.

Recent advances
- *Danazol:* It is a progestogen only with antigonadotrophic activity. It prevents implantation by making unfavorable

endometrium. Dose—2 doses of 400 mgm each at 12 hours interval. This is more effective than Yuzpe regimen.
- *Mifepristone:* It is antiprogesterone. It prevents ovulation when given in early proliferative phase and hinders the development of endometrium if given in the luteal phase, (i.e. within 72 hours of unprotected sex). Dose—600 mg stat. This is more effective than Yuzpe regimen and Danazol.

Note: A woman should not use the hormonal method unless she intends to have abortion if the method fails.

Mechanical method of emergency contraception: This consists of insertion of copper IUD within 3 to 5 days of unprotected intercourse. It prevents implantation due to endometrial changes and also possibly it has embryotoxic effect by copper ions. Additional advantage is that it provides contraceptive protection for few more years. This is particularly useful when hormonal pills are contraindicated. This is contraindicated in women who are at risk of STD because of rape. This is more effective than hormonal method as an emergency method.

Once a Month Pill (Long Acting Pill)

Trials were conducted with a combination of long acting estrogen (quinestrol) with short acting progesterone. Results were not encouraging because of high failure rates and irregular bleeding.

Male Pill

Researches have been going on since 1950 to prepare pill for men based on the following principles:
- To prevent spermatogenesis
- To interfere with storage and maturation of sperms
- To prevent the transportation of sperms in the vas
- To change the composition of the seminal fluid so as to affect the viability of the sperms.

A male pill, derived from cotton seed oil, named as 'Gossypol', has been found to be effective in causing oligospermia. It has resulted in permanent azoospermia in 10 percent of cases after taking for 6 months. Further, it tends to lower testosterone level affecting potency and libido. So, it is not used.

Injectable Contraceptives

They are also called as 'Depot formulations' or 'Slow release formulations'.

These are the formulations containing only synthetic progesterone (and not estrogen) which is released slowly over a long period of time, thus providing longlasting hormonal contraceptive activity.

During 1960's these were used to treat cases of threatened abortion and also to prevent endometriosis, endometrial cancer and premature deliveries. Meanwhile, it was observed that such women who received progestogen injections remained unfertile for many months afterwards. This led to the recognition of the contraceptive property of depot preparations. Since 1966, they are also used as contraceptives.

The most widely used injectables are DMPA and NET-EN.
- *DMPA:* Depot medroxy progesterone acetate, a micro-crystalline suspension, to be given deep intramuscularly, once in 3 months, each dose containing 150 mgm of progestin (synthetic progesterone) and is less painful, marketed as Depo-provera, Megestron. One dose protects for 3 months.
- *NET-EN:* Norethisterone Enanthate, an oily solution, to be given deep intramuscularly, once in 2 months, each dose containing 200 mgm of synthetic progesterone. It is more painful. This disappears more rapidly from the circulation compared to DMPA. So, it is given more frequently. It is marketed as noristerat. One dose protects for two months.

Mechanism of action
- These synthetic progestogens inhibit ovulation by inhibiting the secretion of gonadotrophins (FSH and LH).
- They also thicken the cervical mucus thereby forming a barrier to sperms.
- They also induce a thin endometrium, less suitable for implantation.

Time of administration: These can be administered to women of any age, whether they have children or not. Usually, they are given during the first five days of menstrual period, to rule out the possibility of pregnancy. However, it can be given at any time in the menstrual cycle, provided it is reasonably certain that she is not pregnant.

For a lactating mother these injections are given as early as 6 weeks after childbirth. No need to wait for periods to return.

It can also be given after abortion, within 7 days.

Instructions to the user
- Not to massage the site of injection, so that it is absorbed slowly.
- To take the injection once in 3 months if DMPA is given or once in 2 months if NET-EN is given.
- To come back on the due date for the next injection.
- That she will have her cycles once in 2 to 3 months, depending upon the type of injection.
- She should come back even if she is late.
- She should also come back if she develops side effects, such as heavy bleeding.

Return of fertility: It is delayed by 4 to 6 months, after stopping the drugs.

Failure rate: About 0.3 pregnancies per 100 women years.

Merits
- Very safe, effective, convenient and reversible.
- Long-term pregnancy prevention (One injection serves the purpose for 2 to 3 months, depending upon the type).

- Does not interfere with sex (So prolonged sexual pleasure).
- Does not interfere with lactation (So can be given to a lactating mother).
- Quality and quantity of milk is not affected.
- Does not contain estrogen (So free from all the side effects of estrogen).
- Can be used by women of any age in the reproductive period, including nulliparous women.
- Helps prevent ectopic pregnancies, endometrial cancer and uterine fibroids.
- May help prevent ovarian cancer, iron deficiency anemia, and decrease the frequency of seizures among epileptic women.

Demerits

- Menstrual cycles become irregular, once in 2 to 3 months, depending upon the type (Once in 2 months with NET-EN and once in 3 months with DMPA).
- Changes in the menstrual bleeding are also likely such as varying from light spotting to heavy bleeding.
- May cause weight gain of 1 to 2 kg per year.
- Delayed return of fertility by 4 to 6 months or even longer.
- Injection to be taken regularly, every 2 to 3 months, depending upon the type.
- May cause headache, breast tenderness, mood changes and loss of libido.

Postpartum use: If used within 6 weeks of delivery, it may result in heavy bleeding.

Contraindications

- Pregnancy (If given during pregnancy, it is not dangerous. But it is waste).
- Early postpartum period (within 6 weeks of delivery).
- Suspected malignancy.
- Pelvic inflammatory disease.
- Bleeding disorders.

Note: Monthly injectable contraceptives, containing estrogen and progestin are available in other developed countries but not in India. The potential advantages are high contraceptive effectiveness, regularity in the cycles and rapid return of fertility. But monthly visit to the clinic is necessary.

Subcutaneous Implants (Norplant Implants)

This system consists of a set of 6 small, silicon rubber soft capsules, about the size of a small match-stick, each containing 35 mgm of synthetic progestogen (Levonorgestrel), which when implanted subcutaneously, release the hormone slowly over a long period of time, providing contraceptive effect for at least 5 years.

Insertion: The capsules are inserted subcutaneously, by a small incision under local anesthesia in the upper arm of the woman using a template as shown in the figure. After all the capsules are inserted, the incision is closed with an adhesive bandage. Stitches are not necessary **(Figs 24.14 A and B)**.

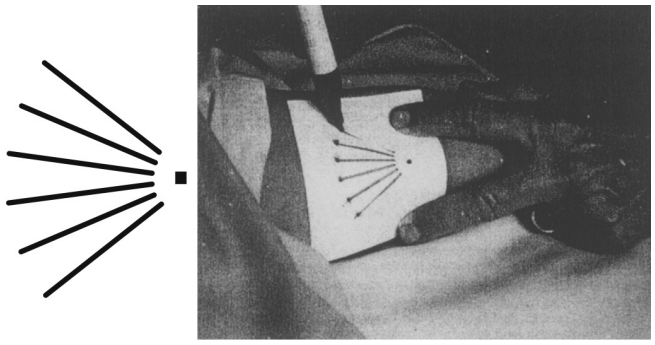


Fig. 24.14A Template (left) can help providers position norplant capsules correctly. The provider places the template against a woman's arm and marks the ends of the 6 slots of her skin with ball point pen or similar marker. When inserting the capsules, the provider lines up each capsule with one of the marks

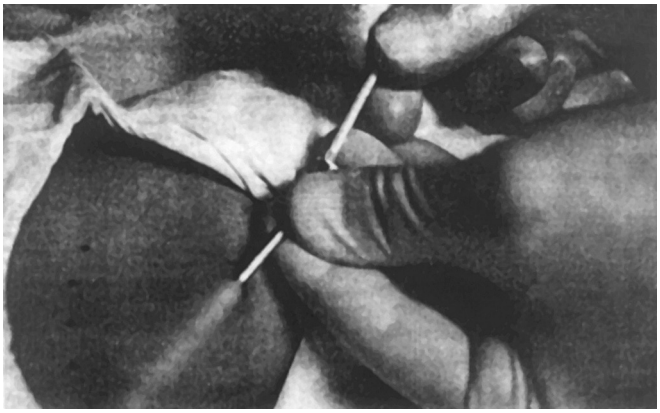


Fig. 24.14B Insertion of norplant capsules

Once inserted, they start functioning within 24 hours.

Removal is also by minor surgery, whenever pregnancy is desired.

Mode of action: It is the same as that of IM injectables.

Effectiveness: Contraception is provided for 5 years approximately.

Failure rate: The 1-6 pregnancies per 100 women years.

Merits and demerits are same as those of DMPA and NET-EN. Additional merit is that the effect lasts for 5 years and additional demerit is that removal and insertion is by minor surgery.

Note: There is another version called 'Norplant II' which consists of only two rods instead of 6 capsules. It is under clinical trial. 1-capsule implant containing disogestrel, is also being studied.

Vaginal Rings

These devices are in the form of ring, containing the same levonorgestrel, which when inserted inside the vagina, the

hormone is released and absorbed slowly through the vaginal mucous membrane. It is worn for three weeks of the cycle and removed during the 4th week.

Postconceptional Methods

There are three methods:
A. Menstrual regulation
B. Menstrual induction
C. Induction of abortion.

Menstrual Regulation

Menstrual regulation (MR) means regularizing the menstrual cycle in a woman, who had her cycles regularly previously, but now missed and delayed by 1 to 2 weeks, before any pregnancy test can confirm whether she is pregnant or not. The missed (or delayed) period could be due to the reasons other than pregnancy, such as psychological factors. The MR consists of evacuation of the contents of the uterus.

Procedure: This is done by using a small, flexible, plastic cannula of 5 to 6 mm diameter (Karman cannula) in association with a gynecological syringe, (MR syringe) as a source of negative pressure. Cervical dilatation is not necessary, except in nulliparous women and in those who are too apprehensive. Interposed between the cannula and the syringe is a bottle to collect the aspirate. Tip of cannula is shifted to various positions and aspirated.

Merits: This is carried out without anesthesia as an outpatient. It is safe and simple measure by an experienced person. This procedure does not require the confirmation of the pregnancy nor does it attract the legal provisions for abortion.

Demerits: The immediate complications are trauma, sepsis and perforation of uterus. Late complications include tendency to abortion, premature labor, infertility, menstrual irregularities, and ectopic pregnancy.

If the delay in the missed period were to be due to pregnancy, then this procedure is considered as an early abortion. Thus, menstrual regulation differs from early abortion in that:
- There is no certainity that she is pregnant
- There is no legal restrictions
- There is increased safety of the early procedure.

Menstrual Induction

Means inducing menstruation in a woman, who is in early pregnancy, by intrauterine application of 2.5 to 5 mgm solution of prostaglandin F2 under sedation. Within about 10 minutes, there will be sustained, spasmodic contractions of the uterus lasting for 3 to 4 hours, resulting in expulsion of product of conception, thus terminating the pregnancy. Bleeding starts and lasts for about 5 days.

Induction of Abortion

Means terminating the pregnancy as a contraceptive method, deliberately in a pregnant woman before the fetus becomes viable (i.e. before 28th week of pregnancy), which may be legal or illegal. Abortion is sought by women for many reasons including birth-control (Spontaneous abortion is Nature's method of birth control).

Legal abortion is the one which is done by a qualified doctor, in a recognized hospital, under specific reasons (indications).

Illegal abortion is the one which is performed by an unqualified person clandestinely, under unhygienic conditions, when the pregnant women approach such persons as the last resort to end their pregnancies at the risk of their own lives.

The recognized complications of inducing abortion are hemorrhage, shock, perforation of uterus, thromboembolism and the late complications are infertility, ectopic pregnancy, covering the life risk of the mother, thereby increasing the maternal morbidity and mortality. The risk is directly proportional to the duration of pregnancy. 6th to 8th week of pregnancy is the optimal time for termination of pregnancy. However, under the Medical termination of pregnancy Act, it is allowed up to 20 weeks. Menstrual regulation v/s medical termination of pregnancy is described in the **Table 24.2**.

Table 24.2 Menstrual regulation v/s medical termination of pregnancy

Menstrual regulation/ menstrual induction	Medical termination of pregnancy
Done when pregnancy is suspected	Done after pregnancy is confirmed
It is a simple and safe procedure	Procedure is less safe and more difficult
Not subject to legal restrictions	Subject to provisions of MTP Act

Medical Abortion

It is a nonsurgical intervention to terminate unintended, early pregnancies, based on a proven regimen combining two drugs – Mifepristone (RU 486) and Misoprostol.

In April 2002, the Drugs Controller General of India approved the use of Mifepristone for termination of pregnancy up to 49 days (7 weeks) from LMP (Last menstruation period). Misoprostol has been available in India since a longtime for the treatment of gastric ulcer.

RU 486 or Mifepristone is a synthetic steroid, discovered in 1980 by Dr. Etienne Emile Beaulieu of France. It is an anti-progestin. If softens the cervix and stops pregnancy from growing. Misoprostol is a prostaglandin E1 analog. It causes the uterus to contract and expel the product of conception. It is well absorbed through gastrointestinal as well as vaginal mucosa.

Drug protocol
- Day 1, 200 mg mifepristone orally. Anti-D if Rh –ve
- Day 3, 400 mcg misoprostol orally/vaginally. Analgesics
- Day 14. Confirm completion of abortion. Contraceptives.

Duration of the abortion process: About 60 percent of the women abort within four hours of taking misoprostol, the rest may abort any time in the next seven to ten days. Heavy bleeding generally occurs during the actual abortion and is almost always accompanied by cramps. Bleeding might continue for about eight to ten days.

Contraindications for medical abortion
- Ectopic pregnancy
- Intra uterine device in place
- Cardiovascular disease
- Current long-term use of systemic corticosteroids
- Hemorrhagic disorder
- Allergy to mifepristone, misoprostol or any other prostaglandin.

Side effects: Nausea, vomiting, abdominal cramps, diarrhea, fatigue and often fever.

Warning signals
- Excessive bleeding (soaking more than two pads per hour for two consecutive hours).
- Persistent fever of 100.4°F or higher or fever beginning more than eight hours after taking misoprostol.
- No bleeding within 24 hours after taking misoprostol.
- These drugs can be given in the outpatient clinic provided there is a linkage with a facility which provide 24 hours emergency services for surgical evacuation.

Medical Abortion and the MTP-Act

Since medical abortion is a process of termination of pregnancy, it falls under the preview of the MTP-Act 1971 (Medical termination of pregnancy-explained later). A recent amendment in MTP rules (made in 2003) allow certified practitioners to provide medical abortion from their clinics, even if the clinic is not registered as long as they have access (i.e. referred linkage) to an approved MTP site. The law requires that a certificate to that effect (i.e. showing that a formal referral link has been established) from the owner of the approved site must be displayed in the clinic, where medical abortion is being provided.

Medical Termination of Pregnancy Act, 1971

Introduction: Before 1970, illegal abortion was one of the causes of increased maternal morbidity and mortality and it was also considered as a crime because of feticide. Since induction of abortion is a method of contraception, in order to reduce the hazards of population explosion and to reduce MMR, termination of pregnancy was legalized and not considered as crime by passing an Act by the Indian parliament, called Medical termination of pregnancy Act in 1971, which came into force from April 1, 1972, modified in 1975. It is applicable to the state of Jammu and Kashmir from Nov 1976. Now MTP is considered as a health care measure to reduce MMR resulting from abortion.

The MTP-Act lays down the following considerations:
- The conditions under which a pregnancy can be terminated.
- The person or persons who can perform such terminations.
- The place where the pregnancy can be terminated.

a. *The conditions (indications) under which the pregnancy can be terminated are:*
   - Medical (therapeutic)—where continuation of pregnancy endangers the life of a woman physically or psychologically. So, it is done as a part of the treatment as in mitralstenosis, severe anemia, viral hepatitis, etc.
   - Eugenic—where there is a risk of the child being born with serious physical or mental handicap as in German measles, mother with steroids, antimitotic drugs or radiotherapy, etc.
   - Humanitarian—where the pregnancy is the result of rape.
   - Socioeconomic—where the extreme poverty can injure mother's health.
   - Failure of contraceptive method—where the unwanted pregnancy occurring from failure of contraceptive method can affect mental health of the woman.

   A written consent of the guardian is necessary before performing abortion in women under 18 years of age and in lunatics, even if they are older than 18 years.

b. *The person or persons who can perform abortion:*
   Under the Act, only Registered medical practitioner (RMP) having the following criteria, is authorized to perform the abortion.
   - A postgraduate degree or diploma in ObG
   - Has undergone 6 months of residency in ObG
   - Has assisted at least 25 MTPs in approved institutions
   - Registered before the Act, 3 years of practice in ObG (before 1971)
   - Registered after the Act, 1 year of experience in ObG. AND

     He/she should have obtained licence from Dist. health officer, based on the above criteria.

   Such an authorized RMP can perform MTP where the length of the pregnancy does not exceed 12 weeks. However, if pregnancy exceeds 12 weeks but less than 20 weeks, requires the opinion of another RMP.

c. *The place where MTP can be performed:*
   - A Government hospital
   - Any other health care institution approved for this purpose by Government.

Thus, MTP should be performed in a right time, by a right person, in a right place by a right technique.

Since the MTP services are considered purely as a personal matter, strict professional confidence is maintained.

Repeated abortions are not conducive to the health of the mother. The doctor is protected from any legal action from any damage caused by termination of pregnancy, provided he/she has acted in good faith under proper care. If RMP contravenes the rules, he/she is liable to be punished with rigorous imprisonment varying from 2 to 7 years.

Thus, induction of abortion, even under the best of circumstances, can never be as safe as efficient contraception.

Methods of MTP: There are three methods:

Suction evacuation: Where the pregnancy is less than 12 weeks, evacuation of the contents of uterus is done by using a cannula and a suction apparatus. The apparatus is started to run and the cannula is passed slowly over the entire lining of the uterus. The contents are evacuated under a pressure of 70 mmHg and aspirated.

Extraovular injection: This is done when the pregnancy is between 12 and 14 weeks and the product of conception is so big that it cannot be sucked out. This consists of giving injection transcervically using a Folley's catheter, either prostaglandin F2a 500 g or Ethacridine acetate 150 mL. Abortion occurs within 24 hours.

Intra-amniotic injection: This is done when the pregnancy is between 14 and 20 weeks duration. This consists of injection of 150 mL of saline or 80 mgm of urea or 50 mgm of prostaglandin F2a into the amniotic cavity, under local anesthesia, through a lumbar puncture needle, passed just below and left to the umbilicus. Penetration of the needle into the amniotic cavity is confirmed by the free flow of the amniotic fluid through the needle. Abortion takes place within 72 hours.

Miscellaneous Methods

- Abstinence
- Coitus interruptus
- Fertility awareness based methods
- Lactational amenorrhea method
- Nonhormonal long acting oral pills
- Birth control vaccines.

Abstinence

Complete sexual abstinence is easy to say but impossible to practice. It amounts to repression of a natural biological necessity, which may result in temperamental changes and even nervous breakdown. So, this cannot be advocated.

Coitus Interruptus

In this method, during the act of intercourse, the male partner withdraws his organ at the time of climax, so that deposition of semen into the vagina is prevented.

Merits: It is better than not using any method at all.

Demerits: Difficult to practice. Precoital secretion may contain sperms and result in pregnancy. Delay in withdrawl results in pregnancy. Failure rate is high.

Failure rate: Failure rate is 25 percent.

Fertility Awareness-based Methods

'Fertility awareness' means educating a woman to know when the fertile time of her menstrual cycle starts and ends. Fertile time is the time when she can become pregnant.

Following are the methods to assess the fertile time.

- Rhythm method
- Basal body temperature method
- Cervical mucus method
- Feel of the cervix
- Symptothermal method.

With this knowledge, a couple can avoid pregnancy, by abstaining from sex or by using a barrier method during the fertile time.

Failure rate: Varies from 5 to 20 per 100 women users.

Merits: Simple, safe, effective, economical and immediately reversible.

Demerits

- Requires a long time of about 6 months to know the shortest and longest cycle.
- Requires continuous cooperation and commitment of both the partners.
- It is hard to use if the woman has fever, vaginal infection or after child birth during breastfeeding.
- Not effective in irregular cycles.
- Does not protect against STDs including HIV/AIDS.

Rhythm method (calendar method; safe period method): In this method, the couple should avoid sex during the fertile period.

Before relying on this method, the woman records the number of days in each menstrual cycle for at least 6 months. The first day of bleeding is counted as day 1. Thus, she should record the period of shortest and longest cycle.

Ovulation occurs from 12 to 16 days before the onset of menstruation (Average = 14 days). Suppose, intercourse takes place on 10th day, and ovulation takes place on 12th day, fertilization can occur, because sperms live for 2 days. Similarly, if ovulation occurs on 16th day, even if sexual intercourse is performed on 17th day, fertilization can take place, because ovum lives for 1 day. Thus, period from 10th to 17th day is fertile period, provided her cycle is of 28 days regularly.

In case of variations in the cycle to know the fertile period, subtract 18 from the length of the shortest cycle. This gives the estimated first day of the fertile period.

Then subtract 11 days from the length of the longest cycle. This gives the last day of the fertile period.

The couple should avoid sex or use condom during the fertile period.

Example: If the recorded cycles vary from 26 to 32 days,

26-18=8. Avoid sex from 8th day.

32-11=21 can have sex from 21st day of her cycle.

Fertile period = 8th day to 21st day.

In normal cycle, 28-18=10 and 28-11=17, the fertile time is from 10th to 17th day. Thus, the first week and the last week of the cycles is the 'Safe period' (Infertile period).

Demerits: If the cycles are irregular (as in most of the women) it is difficult to predict fertile period and safe period. If the couples are illiterate, it is difficult to practice. Compulsory abstinence during the fertile period or condom to be used. This method is not applicable during postnatal period. Failure rate is high, i.e. 21 per 100 women years (It is due to wrong calculations).

Basal body temperature method: This depends upon an event that Basal body temperature method (BBT) rises by about 0.5° C on the day of ovulation, because of an increase in the progesterone level.

The woman should record her temperature daily in the morning, at the same time, before she gets out of the bed.

This method is reliable if the couple avoid sex or use condom from the first day of the cycle till the day the woman's temperature is raised and also if the couple restrict the intercourse to the postovulatory safe period, commencing three days after the rise of BBT.

Practically difficult to record the temperature daily and adopt. Failure rate is about 20 per 100 women users.

Cervical mucus method (Billing's method): This is based on the observation that at the time of ovulation, the cervical mucus becomes watery, can be stretched, clear (like raw egg white), smooth, slippery and profuse. After ovulation, because of progesterone, the mucus thickens and lessens in quantity **(Fig. 24.15)**. This requires a high degree of motivation to the women.

Feel of the cervix: As the fertile time begins, the cervix opens slightly and cervix is felt soft and moist. During the remaining period the cervix is firm and closed.

Symptothermal method (multiple indicator method): This method consists of a combination of BBT + Billing's method and also rhythm method and feel of the cervix (2 or more of the four methods).

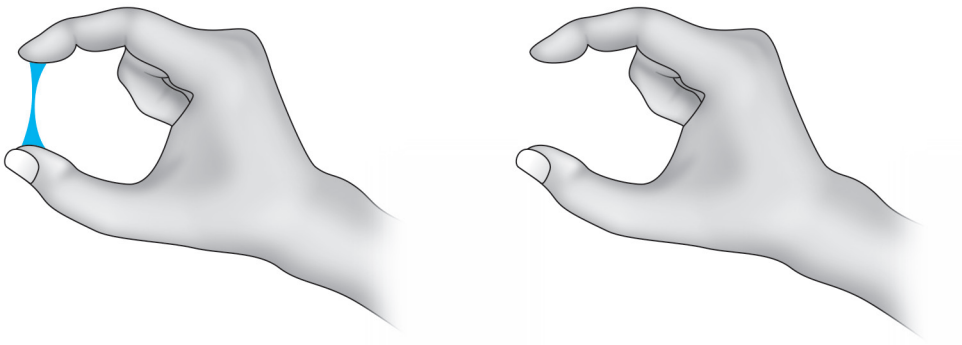
Lactational Amenorrhea Method

Lactational amenorrhea method (LAM) is based upon the beneficial effect of exclusive breastfeeding in a lactating mother, because exclusive breastfeeding is associated with increased prolactin level, which prevents ovulation, thus protecting the mother from pregnancy, in a natural way.

Thus, this method is effective when:

- The mother practices exclusive breastfeeding (i.e. frequent feeding during day and night as during the first six months after delivery).
- Her menstrual periods have not returned.
- Her child is less than six months of age.

When weaning is started, protection from pregnancy decreases because of decrease in prolactin level. Thus, this method is very effective up to first six months. However, if



Avoid sex
Secretions – especially when slippery, wet, and can be stretched – mean the couple should avoid sex or use withdrawal or a barrier method until the 4th day after the peak day.

Can have sex
No secretions mean the women probably cannot become pregnant. She can have unprotected vaginal sex

Fig. 24.15 Cervical mucus method

she keeps breastfeeding more frequently, protection from pregnancy may last even longer (up to 9 to 12 months).

Failure rate: 0.5 to 2 pregnancies per 100 women users.

Merits
- Simple, safe and effective, specially during the first six months after child birth.
- Encourages scientific practice of breastfeeding.
- No direct cost for family planning.
- No hormonal side effects.
- Child gets all the benefits of exclusive breastfeeding.
- Encourages the mother to start a follow on method after six months.

Demerits
- Effectiveness after six months is not certain
- Frequent feeding is difficult for working mothers
- Does not protect against STDs including HIV
- If the mother is HIV positive, there is a risk of transmission to the baby.

Nonhormonal, Long Acting Oral Pills

Its composition is methoxychroman hydrochloride, marketed as 'SAHELI' or 'CENTCHROMAN.' It differs from the hormonal pills in that it does not contain hormones, not to be taken daily and the side effects are minimal.

It is taken twice a week, starting on the first day of the menstrual cycle, for the first three months and subsequently once in a week, irrespective of the duration of the cycle, as long as contraception is required.

It is a potent antiestrogen compound. It exerts its contraceptive effect by interfering with nidation, which is an estrogen dependent postovulatory process. It induces a mismatch between embryo transport and endometrial suitability.

Each pill contains 30 mg of centchroman. It does not affect hypothalamo-pituitary-ovarian axis. It does not inhibit ovulation.

Fertility returns about six months after cessation of therapy. Sometimes menstruation is delayed. However, if the delay exceeds 15 days, pregnancy has to be ruled out. If pregnancy is confirmed, centchroman should be discontinued immediately.

In case of missed dose:
- It should be taken as soon as possible within two days of missing and normal schedule days adhered to.
- If the dose is missed by two or more days, but less than seven days, normal schedule is continued, preferably with condom, till the next period.
- If the dose is missed for more than seven days, adopt condom till the next cycle then the dosage regimen is reinitiated as a fresh one, i.e. biweekly for three months, followed by once a week schedule.

Contraindications
- Lactation period, specially during the first six months
- Hypersensitivity to centchroman
- Hepatic dysfunction (jaundice), chronic lung and renal disease
- Polycystic ovarian disease
- Cervical hyperplasia.

Birth Control Vaccines

There are three types of vaccines under research, namely:
1. Anti-hCG vaccines
2. Anti-zona vaccine
3. Anti-sperm vaccine.

Anti-hCG vaccine: It is anti human chorionic gonadotrophin vaccine. Normally, hCG is produced by the trophoblast cells of the human blastocyst during implantation in early pregnancy. hCG stimulates the ovarian corpus luteum to produce progesterone, which is essential for the maintenance of pregnancy in early stages, followed by the progesterone secreted by the placenta. In an infertile cycle, the corpus luteum regresses leading to menstruation.

Antibodies produced by the anti-hCG vaccine neutralizes hCG produced by the blastocyst (i.e. fertilized egg) and intercepts this signal. As a result, corpus luteum is not stimulated and progesterone level is not sustained, leading to endometrial shedding alongwith the loss of the fertilized ovum. This mechanism of action is called 'interception,' as against abortifacient, which disrupts pregnancy after a period of amenorrhea. Thus, immunization with anti-hCG would block the continuation of pregnancy.

There are two types of vaccines, alpha subunit and beta subunit. The antibodies to the vaccine appears in 4 to 6 weeks and reaches maximum after 5 months and slowly declines to zero level by 10 months. Immunity can be boosted by second injection.

The beta subunit vaccine, being developed by Dr GP Talwar of National Institute of Immunology, New Delhi, appears to be safe and reversible, showing promising results in the clinical trials.

Recommended dosage schedule is three doses given at six weeks interval, followed by a booster dose every year to the woman.

Researches are going on to produce single dose of genetically engineered vaccine.

Anti-zona vaccine: It is a vaccine against the zona pellucida of the ovum. The antibodies produced against the zona pellucida exert their contraceptive effect by occluding the sperm receptor sites on the surface of the ovum, thereby preventing fertilization.

This has been found to be effective in primates. However, its efficacy has not been demonstrated in the human beings.

Anti-sperm vaccine: The antibodies produced with this cause either immobilization of the sperms or their agglutination resulting in diminution of fertility. Researches are going on.

TERMINAL METHODS

These are the permanent methods. They are also called as 'Sterilization methods'.

There are two methods—Vasectomy and Tubectomy.

Vasectomy

It is a simple, safe, very effective, cheap, convenient, permanent and quick, surgical method of family planning for men, who decide that they do not want any more children. It is not castration, it does not affect the testes and it does not affect sexual ability.

Procedure

A small incision is made in the scrotum on either side above the testes under local anesthesia, under aseptic precautions, vas-deferens tubes are lifted, cut and tied with thread or clamped and the incisions are closed with stitches. Then bandage is put **(Fig. 24.16)**.

No Scalpel Vasectomy

This is a newer procedure, only one small puncture is made instead of incisions. At the end, it is not sutured, just a bandage is sufficient. It is of shorter duration, less painful and bruising and shorter recovery time.

Both no-scalpel technique and conventional procedures are quick, safe and effective.

Instructions after Surgery

- Rest for two days. He should not do any heavy work or vigorous exercise for a few days.
- The wound should be kept clean and dry.
- If possible put ice on the scrotum for four hours to lessen swelling.
- He should wear snug underwear or pants for two to three days to help.
- He can have sex within 2 or 3 days after the procedure if it is not uncomfortable, but he should use condoms or another effective family planning method for his next 20 ejaculations or three months after the procedure, whichever comes first, because the sperms which are present beyond the site of cut end can result in pregnancy. It requires about 20 ejaculations or about three months for him to become aspermic.

Effectiveness

Vasectomy is highly effective and permanent method. Failure rate is about 0.15 pregnancies per 100 men in the first year after the procedure. It can still be reduced if he uses condom or any other effective method consistently for the first 20 ejaculations or for three months after the procedure, whichever comes first.

Merits

- It is simple, safe, highly effective, life-long permanent method of family planning.
- Nothing to remember except to use condoms till he becomes aspermic.
- Prolonged sexual pleasure, because no need to worry about pregnancy.
- Compared to tubectomy, vasectomy is easy to perform, more effective, less expensive and able to be tested for effectiveness at any time.
- The surgery can be done even in the clinic.
- Does not require hospitalization.

Demerits

Common short-term surgical complications are:

- Pain in the scrotum, swelling and bruising
- Uncomfortable for 2 to 3 days
- Feeling of faintness after the procedure.

Uncommon complications are:

- Bleeding or infection of the wound
- Blood clots in the scrotum
- Not immediately effective
- It will be effective only when he becomes aspermic.

Constraints

- Since it is relatively a new surgical techniques, skilled providers are not available at the PHC level.
- Acceptance of this method by men is still very low. So training of the doctors in this skill is limited.
- Thus, there is a lack of both providers and acceptors.
- Awareness and knowledge of this method is still limited among acceptors and providers.

Tubectomy

This is also known as 'Voluntary surgical contraception', 'Tubal ligation', and 'Minilap'.

It is a simple, safe, very effective, cheap, convenient and permanent method of contraception for women, who do not want any more children. It consists of blocking both the

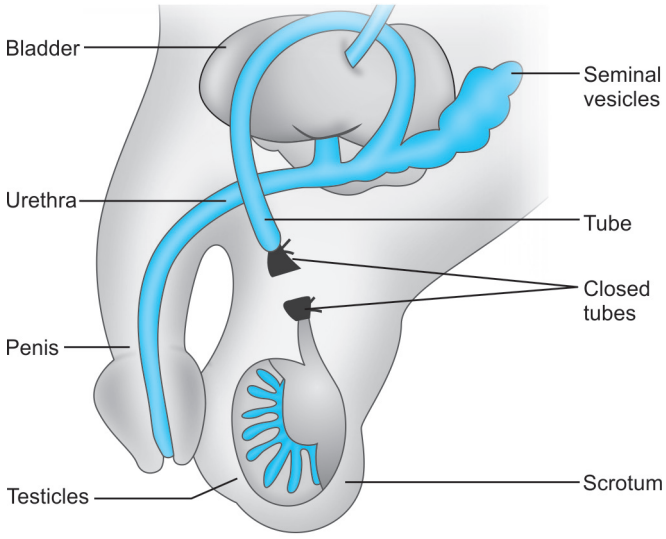


Fig. 24.16 Vasectomy

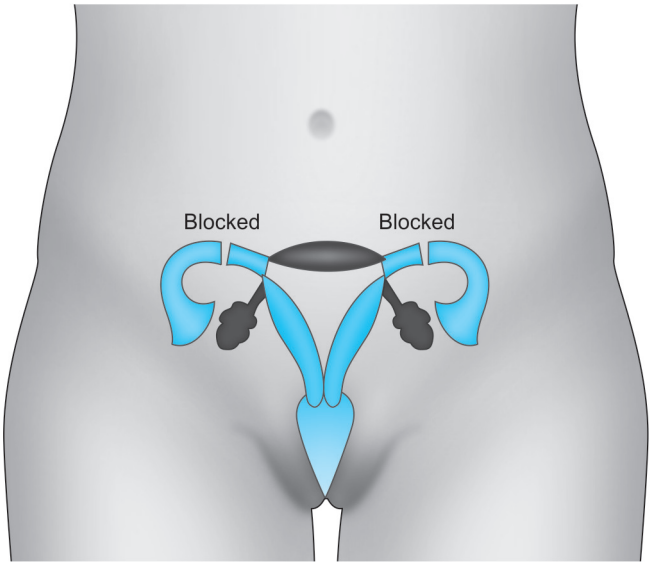


Fig. 24.17 Female sterilization (tubectomy)

fallopian tubes. The procedure is permanent and probably cannot be reversed **(Fig. 24.17)**.

There are two approaches:

- Minilaparotomy
- Laparoscopy.

Minilaparotomy (Pomeroy Technique or Interval Procedure)

Following thorough physical and pelvic examination of the woman, under the influence of light sedation and local anesthesia, a small incision of 2 to 5 cm is made in the anesthetized area, just above the pubic hair line, under aseptic precautions **(Fig. 24.18A)**. The uterus is raised and turned with the elevator to bring each of the fallopian tubes under the incision. Each tube is tied and cut or else closed with a clip or ring. Incision is closed with stitches and bandage is put. She can leave the hospital in a few hours.

This is more suitable than laproscopy for immediate post-partum period, i.e. six weeks after childbirth.

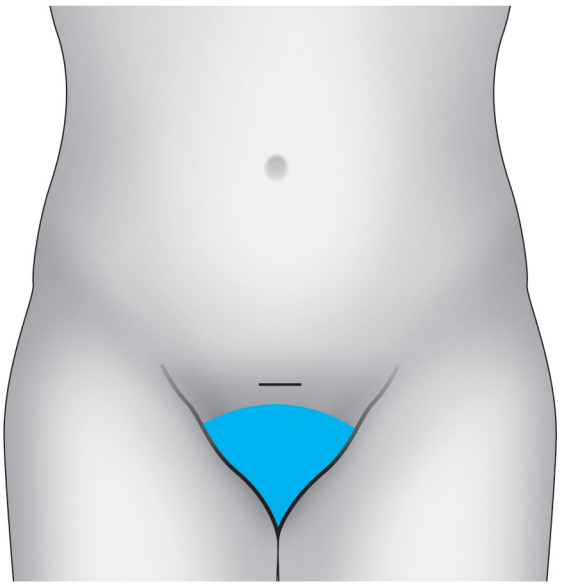


Fig. 24.18A Minilaparotomy for female sterilization involves a small incision just above the pubic hair

Laparoscopy Procedure

Following thorough physical and pelvic examinations, the woman is given a light sedation and local anesthesia is given just below the umbilicus **(Fig. 24.18B)**. Under aseptic precautions, a special needle is put into her abdomen and inflated with gas or air, so as to raise the wall of the abdomen away from the organs inside.

Then laparoscope is inserted through a small incision of about 2 cm. It is a special, long, thin tube containing lenses as to visualize inside the abdominal cavity and find the fallopian tubes.

Then an instrument is inserted through the laparoscope to close off the tubes with a clip or a ring or by electro-coagulation and then the instrument and the laparoscope are removed, the gas or the air is let out of the abdomen. Then incision is closed with stitches and covered with bandage. She can leave the hospital in a few hours.

Ideally, the operation should be performed within a week of the menstrual period. This confirms the fertility and absence of pregnancy in the woman.

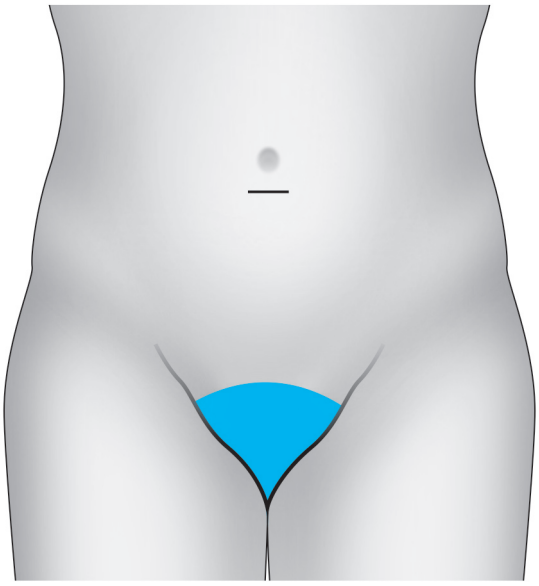


Fig. 24.18B Laparoscopy for female sterilization usually involves 1 small incision just below the navel

Instructions after Surgery

- Rest for 2 to 3 days and avoid strenuous work for one week.
- Keep the wound clean and dry.
- Not to have sex for at least one week or until all pain is gone.
- To report at once if she develops, fever, bleeding or pus in the wound.

Effectiveness

Failure rate is about 0.5 pregnancies per 100 women years. Postpartum tubal ligation is one of the most effective female sterilization techniques. In the first year after the procedure 0.05 pregnancies per 100 women years.

Merits

- It is simple, safe, very effective, permanent, lifelong method of family planning.
- Nothing to remember (like using condoms unlike in vasectomy).
- No interference with sex; so prolonged sexual pleasure.
- No effect on breast milk.
- No long-term side effects.
- Helps to protect against ovarian cancer.

Demerits

- Usually painful for several days after surgery.
- Postoperative infection or bleeding.
- In rare cases when pregnancy occurs, it is more likely to be ectopic.
- Compared to vasectomy, it is slightly more risky and expensive.
- Reversal surgery is probably not possible.
- Does not protect against STDs including HIV/AIDS.

EVALUATION OF CONTRACEPTIVE METHODS

The contraceptive methods are evaluated based on their effectiveness, which is expressed as 'failure rate per 100 woman - years of exposure (HWY).' This is estimated by using an indicator called 'Pearl Index,' named after Raymond pearl. This is the most commonly used index and is calculated by using the formula:

$$\text{Pearl index (Failure rate)} = \frac{\text{Total number of accidental pregnancies}}{\text{Total woman months of exposure}} \times 1200$$

The numerator includes all pregnancies, whether this has terminated as abortions, stillbirths, livebirths or not yet terminated pregnancies. The factor 1200 is the period of follow-up (observation) in number of months, i.e. 100 women followed-up for 12 months or 50 women for 24 months. The denominator is obtained by deducting from the period under review all those months during which contraception was not possible, i.e. by convention 10 months are deducted for a full term pregnancy and 4 months for an abortion.

Thus, this index has a range from 'O,' when no pregnancy occurs in any woman during the period of follow-up to '1200' when all woman become pregnant in the first month of use.

A pearl index (or failure rate) of 20 per HWY means that 20 out of 100 women will become pregnant if they are using that particular method of contraception in the given time, usually one year.

In designing and interpreting use effectiveness trial, a minimum of 600 months of exposure is usually considered necessary before any firm conclusion can be reached.

The other methods of evaluation are:

- *Method failure:* That is percentage of women becoming pregnant in the first year of use of a contraceptive. But the pregnancies occurring due to errors in using are excluded.
- *User failure:* That is percentage of women becoming pregnant in the first year of use of a contraceptive method including 'User failure' (Errors in using, i.e. patient failure).
- *Life table technique:* That is the percentage of women who continue to use the method at the end of one year unless they become pregnant. This involves both method failure and patient failure. Thus, this helps to calculate separate failure rate for each month in the year. This gives reliable and consistent results.

Family welfare linked health insurance scheme: This was introduced w.e.f. Nov 29, 2005, to take care of the cases of

Table 24.3 Benefits of family welfare linked health insurance scheme

	Coverage	Financial compensation
IA	Death 1 week of sterilization from the date of discharge from the hospital	₹ 2 Lakhs
B	Death following sterilization between 8 and 30 days from the date of discharge from the hospital	₹ 50,000
C	Failure of sterilization	₹ 30,000
D	Cost of treatment up to 60 days arising out of complication following sterilization from the date of discharge	Not exceeding ₹ 25,000
II	Indemnity insurance per doctor/facility not more than 4 cases per year	Up to ₹ 2 Lakh per claim

failure of sterilization, death resulting from sterilization and also to provide indemnity cover to the doctor/health facility performing sterilization procedure. The scheme is renewed with ICICI Lombard Insurance Company w.e.f 01.01.2011, based on 50 Lakh sterilization acceptors.

Benefits of the scheme w.e.f. 01.01.2011, is shown in the **Table 24.3**.

BIBLIOGRAPHY

1. A letter from India Country Office Palam Marg. New Delhi.
2. GOI. MOHFW. Contraceptive updates. Reference Manual for Doctors. UNFPA. Oct 2005.
3. Grewal S. Journal of Indian Medical Association 66, 1976.
4. Hatcher, Rinehart, Blackburn, Geller. The Essentials of Contraceptive Technology. A Handbook for Clinical Staff. John Hopkins Population Information Program 1997.
5. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.

CHAPTER 25

Biostatistics

Statistics is a methodology of collection, compilation, analysis and interpretation of numerical facts.

Study of statistics in relation to biological science (such as biological, social and environmental factors) is known as 'Biostatistics' (Medical statistics).

Study of statistics in relation to health and diseases of human population and the different factors related to them, is known as 'Health statistics'.

Study of statistics in relation to the vital events of life such as births, deaths, marriages, divorces, etc. is known as 'Vital statistics', which in turn is a branch of 'Demography', which deals with the study of human populations.

In medicine, the diagnosis and treatment, depends upon collection of data in numerical figures such as recording blood pressure, serum cholesterol level, hemoglobin level, etc. Thus Medical statistics or biostatistics is often called as 'quantitative medicine'.

VARIABILITY

An inherent feature of all biological observations is their variability, e.g. every individual varies with one another. Similarly each group of individuals are different from other groups. For example, the pulse rate, hemoglobin level, the number of white cells, etc. varies from person to person. So a range is always expressed as a standard or normal value. Again this varies from one group to another. For example, pulse rate among infants varies from that of older age group.

The measurable variable like height, weight, BP, glucose or cholesterol level in blood, etc. is called 'Quantitative variable' and the non-measurable variable like sex, occupation, socio-economic status, etc. is called 'Qualitative variable'.

APPLICATIONS OF BIOSTATISTICS

- Helps in effective comparisons between two groups or two countries.
- Helps in measurement of health status of a community in terms of rates, ratios, proportions, etc., which in turn helps in comparison with other countries and helps to study the influencing factors.

  For example, the prevalence of typhoid fever is higher among people of poor socioeconomic status, living in unhygienic areas with unsafe water supply, not protected through immunizations and so on. Thus by a systematic analysis of the factors related to the disease, a health worker or a health administrator can define the problems in terms of contrasts.
- Helps in estimating the magnitude of a health problem.
- Helps in analyzing the causes of the public health problems, including epidemics, to the public health personnel.
- Helps in monitoring and evaluation of the control measures and also in introducing midcourse correction measures, wherever necessary.
- Helps in health planning and management.
- Helps in research purposes.

  Thus, biostatistics, if properly recorded constitutes 'Eyes and Ears' of a health worker/administrator, otherwise it would be like 'sailing in a ship without compass'.

Types and Sources of Data

Whenever an observation is made, it is recorded. A collective recording of these observations, either numerically or otherwise is called as 'Data'.

When the data is obtained by enumeration or counting, e.g. sex, occupation, type of disease, cause of death, etc. it is called qualitative data. Only full numbers are possible and no fractions.

When the data is obtained by measurement, such as Hb, height, weight, BP, RBC count, WBC count, etc. it is called Quantitative data.

Quantitative data are of two types: Continuous data and discrete data.

Continuous Data

In which the measurement can be made to a precise value, e.g. Hb percent, Ht, Wt. Fractions are possible.

Discrete Data

In which the measurement is made in whole numbers (Range is given), e.g. RBC count, WBC count, BP, pulse, etc.

Sources of Data

The main sources of collection of medical statistics are experiments, surveys and records.

Experiments

Experiments are performed in various departments like physiology, biochemistry, pharmacology, clinical pathology, etc. The results are employed in the preparation of dissertations, scientific papers, etc. for publications.

Surveys

Surveys are carried out by epidemiologists or health workers in the field to know the magnitude of the problem or health status, etc. for the implementation of control measures, etc.

Records

These are the registers or books maintained over a long period for vital statistics like births, deaths, marriages, divorces, etc. or for diseases and deaths in the hospitals. They are employed in population studies and public health practice.

Sources of Health Statistics

The sources depend upon the health statistics. The different health statistics and their sources are as follows:

Health statistics		*Sources*
• Population	-	Census reports; population estimates
• Births	-	Register of births Baptism records at churches
• Deaths	-	Registers of deaths Registers at the burial and cremation grounds Postmortem records
• Diseases	-	Hospital and dispensary records. General practitioners records. Records of health and welfare centers. Records of educational institutions. Records of recruitment and sickness at armed forces. Industrial absenteeism records. Records of social security schemes (such as ESI, LIC, contributory health service schemes, etc.). Records of notifiable diseases. Reports of routine and special sickness surveys.

The drawbacks of hospital records are:

i. The hospital records represent only the tip of iceberg, because all cases do not come to hospital. Thus the mild and sub-clinical cases are missed. So it cannot be a representative sample of the population.
ii. Hospital statistics tend to be selective, because admission policy varies from hospital to hospital.
iii. As there is no specific catchment area and no geographical boundary, hospital statistics provide only numerator and no denominator. Therefore, it is a poor guide to estimate disease frequency.

PRESENTATION OF STATISTICAL DATA

The raw data, collected from different sources, is rearranged (or processed) in a meaningful and understandable way. The data can be presented in several methods—as tables, charts, diagrams, pictures and special curves (or graphs).

TABULATION

This means presentation of the data in the form of tables.

This is the most common and preliminary way of presentation of data.

There are different types of Tables depending upon the nature of data and purpose of tabulation. The Table can be qualitative or quantitative. Whether qualitative or quantitative Table, the basic principles of tabulation of data are:

- The information should be in a simple, unambiguous and orderly manner.
- The Table should have a title, which must be brief and comprehensive reflecting the nature and contents of the Table. Title should be at the top or bottom of the Table.
- Rows and columns must have their own captions (titles).
- The titles of the rows must be entered on the left side of the Table, constituting the stub. The rest of the Table constituting the body may contain numerical information in actual numbers, in percentages or in both forms.
- Standard codes or symbols are to be used, wherever necessary and are explained as footnote.
- When the data tabulated is not original, the source of the data is to be mentioned at the bottom of the Table.
- Number of class intervals should depend upon the aims of presentation.
- The class intervals are usually taken at equal intervals, e.g. 1 to 5, 6 to 10, 11 to 15, 16 to 20, etc.
- Units of the measurements of the data are to be specified.

With the above principles, the table becomes, as self-explanatory, as possible.

Qualitative Tables

There are three types of qualitative Tables, namely:

1. One way table, which depicts the distribution of data in relation to a single attribute (quality, characteristic; variable) **(Table 25.1)**.
2. Two way Table, which depicts the distribution of data in relation to two attributes **(Table 25.2)**.
3. Higher order Tables, which depicts the data in relation to more than two attributes **(Table 25.3)**.

Quantitative Tables

When a large data is collected by measurement, it is presented in the form of a table showing the characteristics as well as the number of observations (i.e. frequency), both of which are variable. The characteristic may be discrete or continuous (indiscrete). Such tables are called as frequency tables or frequency distribution tables **(Table 25.4)**.

Table 25.1 Distribution of leprosy patients according to blood group (one way table)

Blood group	Leprosy patients	Percentage
A	26	21.7
B	20	16.7
AB	16	13.3
O	58	48.3
Total	120	100.0

Table 25.2 Distribution of leprosy patients by type and their blood group (two way table)

Blood group	Lepromatous leprosy no (%)	Nonlepromatous leprosy no (%)	Total no (%)
A	06 (13.9)	20 (25.9)	26 (21.7)
B	08 (18.6)	12 (15.6)	20 (16.7)
AB	07 (16.3)	09 (11.7)	16 (13.3)
O	22 (51.2)	36 (46.8)	58 (48.3)
Total	43 (100)	77 (100)	120 (100)

Table 25.3 Distribution of leprosy patients by type and gender (higher order table)

Blood group	Lepromatous leprosy patients		Nonlepromatous leprosy patients		Total
	M	F	M	F	
A	4	2	12	8	26
B	5	3	8	4	20
AB	4	3	6	3	16
O	15	7	20	16	58
Total	28	15	46	31	120

Table 25.4 Frequency distribution of students in a hostel according to the number of illness suffered in a year

No. of illnesses (Discrete frequency)	No. of students	Percentage
0	24	4.7
1	76	14.9
2	114	22.4
3	115	22.5
4	86	16.9
5	51	10.0
6	26	5.1
7	18	3.5
Total	510	100.0

In the above table, the characteristic forms are whole group and is not split into subgroups because there is no range of variability. Illness means illness and no fractions or parts are there. This is an example of Discrete Frequency-Distribution Table (i.e. no of observations are made against discrete variables).

If the data on the otherhand, were to be a continuous data like Hb percent level, height, weight, etc. having a range, from lowest to the highest. This range is sub-divided into sub-ranges and class-frequency is noted opposite each group.

Table 25.5 Frequency distribution of heights of boys

Heights (cm) with class interval	Frequency of each group	Percentage
160–162	10	12.5
162–164	15	18.8
164–166	16	20.0
166–168	19	23.7
168–170	20	25.0
Total	80	100.0

Table 25.6 Cumulative frequency distribution of heights of boys

Heights (cm)	Frequency	Cumulative frequency
160–162	10	10
162–164	15	25
164–166	16	41
166–168	19	60
168–170	20	80
Total	80	

The interval in each sub-range is called 'Class interval' and is equal (uniform) throughout. This is also called as Indiscrete Frequency Distribution Table. Example: Frequency **(Table 25.5)** for heights of 80 boys, varying from 160 to 170 cm, with a class-interval of 2 cm as follows. The number of boys (class frequency) with the heights falling in a particular group is recorded opposite. Percentage of each frequency is calculated and mentioned in the last column.

Cumulative Frequency Table

In this table, there is an additional column, giving the total frequencies up to each of the class interval, from the lowest value. It is obtained by adding all the frequencies up to and above that particular class interval **(Table 25.6)**.

The above frequency distribution table is converted into cumulative frequency distribution table as follows.

DIAGRAMMATIC PRESENTATION

Diagrammatic presentation consists of projecting the statistical material in geometric figures, pictures, maps, which are simple, attractive and easily understandable even to common man, thereby facilitates the communication of statistical information by a quick grasp.

Limitations of diagrammatic presentation are:

- Great care must be taken in designing the diagram
- Every aspect of the data cannot be presented in the diagram
- They fail to reflect small differences and emphasize only major characteristics
- They fail to provide basis for application of tests.

Let the diagrammatic representation play an important role in making intricate and perplexing statistical facts intelligible to common people.

Points to be Remembered in the Construction of a Diagram or Graph

- Diagram should be simple and consistent with the type of data
- Diagram should be self-explanatory, including title, scale, index, etc.
- Diagram should not look clumsy by too many lines
- Usually the rulings of the graph paper should be light and the lines of the diagram should be heavier
- Ordinarily the values of the variable are represented on the horizontal X-axis and the values of the frequency on the vertical Y-axis (respectively called as abscissa line and ordinate line)
- The lines drawn on the graph should never be extrapolated beyond the range of the values of the variable to which the graph is drawn.

The various types of diagrammatic presentation are:

- Bar diagrams/charts
- Histogram
- Frequency polygon
- Line diagram
- Frequency curve
- Cumulative frequency curve
- Scatter diagram
- Pie diagram
- Pictogram
- Map diagram.

Bar Diagrams/Charts

It is a simple diagram or a chart, popularly used to compare the magnitude of the qualitative data. Bars are the rectangles drawn along the graph sheet. Height of each bar or rectangle corresponds to frequencies in a data, while the breadth or base corresponds to the length of the class interval of the variable in quantitative data and to various groups in qualitative data. The bars are arranged either vertically or horizontally in ascending or descending order. Bars should stand on the same line and possess the same width; the spacing between the two consecutive bars should be equal to the half of the width of the bar. The bars can be placed either vertically or horizontally.

By comparing the height of the rectangles, comparison of different groups can be made.

A suitable scale must be chosen to present the length of the bars.

There are three types of bar diagrams—Simple, Multiple and Component (Proportional).

1. *Simple bar diagram:* It consists of single, rectangular bars having uniform color or shade **(Fig. 25.1)**.
2. *Multiple bar diagram:* It is also called as compound bar diagram/chart. In this type, two or more bars can be grouped together **(Fig. 25.2)**. Such diagrams are useful to make comparisons between various groups. Multiple bars may have uniform or different shades.
3. *Proportional bar diagram:* This is also called as 'Component Bar Diagram'. In this type, the bars may be divided into two or more parts, depending upon the number of sub-groups to be compared in proportions or percentages. Each bar representing 100 percent as their height, each component representing the magnitude of an attribute or variable. A component bar diagram resembles a simple bar externally and multiple bars internally. Since the diagram represents the percentage, they are often referred to as 'Percentage bars'.

In **Figure 25.3**, the percentage of admission in each ward for a particular year is depicted within each bar.

Histogram

In Greek language 'Histos' means web. Just like the toes of frog are webbed, so also in histogram the bars are joined together.

It is a graphic representation of a frequency distribution table in which the vertical axis represents the frequency and the horizontal axis the class interval.

It consists of series of bars adjoining to each other, the length of each bar is being proportional to the frequency and the width to the class interval **(Fig. 25.4)**.

The concept in this graph is that the area under each rectangle represents the proportion of the total area of all the rectangles, considering as one.

Histograms are ideally suited to represent the distribution of anthropometric values like height, weight, midarm circumference, etc. They can also represent other types continuous data series such as blood pressure, pulse rate and hemoglobin level.

Histograms provide a better understanding of quantitative data of continuous type than frequency distribution tables.

Age and Sex Pyramid (Population Pyramid)

This is a double histogram, wherein the bars are drawn on either side of a vertical axis, which forms the base and the bars

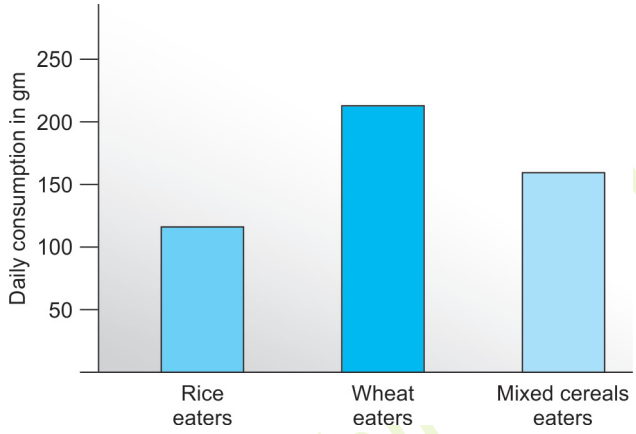


Fig. 25.1 Bar diagram showing type and quantity of cereals consumed by 500 hostlers

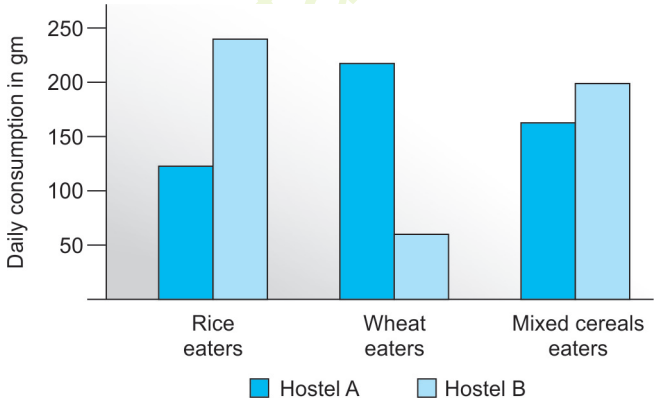


Fig. 25.2 Multiple bar diagram showing cereal consumption by quantity and type in inmates of two hostels

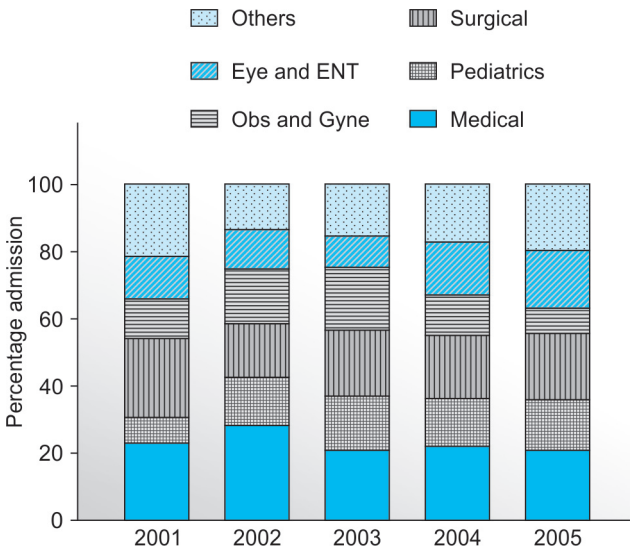


Fig. 25.3 Proportional bar diagram showing the number of admissions in a teaching hospital during 2001–05 according to specialities

are adjoining to each other with a common scale. The left side represents the age-wise distribution of the female and the right-side, age-wise distribution of the male population. Thus the percentage distribution or the number of persons in any age group is taken on the horizontal axis and the variable, i.e. age group, is taken on the vertical axis in the center **(Fig. 25.5)**.

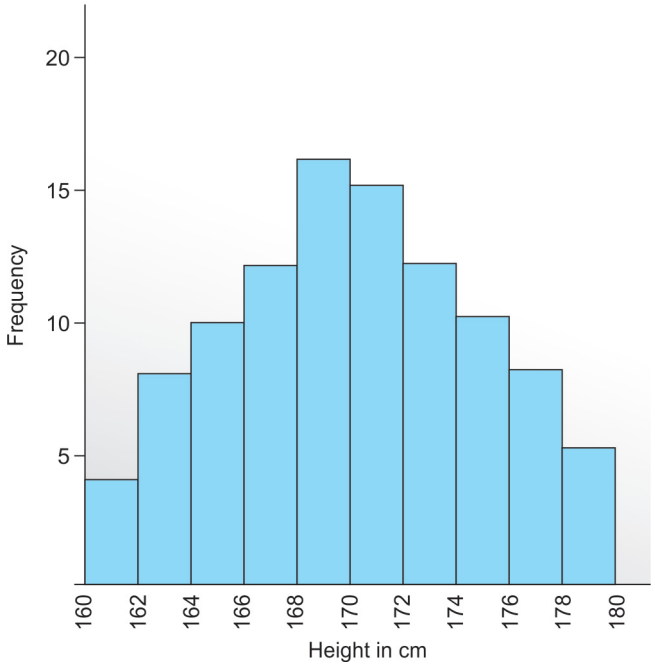


Fig. 25.4 Histogram showing the heights amongst students in a class

The age and sex pyramid reflects several features. The height of the pyramid represents the maximum age-span of the population. The shape of the pyramid reflects the fertility behavior of the population (It has a broad base, concave outer borders and acute angle of apex for developing countries and a narrow base, convex outer border and obtuse apical angle for the developed countries). Asymmetry of the pyramid indicates presence of gender bias.

Frequency Polygon

It is a line diagram that represents a frequency distribution table. It can be obtained by joining the midpoints (dots) of the heads (heights) of the histogram, each dot represents two characteristics; class interval as indicated on the horizontal axis and the class frequency as indicated on the vertical axis.

Joining the dots gives a curve with many angles. Hence, the name 'Frequency polygon' **(Fig. 25.6)**.

This type of diagram is useful especially, when it is necessary to compare two or more frequency distributions. The curves for different distributions should be drawn with different types of lines on the same graph paper for easy comparison, which is not possible through histograms because of overlapping of rectangles resulting in confusion.

Frequency Curve

When the number of observations is very large and the group interval is reduced, the frequency polygon tends to lose its angulations, resulting in a smooth curve, known as 'Frequency curve' **(Fig. 25.7)**.

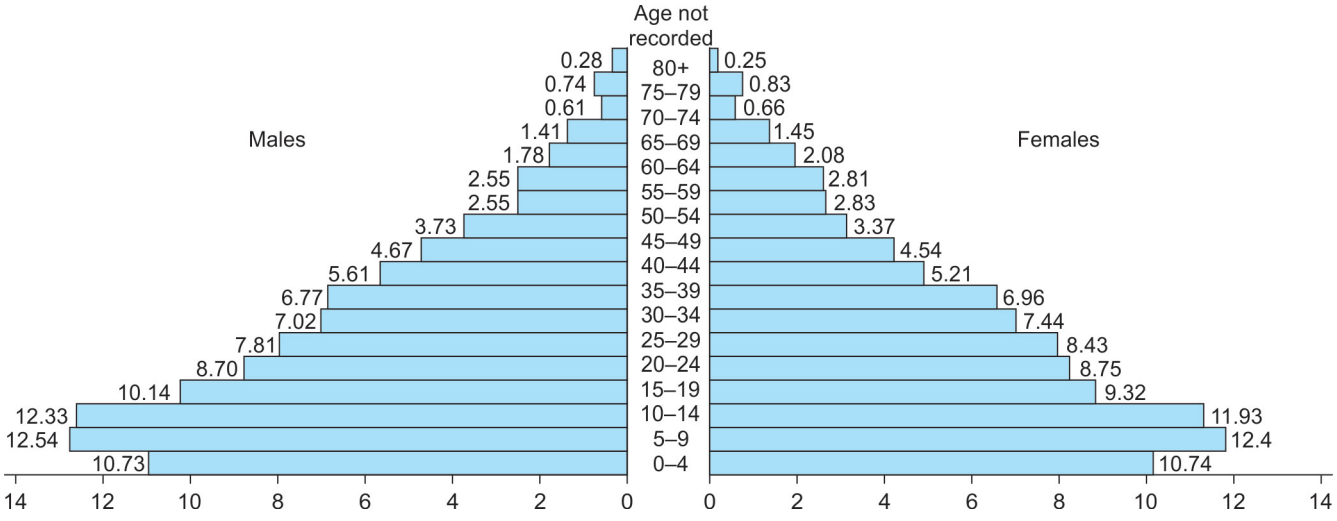


Fig. 25.5 Age and sex pyramid of India 2001 (Histogram showing the population pyramid)
Source: Sunderlal, Adarsh, Pankaj. Textbook of Community Medicine, 1st edn, 2007

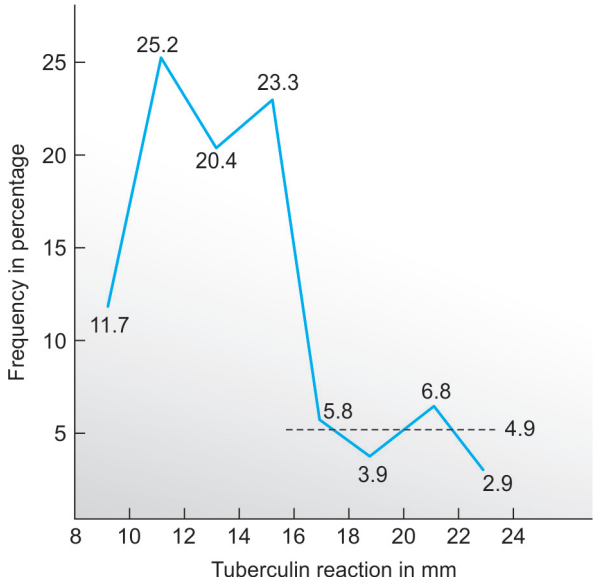


Fig. 25.6 Frequency polygon showing tuberculin reaction in 206 persons, never vaccinated
Source: Mahajan BK. Methods in Biostatistics 3rd edn. 1981

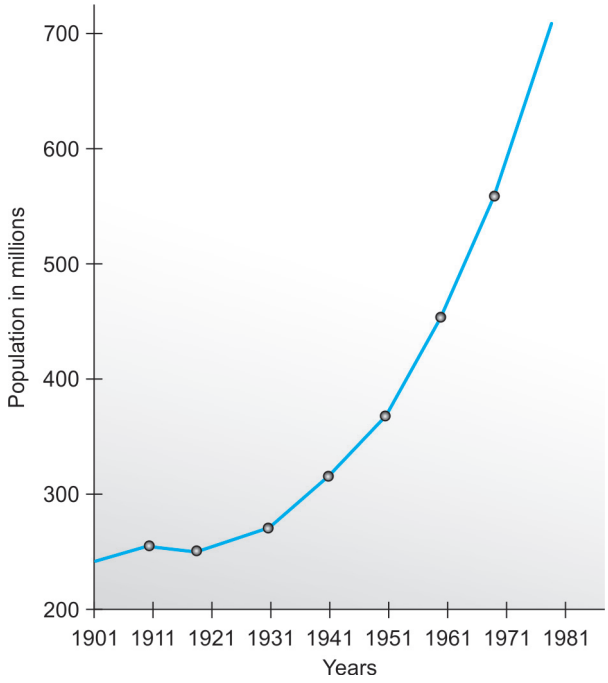


Fig. 25.8 Line chart showing the population trend in India
Source: Mahajan BK. Methods in Biostatistics 3rd edn. 1981

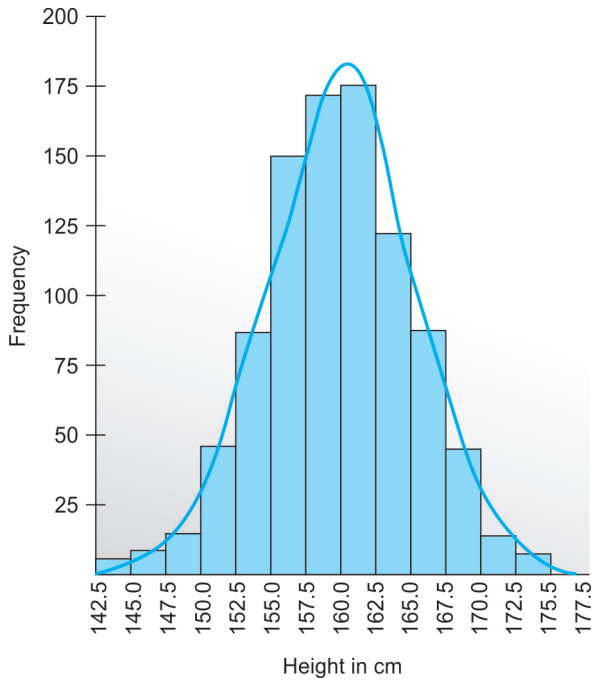


Fig. 25.7 Frequency curve of heights superimposed over histogram
Source: Mahajan BK. Methods in Biostatistics 3rd edn. 1981.

Line Diagram

In this diagram, the vertical axis represents the magnitude and the horizontal axis represents time. Thus this diagram provides a simple, easily understandable and highly effective means of understanding the trend or behavior of an event over a period of time, e.g. rising or falling or fluctuations, such as birth rate, death rate, population trend, etc. the class interval may be one month, one year or one decade **(Fig. 25.8)**.

Since line diagrams do not occupy any space, several lines may be projected on the same graph for comparing the trends of interrelated events.

Multiple line diagrams can coexist only if they share the scales given on the two axes of the graph.

Cumulative Frequency Curve or 'Ogive'

It is a line diagram, representing the cumulative frequency distribution of the quantitative data. To draw this, an ordinary frequency table in a quantitative data has first to be converted into a cumulative frequency table. Cumulative frequency is the total number of persons in each particular range from lowest value of the characteristic up to the any higher group value **(See Table 25.6)**.

The curve is plotted by taking the variable on the X-axis and the cumulative frequency on the Y-axis **(Fig. 25.9)**.

From the ogive, median value of the characteristic (variable) can also be calculated. The calculation and the application will be discussed under 'Central tendency'.

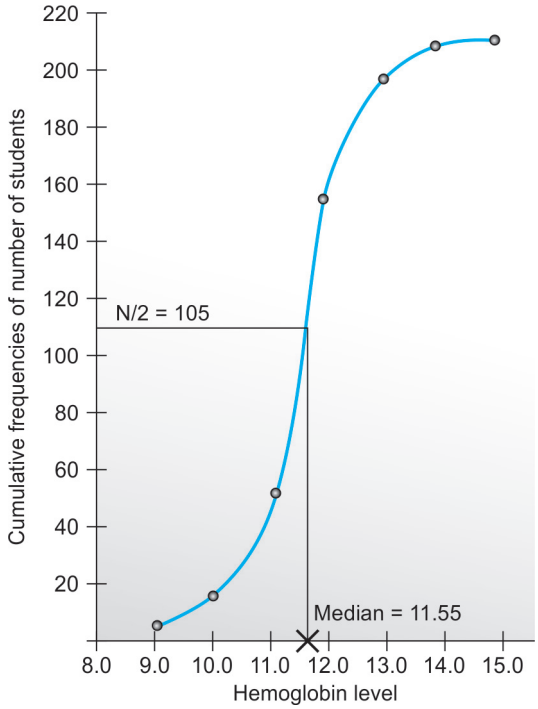


Fig. 25.9 Ogive for the distribution of hemoglobin levels of students in a class

Source: Rao NSN. Elements of Health Statistics. 1st edn Reprint 1985

Scatter Diagram or Dot Diagram

All the diagrams described so far, are useful only for frequency distributions with single variables. When observations for two variables (e.g. weight and mid-arm circumference or Weight and Height) are made in each of the individuals in a group, it helps to study the relationship between the two variables. One variable is represented on X-axis and another variable on Y-axis. Perpendiculars drawn from these readings meet, to give one scatter point. There will be as many points as there are individuals in the observation. When all the points are plotted, the diagram gives the picture of a scatter. Hence the name 'Scatter diagram' (Dot diagram). The direction of scatter helps to determine presence or absence of the association. If the scatter takes the direction midway between the two axes, it signifies positive association (correlation) **(Figs 25.10A to C)**. If it takes a direction at right angles to midway scatter it indicates negative association. A haphazard scatter represents neither positive nor negative association.

Pie Diagram

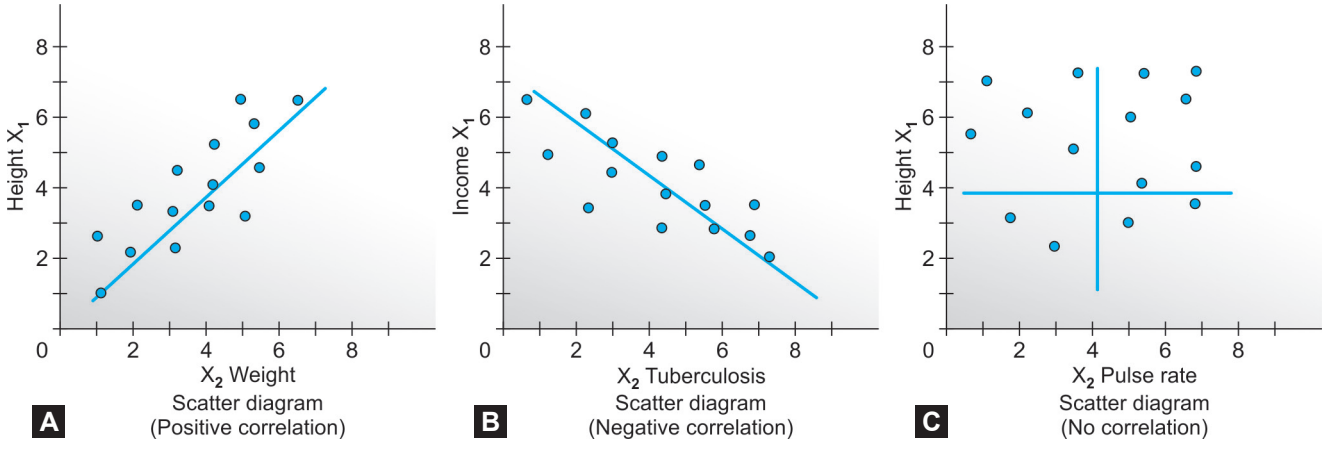
It is an improvement over a bar diagram. It is an another way of depicting qualitative data, such as blood groups, age group, sex groups, morbidity, mortality rates, etc. in a population. It is a circular diagram in which the frequencies of observations are shown as sectors or wedges in a circle, the size of each sector being proportional to the frequency. Degrees of angle denote the frequency and the area of the sector gives comparative difference at a glance. ('Pie' means a piece or a sector).

Before constructing a pie diagram, angles are distributed among the various frequencies in proportion to their individual magnitudes, treating the total magnitude of the attributes (frequencies) as 360; 360° representing the sum total of all angles at the center of the circle.

Sectors are then outlined by hatching or coloring or shading. Thus a pie diagram is more attractive and gives a better visual display of its component parts.

To draw a pie diagram, first a circle is drawn. The radius is marked. A second radius clockwise is drawn at an angle with the first radius, depending upon the angle for the sector, which can be calculated by the following formula.

$$\text{Angle for any sector} = \frac{\text{No of observations (frequency) in a specific group}}{\text{Total number of observations in all the groups}} \quad 360°$$



Figs 25.10A to C Scatter diagram showing different types of correlations

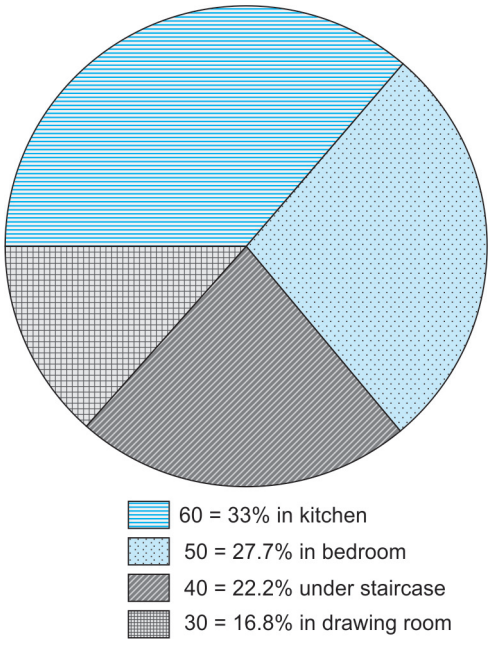


Fig. 25.11 Pie or sector diagram showing distribution of accidents

Example: The results of a study of domestic accidents were as follows. Out of total 180 accidents in the house, 60 occurred in the kitchen, 50 in the bed room, 40 under the staircase and 30 in the drawing room. The findings are portrayed in the form of a pie diagram **(Fig. 25.11)**.

Degree

Angle for accidents in kitchen = $\frac{60}{\cancel{180}} \times \overset{2}{\cancel{360}} = 120°$

Angle for accidents in bedroom = $\frac{50}{\cancel{180}} \times \overset{2}{\cancel{360}} = 100°$

Angle for accidents under staircase = $\frac{40}{\cancel{180}} \times \overset{2}{\cancel{360}} = 80°$

Angle for accidents in the drawing room = $\frac{30}{\cancel{180}} \times \overset{2}{\cancel{360}} = 60°$

Percentage (of accidents)
(considering 360 = 100%)

$$\frac{\overset{1}{\cancel{60}}}{\underset{3}{\cancel{180}}} \times 100 = \frac{100}{3} = 33.3\%$$

$$\frac{50}{\cancel{180}} \times \cancel{100} = \frac{500}{18} = 27.7\%$$

$$\frac{40}{\cancel{180}} \times \cancel{100} = \frac{400}{18} = 22.2\%$$

$$\frac{30}{\cancel{180}} \times \cancel{100} = \frac{300}{18} = 16.8\%$$

The sectors should be arranged clockwise either in ascending or descending order of magnitude. It is often necessary to indicate the percentage for easy comparison.

This type of representation is effective only when the number of observations are not many and the number of observations in each group can be added to get the total number of observations of all the values of the variable.

The pie diagram can be made more attractive by giving a three dimensional effect to it.

Each sector can be sliced out from the main diagram to highlight the fact.

Pictogram

It is also called as picture diagram or pictorial diagram. It consists of a series of small pictures or symbols or silhouetts, each representing a group of data. This method is used to impress a lay person, who cannot understand the orthodox charts **(Fig. 25.12)**.

The pictures are drawn in horizontal lines, each picture indicating an unit of 10, 20, 30, etc. happenings. The number of pictures in each row gives an idea of frequency of the attribute. In essence, pictograms are a form of bar charts.

Map Diagram or Statistical Map

This is commonly used to represent the geographic distribution of disease or deaths of public health importance.

The statistical maps are of two types—the spot maps and the shaped maps.

Spot Map (Geographic Spot Map)

In this type, the distribution of the disease frequency is represented in the form of dots or spots, each dot representing an unit number of 10, 20, 30, etc. in the area map prepared. Number of dots will indicate the frequency in units. Such maps show at a glance areas of high frequency (clustering of spots) or low frequency. Clustering of spots may indicate a common source of infection or a common risk factor shared by all the cases. This is how John Snow of England, in 1854, was able to find out that the particular water pump in Broad Street of London was the source of infection of cholera **(Fig. 25.13)**. Thus, he was able to hypothesize that cholera was a water borne disease, much before the bacilli were isolated by Robert Koch. It was with the spot-map, Maxcy (1922-25) hypothesized rodent as the reservoir of typhus fever. Thus, spot-map help the epidemiologist to study the place

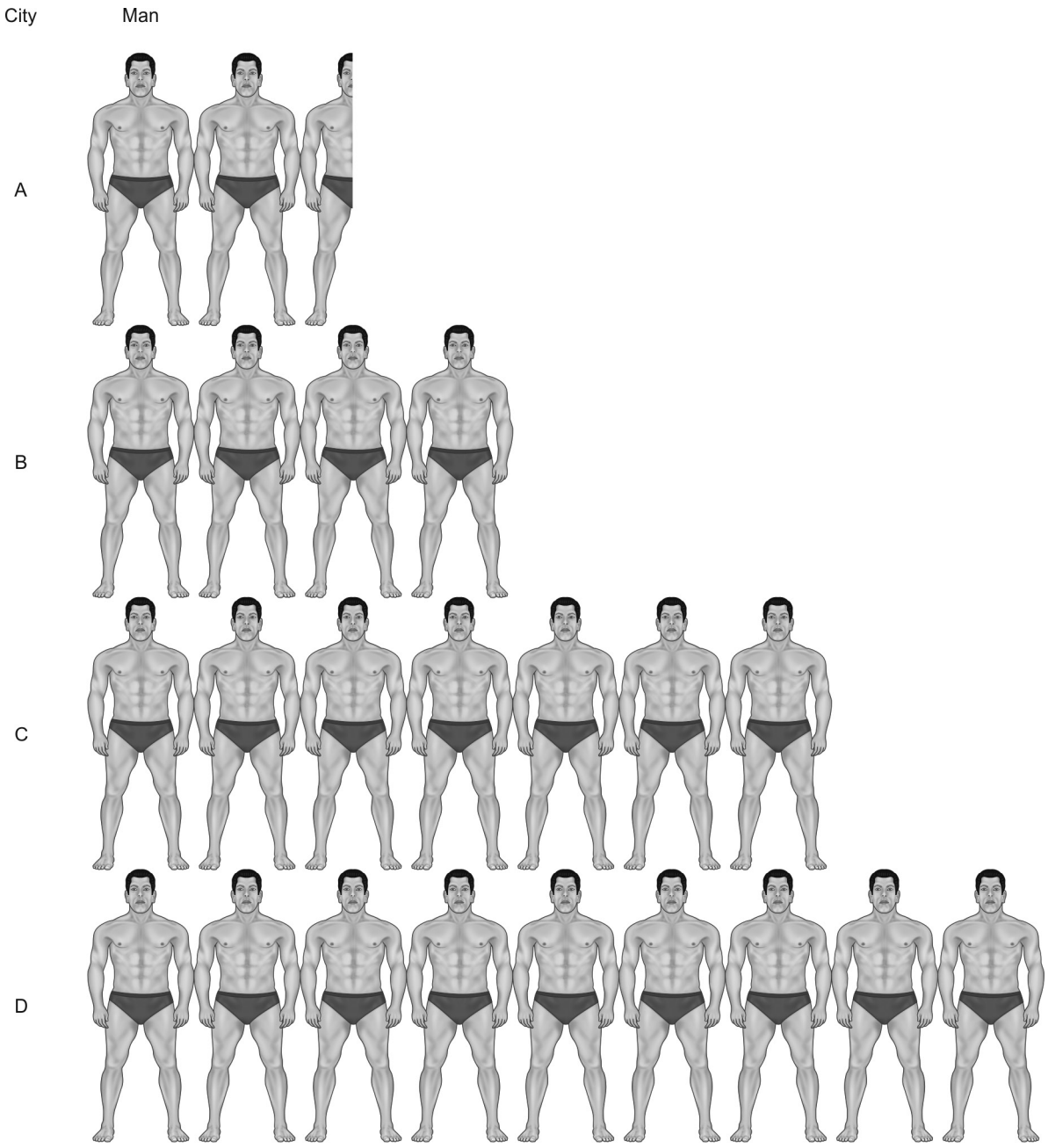


Fig. 25.12 Pictogram of cholera in 4 cities, each man's figure indicates 10 cases

distribution, source/reservoir of infection and behavior of a disease.

Two different colored dots may be marked on the map to show attacks and deaths, in the area.

Maps prepared on weekly or monthly basis help in monitoring changes in the magnitude of epidemics over a period of time and also the direction of their spread.

Shaded Map

These are used to indicate the variability in the incidence and prevalence of diseases in different parts of the world/country or from time to time **(Fig. 25.14A)**.

Shaded maps indicating state-wise prevalence of diseases are commonly used for formulating appropriate

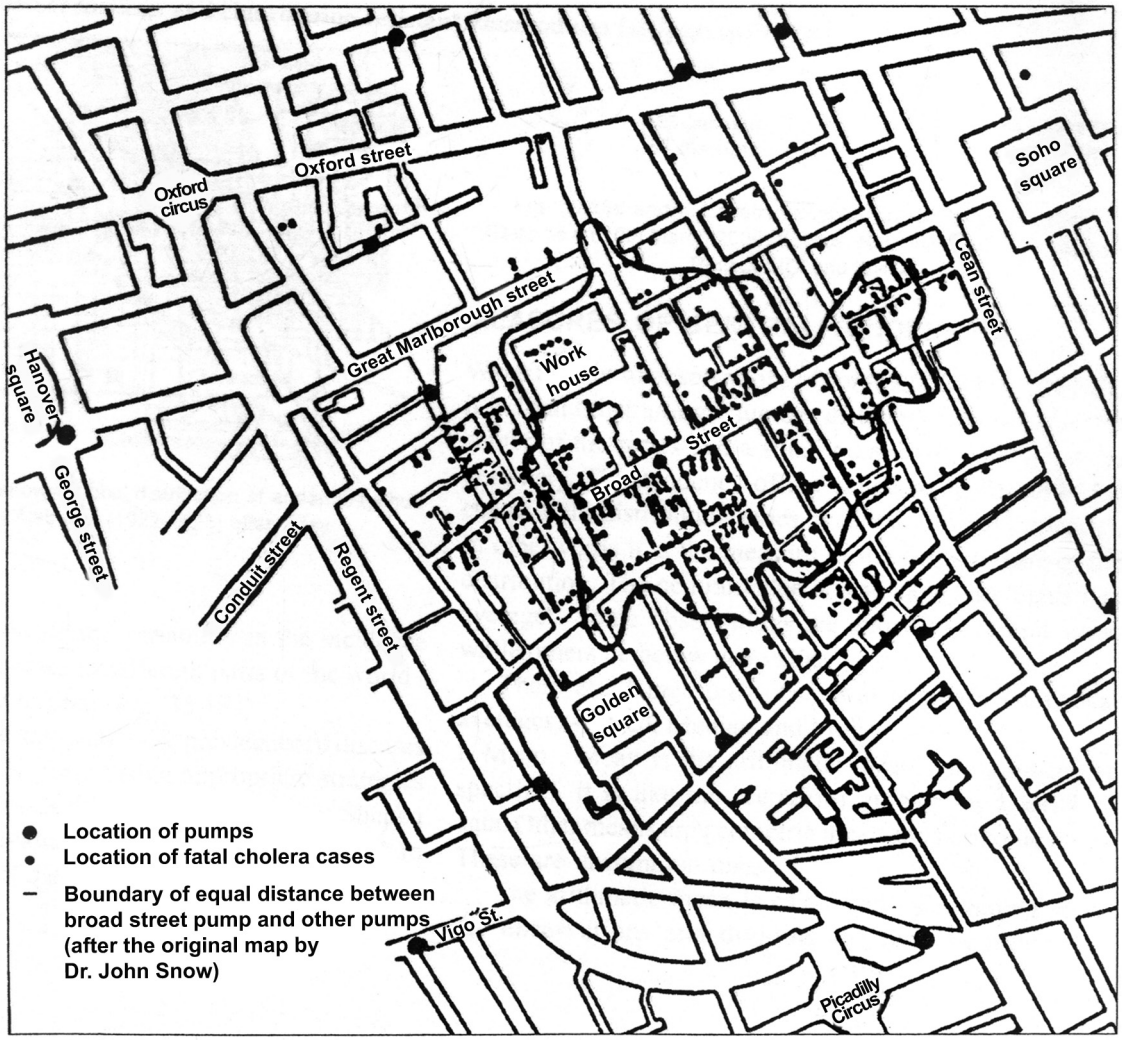


Fig. 25.13 Spot map Asiatic cholera in London (*Source:* Park K. Park's Textbook of Preventive and Social Medicals 18th edn. 2005)

strategies for the control of diseases of national importance. Shaded maps also help in evaluating the progress achieved in reducing the burden of diseases over a period of time **(Figs 25.14B and C)**.

MEASURES OF CENTRAL TENDENCY

When a series of observations of continuous series are made, it is found that a large number of them concentrate at the center of the series and a small number of them lie at the periphery. This tendency of the values to aggregate in the center of the distribution series, is called 'Central tendency'. In otherwords it is the measure of the central value of the distribution. The central value is also called as 'Statistical average'. Some observations are above the central value while others lie below this value.

There are 3 measures of central tendency (statistical averages)—Mean, Median and Mode.

Mean

Mean is the arithmetic mean unless otherwise specified. It is like the 'center of gravity' of a series of data. Other means are geometric mean and harmonic mean. These are uncommon ones.

The arithmetic mean is calculated by summing up all the observations and dividing the total by number of observations. This central value has got highest utility in statistics. It represents the most appropriate measure of central tendency.

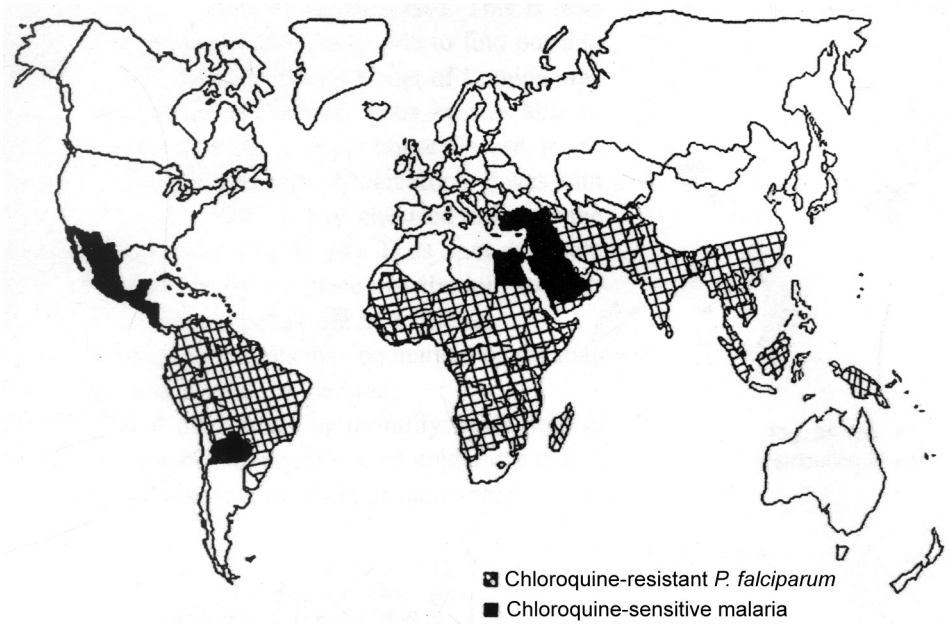
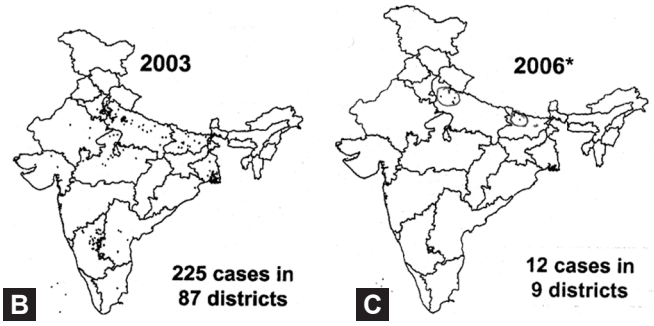


Fig. 25.14A Shaded map showing distribution of malaria and chloroquine-resistant *Plasmodium falciparum* (1993)
Source: Ghai OP, Piyush Gupta. Essential Preventive Medicine 1st edn. 1999.



Figs 25.14B and C Location of polio-virus in India, 2003-06. *Data as on 10th March 2006. *Source:* National Polio Surveillance Project: GOI and WHO

Formula:

$$\text{Mean} = \frac{\text{Sum of all observations made}}{\text{Number of observations made}}$$

Mean is symbolically represented as $\bar{x} = \frac{\Sigma x_1}{n}$

Where x_1—is the value of each observation in the data,
$\bar{x}$—is mean value (read as x-bar)
Σ—means sum of
n—is the number of observations in the data.

Example: The systolic blood pressure in mm Hg of ten students are as follows:

116, 118, 122, 120, 120, 124, 122, 116, 118, 124

Mean, $\bar{x} = \frac{1200}{10} = 120$ mm Hg

The limitations of mean is that it is greatly affected by extreme values.

Median

It is the central value of a series of observations or variables, when arranged in a definite order, either ascending or descending, so that one-half of the value lie above it and the other half below it. It is easy to locate when there are odd number of values. When there are even number of values, the median is taken as the average of the two central values of the distribution series.

The advantage with the median value is that it is easily detected and much less disturbed by extreme values. The disadvantage is that it is not suitable for mathematical treatment.

Example: In a hospital ward, the following are the number of days of stay of patients.

13, 42, 8, 9, 7, 3, 6, 52, 8, 2, 11, 11, 10, 9

For calculation of the median, all the numbers are first arranged in the ascending order, as:

2, 3, 6,7, 8, 8, 9, 9, 10,11, 11, 13, 42, 52

As there are 14 patients, the average of the periods of stay corresponding to the 7th and 8th patients is calculated as median:

i.e. Median = $\frac{9+9}{2}$ = 9 days

The application of median in pharmacology is to denote the median lethal dose of a drug. That means, it is that dose or concentration of the drug, which is toxic to 50 percent of the lab animals or kills 50 percent of the animals.

Graphic Method for Locating the Median

The median can also be calculated from the curve 'Ogive' obtained by plotting the cumulative frequencies against the end points of the corresponding class intervals as shown in **Figure 25.9**. Curve is prepared by taking the variable on X-axis and the cumulative frequency on Y-axis.

Median can be located by the following procedure. On the Y-axis, N/2nd frequency is located (e.g. 210/2 = 105). From this point a line parallel to X-axis is drawn to meet the curve. From the point of intersection, a line parallel to Y-axis is drawn to meet the X-axis. The point of intersection on X-axis is the median value of the observation.

As seen in the **Figure 25.9**, the median value of the series of observations is 11.55. It corresponds to 50th percentile value (details later).

Median is a better indicator of an attribute than mean when the lowest and the highest observations are wide apart or not so evenly distributed.

Mode

This is the most frequently occurring value in a series of values or observations. It is least influenced by the extremes of values. It is easy to calculate. But the disadvantage is that it may not exist in a small group of values and it cannot be subjected to mathematical treatment.

Example 1: When studying the age of onset of a disease, it is advisable to know the age at which maximum number of persons are affected rather than the mean age of onset or median age of onset.

Example 2: Following is the ages of 10 medical students.

18, 18, 19, 19, 20, 20, 20, 21, 22, 23

Mode is 20 years of age.

Mode is the only average that can be applied to qualitative data.

In a normal frequency distribution mode corresponds to mean and median. Mode can also be calculated from the relationship,

Mode = Mean – 3 (Mean – Median).

It is also to be noted that in a frequency polygon, the mode can be located from the point, where the curve takes a turn from increase to decrease. There can be more than one mode for a series of data.

MEASURES OF LOCATION—QUANTILES

Quantiles are the values of a variable in an ordered series. They divide the total frequencies in equal parts in order of magnitude. Common quantiles are five. They are median, quartiles, quantiles, deciles and percentiles **(Fig. 25.15 and Table 25.7)**.

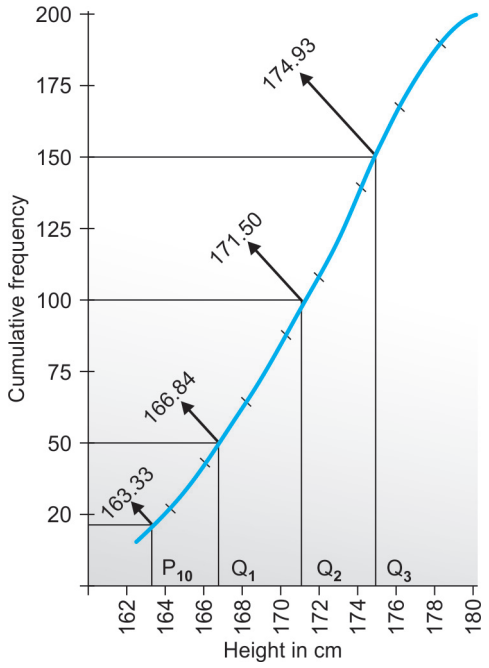


Fig. 25.15 Cumulative frequency diagram showing height values of median (Q_2), first or lower quartile (Q_1), third or upper quartile (Q_3) and tenth percentile (P_{10})
Source: Mahajan BK. Methods in Biostatistics 3rd edn. 1981.

Table 25.7 Cumulative frequency

Height of groups in cm	Frequency	Cumulative frequency
160–162	10	10
162–164	15	25
164–166	17	42
166–168	19	61
168–170	20	81
170–172	26	107
172–174	29	136
174–176	30	166
176–178	22	188
178–180	12	200
Total	200	

a. *Median*: It divides the total frequencies into two equal parts, each part will have 50 percent of the total observations on each side of the median (Q_2).
b. *Quartiles*: They are three (Q_1, Q_2 and Q_3), dividing the series in 4 equal parts, each part having 25 percent of the total observations.
c. *Quintiles*: They are four, dividing the total frequencies into five equal parts, each part having 20 percent of the total observations.
d. *Deciles*: They are nine, dividing the total frequencies into 10 equal parts, each part having 10 percent of the total observations.
e. *Percentile*: They are 99, dividing the total frequencies into 100 equal parts, each part having 1 percent of the total observations. Thus it reflects the position of an individual, in a grouped series of 100, when arranged in a definite order, either ascending or descending.

Thus Median is the second quartile (Q_2), 5th decile, or 50th percentile, having 50 percent of the total observations on either side.

First quartile will be Q_1 or P_{25} dividing the total observations into two parts, the first part having 25 percent and the second part 75 percent of the observations.

Second quartile will be Q_2 or P_{50} or 5th decile or median, as described above.

Third quartile will be Q_3 or P_{75}, dividing the total observations into two parts, one part having 75 percent of the observations and the other part 25 percent.

Accordingly third quantile divides the series into two parts, the first part having 60 percent of observations on one side and the remaining 40 percent on the other side.

7th decile will have 70 percent values in the first part and 30 percent values on the other side, represents 70th percentile.

10th percentile will have 10 percent in the first part and 90 percent in the other part and so on.

MEASURES OF DISPERSION

In the previous chapter, it was understood that measurement of central tendency was useful for defining a distribution in a concise manner. But by knowing only the mean, median and mode, it is not possible to fix the distribution completely. For example, there are 2 groups of cricket teams, having their diastolic pressures (in mm Hg) as:

Team A—92, 90, 88, 88, 88, 86, 84, 84, 84, 82, 80

Team B—100, 98, 96, 94, 90, 86, 82, 78, 76, 74, 72.

It is seen that both the groups have their mean as 86 mm Hg. At the same it is also seen that the range as well as the diastolic pressures of the two groups are different. Hence, two sets of data with a common mean need not be same with regard to various individual values of the observation.

So to know how far these observations are scattered from each other or from the mean, certain parameters are employed to measure the dispersion or scatter. These are Range, Mean deviation, Standard deviation and Coefficient of variation.

1. *Range:* It is the interval between the lowest and the highest of the values. Thus range gives the values of the extremes but does not give any information about the values in between the extreme values.

   In the above example, the range in team A is 12 and in team B is 28. The values are scattered or dispersed around the mean 86 in both the groups.

   Range usually defines the limits of normalcy. However, it will be misleading when the extreme values are of unusual occurrence.

   Sometimes, instead of knowing the range between all the observations, it may be necessary to know the range within which a certain percentage of observations lie. Such a range is called 'percentile range'. For example, the range between Q_1 and Q_3 **(See Fig. 25.15)** includes middle-half of observations in an ordered series. It is also called as 'Interquartile range'. This gives little more information about the distribution of the individual observations than range. It will indicate whether the concentration is more at the extremes or in the middle or the observations are evenly distributed.
2. *Mean deviation (MD):* It is the mean or average of the deviations. The deviation (new value) is obtained by deducting the arithmetic mean from each observations. All the deviations are summed up and then the average of all the deviations is called as 'Mean deviation'. It is calculated by the following procedure.
   i. The 'mean' of the observations is calculated.
   ii. Then the mean is subtracted from each of the observations to calculate the deviation.
   iii. The mean (or average) of these deviations is then calculated by totaling the differences from the mean and divide by the number of observations without considering the sign of the deviation, which gives mean deviation.

   MD is given by the formula,

$$MD = \frac{\Sigma |x_i - \bar{x}|}{n}$$

   Where MD = mean deviation,
   Σ = Summation
   | | = Vertical bracket (modulus) refers to absolute value, ignoring + or – sign (because if the signs are considered, the total value becomes zero).
   x_i = Individual value of observation.
   $\bar{x}$ = Mean of observations.
   n = Number of observations.

Though calculation of mean deviation is simple and easy, it is not used in statistical analysis being of less mathematical value, particularly in drawing inferences.

Example: Calculate the mean deviation of systolic blood pressure in mm of Hg of ten students, which is as follows.

115, 117, 121, 120, 118, 122, 123, 116, 118, 120

(Individual observation) x_i	(Individual observation) – mean $(x_i - \bar{x})$	Deviation
115	115–119	= – 4
117	117–119	= –2
121	121–119	= +2
120	120–119	= +1
118	118–119	= –1
122	122–119	= +3
123	123–119	= +4
116	116–119	= –3
118	118–119	= –1
120	120–119	= +1

$$\bar{x} = \frac{\Sigma x_i}{n} = \frac{1190}{10} = 119 \qquad \Sigma x_i - \bar{x} = 22$$

$$\therefore \text{MD} = \frac{\Sigma |x_i - \bar{x}|}{n} = \frac{22}{10} = 2.2$$

Standard Deviation

Standard deviation (SD) is an improvement of the mean deviation. In the calculation of the mean-deviation, the signs of the deviation (+ or –) of the observations from the mean was not taken into consideration. In order to avoid this discrepancy, instead of the actual values of the deviations, the squares of the deviations are considered for calculation and then the average of the squares in taken, which is known as 'Variance'. As this variance is a square, square-root of the variance is considered as a measure of variation of the observations. The square-root of the variance is known as 'Standard deviation'.

In otherwords, standard deviation is the square-root of the mean of the squared deviations of the individual observations from the mean. It is also called as 'Root mean square deviation'.

Of all the measures of dispersion, standard deviation is the most important one, and is the best measure of dispersion of observations. It is most widely used in statistical methodologies. It is one of the important parameters of the standard distributions like normal distribution and skewed (i.e. asymmetrical) distributions, which are described later.

Further standard deviation is useful in testing of significance or in measurement of correlation between two sets of data and other statistical methodologies (explained below).

It is conventional to represent the standard deviation of a sample by 'S' and that of a population by 'S' (pronounced as 'sigma') and it is expressed in the same unit as that of original observations.

Standard deviation is computed by the following steps:

a. Mean of the observations is calculated.
b. Mean is subtracted from each of the observation to calculate the deviation (i.e. difference of observation)
c. Square the differences of observations (deviations) from the mean, which removes the problem of signs + or –.
d. Total (adding) of the squared values to get 'sum of squares'.
e. This sum is divided by the number of observations minus one (n-1) to get 'mean-squared deviation', called 'Variance'.
f. Finally square-root of this variance is obtained to get 'root-mean squared deviation', called standard deviation. (having squared the original, reverse step of taking square-root must finally be taken).

Formula:

$$\text{SD} = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n - 1}}$$

Where SD = Standard deviation
$\sqrt{}$ = Square root of
Σ = Summation of
x_i = Value of each observation
$\bar{x}$ = Mean of observation
$x_i - \bar{x}$ = Deviation from the mean
n = Number of observations
n – 1 = When 'n' is less than 30

Example: The pulse rate per minute of 10 students in a class are as follows:

80, 90, 96, 80, 94, 72, 84, 92, 82, 90

Mean of the observations = 86

The standard deviation of the pulse rate for the group is calculated as follows:

x_i	$(x_i - \bar{x})$		Deviation	$(x_i - \bar{x})^2$
80	80–86	=	–06	36
90	90–86	=	+04	16
96	96–86	=	+10	100
80	80–86	=	–06	36
94	94–86	=	+08	64
72	72–86	=	–14	196
84	84–86	=	–02	04
92	92–86	=	+06	36
82	82–86	=	–04	16
90	90–86	=	+ 04	16

Mean $\bar{x} = \frac{\Sigma x_i}{n} = \frac{860}{10} = 86$ $\Sigma (x_i - \bar{x})^2 = 520$, n = 10

$$\therefore S = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{520}{9}}$$

$$= \sqrt{57.78}$$

= 7.60 per minute.

Applications of Standard Deviation

1. A standard deviation (SD) is the universally accepted unit of dispersion of values from the mean value ($\bar{x}$).
   In a normal distribution series, a confidence interval of $\bar{x}$ ± 1 SD encloses 68.27 percent values, an interval of $\bar{x}$ ± 2 SD encloses 95.45 percent values and an interval of $\bar{x}$ ± 3 SD encloses 99.73 percent values, for purpose of simplicity, a confidence limit of X + 2SD is treated as including 95 percent values. In other words, six standard-deviations, three on either side of the mean cover almost the entire range of a quantitative series (explained under 'normal curve').
2. SD summarizes the variation of a large distribution in one figure and defines the normal limits of variation.
3. SD measures the position or distance of observation from the mean (i.e. to measure individual variability).
4. SD indicates whether the variation of difference of an individual from the mean is by chance (natural or real) due to some special reasons.
5. SD is used to calculate standard error (SE) of mean and SE of difference between two means.
6. SD helps in finding the size of the sample.
7. SD is used for calculation of 'relative deviate' or 'Z score'. It is the difference of a specific observation from the mean in terms of the SD. Its formula is

$$Z = \frac{z - \text{mean}}{SD}$$

   where Z = relative deviate,
   x = the observation in question;
   Example: The mean height of college students is 150 cm with SD of 10 cm. A particular student's height is 165 cm. Z-score (relative variate) of his height is calculated as follows:

$$Z = \frac{165 - 150}{10} = \frac{15}{10} = 1.5 \text{ cm}$$

8. SD is used in the calculation of 'coefficient of variation' (CV)

$$CV = \frac{SD}{Mean} \times 100$$

Coefficient of Variation

The standard deviation of any two quantitative groups (series) in the same group, cannot be compared if the attributes are different (like SD of Ht and SD of Wt) and even if the values pertain to the same attribute (like height only) comparison cannot be made if the units of measurement are different in the two groups, for example cm and inch. This limitation of SD is satisfactorily removed by converting standard deviation into 'coefficient of variation' (CV).

The CV is the standard deviation expressed as the 'percentage of the mean'. Thus while SD is expressed in different units of measurement, coefficient of variation is an unitless number. Therefore CV is well suited for all types of dissimilar measurements such as Ht and Wt or Hb and Wt or pulse rate and midarm circumference.

Formula:

$$CV = \frac{SD \times 100}{Mean}$$

As an example, the variation of Hb level of a group of persons and the variation of their body weight, which are expressed in different units like gm percent and kgs respectively, will have different means and different standard deviation. Coefficient of variation helps to compare the deviations in two sets of dissimilar measurements in the same group or one character in two groups.

Example 1: Example for two characters in the same group. The mean and standard deviation of Hb level of a group is 12.6 g percent and 1.5 g percent respectively while the mean and standard deviation of the body weight of the same group is 50 kg and 2.2 kg respectively.

To compare the deviations of these two sets of observations coefficient of variation is calculated for each data.

$$\text{CV of Hb level} = \frac{1.5 \times 100}{12.6} = 11.9\%$$

$$\text{CV of body weight} = \frac{2.2 \times 100}{50} = 4.4\%$$

It is seen that the variation is greater for Hb level than for body weight of the same group.

Example 2: Example for one character in two groups. In two series of boys and girls of the same age of 20 years, following values were obtained for the height. Find which sex shows greater variation.

Sex	Mean height (cm)	SD (cm)
Boys	163.25	6.25
Girls	150.35	5.25

$$\text{CV of boys} = \frac{6.25}{163.25} \times 100 = 3.83\%$$

$$\text{CV of girls} = \frac{5.25}{150.35} \times 100 = 3.49\%$$

Thus, it is seen that the height in boys shows slightly greater variation than in girls being in the ratio of 3.83:3.49 = 1.1:1.0.

PROBABILITY

Probability means a chance factor for the occurrence of a specific event, e.g. chances of winning a lottery, chances of being selected, chances of getting a male child in the first pregnancy, etc. This chance factor is associated with uncertainty, because information in the happenings is not available. This uncertainty or mathematical quantity which depends upon the occurrence of the favorable or unfavorable event, is numerically expressed as 'probability'.

The probability of a particular event can be defined as the ratio of the number of favorable cases for the particular event to the total number of cases both favorable and unfavorable to the particular event.

For example, if the probability of a patient leaving the hospital against medical advice during a year's time is to be computed, then this will be the ratio of the number of patients (n) who left the hospital against medical advice during a year's time to the total number of patients (N) admitted to the hospital during that year.

$$\text{Formula} = P = \frac{n}{N} = \frac{\text{No. of favorable cases}}{\text{Total number of both favorable and unfavorable cases}}$$

Example: Suppose there are 100 students in a class, 90 boys and 10 girls, then the probability of a student chosen at random to be a girl is

$$= \frac{\text{No. of girls in the class (n)}}{\text{Total number of students (both boys and girls) N}} = \frac{10}{90+10}$$

$$= \frac{10}{100} = 0.1$$

The probability scale varies from the lowest value '0' (zero) to the highest value '1' (one). In other words if none of the cases are favorable, i.e when the numerator is zero, then the probability of the event will be zero. On the contrary, if all the cases are favorable for the event, then both the numerator (n) and the denominator (N) will be equal, then the probability of that event will be 1. As in the above example, if there are no girl students and all are boys, then the probability of a student to be a girl is zero and the probability of a student to be a boy is one. Thus, zero indicates no occurrence and one implies 100 percent certainty.

When there are only two complimentary events of occurrence, then the probability of one event will be equal to (1-probability of the other event).

As seen in the above example, the probability of selecting a boy at random.

$$= \frac{90}{100} = 0.9$$

$$= (1 - \text{probability of selecting a girl})$$

$$= (1 - 0.1)$$

The probability of an event becomes more and more consistent when the number of observations is increased.

Probability Distributions

The common distributions which help in calculation of probability are normal, binomial and poisson distributions.

Normal Distribution and Normal Curve

Normal distribution is a frequency distribution, in which a large number of observations of any variable biological characteristic such as Hb, Ht, Wt, pulse, BP, etc. are made with a small class interval. Such a distribution will have the following characteristics:

a. Half the measurements lie above the mean and half below.
b. Most of the measurements (observations) are concentrated around the mean.
c. All the observations are symmetrically distributed on each side of the mean; i.e. if they are arranged in an order, the highest frequencies will be seen in the middle around the mean and the lowest at the extremes, decreasing smoothly on both sides. This is called 'central tendency' or concentration of observations around the central value or mean.

Such distribution is called 'Normal distribution' or 'Gaussian distribution' and when plotted graphically it is called Normal curve or Gaussian curve, named after a famous mathematician and astronomer Karl Gauss **(Fig. 25.16)**. The term 'normal' is not used in medical sense. By 'normal' is meant usual and not 'not abnormal'.

The features of a normal curve are:

i. It is a smooth curve, resembling the shape of a bell.
ii. It is symmetrical about the middle point.
iii. The rim of the bell does not rest on the abscissa but is separated from it by a gap. That means the curve stretches from infinity to infinity.
iv. All the three measures of central tendency, i.e. mean, median and mode coincide, i.e. a perpendicular drawn

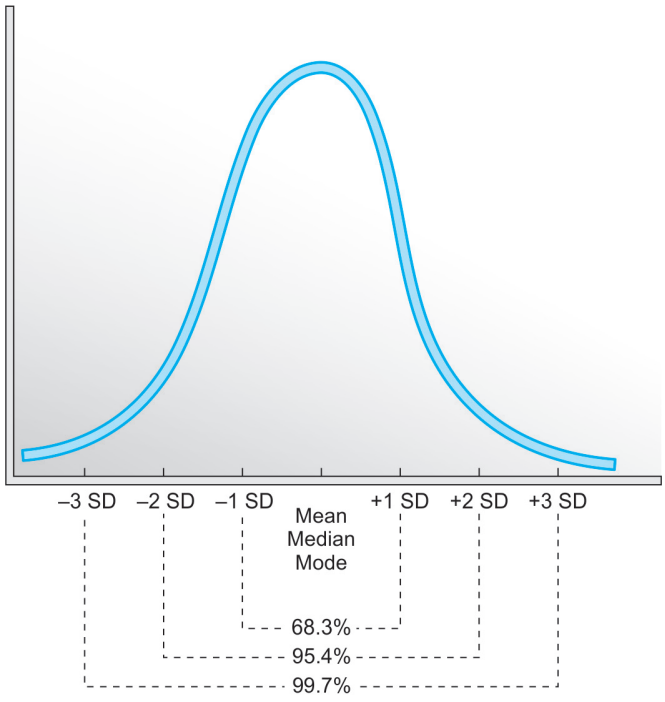


Fig. 25.16 Normal distribution curve

from the peak of the curve to the abscissa, that point on the abscissa is the mean, median and the mode. The mean divides the area under the curve into two equal halves.

v. Maximum number of observations are at the value of the variable corresponding to the mean and the number of observations on both sides of this value gradually decrease and there are few observations at the extreme points.

vi. The area under the curve is proportional to the frequency (i.e. 1).

vii. The area under the curve (number of observations) can be represented in terms of relationship between the mean and the standard deviation. The relationship is expressed as follows:
   a. Mean ± 1 SD includes 68.3 percent of (roughly (2/3rds) of all observations. 1/3rd of the values (34.13 percent) lie on either side of the mean.
   b. Mean ± 2 SD includes 95.4 percent of all observations.
   c. Mean ± 3 SD includes 99.7 percent of all observations.

   Thus, it is seen that almost all the values of observations will be within the range mean ± 3 SD and most of the values are within the range mean ± 2 SD. This relationship is useful for fixing the confidence intervals of the variates. The confidence interval is the limit up to ± 3SD on either side of the mean (i.e. the limits up to ± 3 SD on either side of the mean are called as 'Confidence limits').

viii. The distance of the value X from the mean ($\bar{x}$) of the curve in terms of standard deviation is called 'Relative deviate' or 'Standard Normal Variate' (SNV). It is expressed as a ratio between difference of a given observation and the mean and the standard deviation and is denoted by 'Z' and is calculated by the formula,

$$Z = \pm \frac{\text{Observation} - \text{mean}}{\text{SD}} = \pm \frac{x - \bar{x}}{\text{SD}}$$

   It gives the proportion of individuals who do not exceed this value in nature. If this ratio value is more than two, it is significant and if more than 3, it is considered as highly significant. It is based on the assumption that sample values are normally distributed. In case of small samples, instead of Z, 't' ratio is used.

ix. The properties of a normal distribution and a normal curve form the basis of various tests of significance.

x. Values larger and smaller than mean ± 3SD will be rare (less than 1%) in nature and those larger and smaller than mean ± 2 SD will occur less than 5 percent. In otherwords, suppose we say that the confidence limit is 99 percent, that means 99 percent of the values are distributed within the range of x ± 3 SD and the probability of occurrence of any value falling outside this range is only 1 percent (p = 0.01). Similarly, suppose we say that the confidence limit is 95 percent, that means 95 percent of the values are distributed within the range of x ± 2 SD and the probability of occurrence of any value falling outside or beyond this range is only 5 percent (p = 0.05).

The practical application of the above procedure is illustrated in the following example:

The mean height of 500 students is 160 cm and the SD is 5 cm.

a. What are the chances of heights above 175 cm being normal if height follows normal distribution?
b. What percentage of boys will have height above 168 cm.
c. What number of boys will have height between 168 and 175 cm.

a. First, the SNV is calculated for the given value of the variable.

$$\text{i.e. } Z = \frac{x - \bar{x}}{\text{SD}} = \frac{175 - 160}{5} = \frac{15}{5} = 3$$

To this calculated value 3, the probability level is noted by referring to the table of 'Unit Normal Distribution' (Annexure I) of chapter 25. This corresponds to 0.0013. When this probability value is multiplied by 100, gives the percentage population beyond the value of the variable. Thus only 0.0013 × 100 = 0.13 percent of students have chances of being taller than 175 cm.

b. $Z = \frac{168-160}{5} = \frac{8}{5} = 1.6$

This corresponds to 0.0548 as per the table of 'Unit Normal Distribution'. Thus, the percentage of boys having height above 168 cm will be = 0.0548 × 100 = 5.48 percent

c. The number boys having height above 168 and below 175 cm will be 0.0548 – 0.0013 = 0.0535 out of 1. Thus only 5.35 percent of students will have height within the range of 168-175 cm.

Binomial Distribution

When the population under observation can be divided into two distinct groups, one with a certain characteristic of observation and the rest without this characteristic, the distribution of the occurrence of the characteristic in the population is called as 'Binomial distribution'.

For example, suppose it is required to define the distribution of prevalence of certain disease, then the entire population can be divided into two groups, one with the disease and the other without the disease. If the probability of a person having the disease is 'p' and not having the disease is 'q' (i.e. 1 – p) then the distribution of various probabilities, i.e. the probability of finding name, one, two, three, four ..... Persons with the disease in a group of 'n' persons is given by the successive terms of the binomial distribution $(q + p)^n$. (If the sample is divided into multiple classes like blood group A, B, AB and O groups, that sample is called 'multinomial').

Mean Features of the Binomial Distribution

i. Mean number of frequencies with the characteristic is given by 'np', where 'n' is the number of observations and 'p' is the probability of occurrence of the characteristics.
ii. Standard deviation is npq, where q = 1 – p.
iii. If 'p' and 'q' are equal, i.e. each equal to 0.5, the curve will be symmetrical.
iv. If 'p' and 'q' are not equal, then the curve will be skewed (asymmetrical).
v. For any fixed value of 'p' and 'q', if 'n' is increased to a sufficiently large quantity, binomial distribution becomes more symmetrical and tends to be normal distribution.

Poisson Distribution

If in a binomial distribution, the value of 'p' or 'q' becomes indefinitely small and 'n' the number of observations becomes very large, so that the product 'np', the mean number of events is always finite, then the binomial distribution tends to be 'Poisson distribution'. Here, the occurrence of an event at any point of time is independent of previous event.

The main features of poisson distribution are:

- Mean = m
- Variance = mean = m
- Standard deviation = m
- The distribution can be defined in terms of the mean only.

Skewed Distribution

When the frequency distribution or a frequency curve is not symmetrical about the peak, it is said to be 'skewed' (asymmetrical). In other words, one tail of the curve will be longer than the other. This skewness can be either to the right or to the left of the peak **(Figs 25.17 and 25.18)**.

A relative measure of the skewness as given by Karl Pearson is:

$$\text{Skewness} = \frac{3(\bar{x} - \text{med})}{s}$$

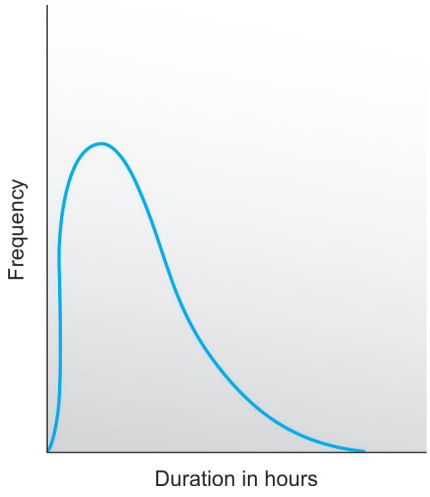


Fig. 25.17 Asymmetrical distribution of duration of labor (1st child) showing skewing to the right

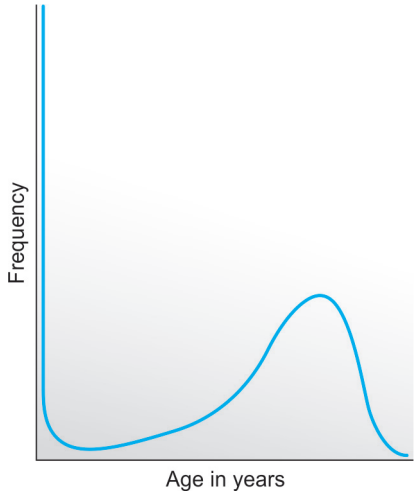


Fig. 25.18 Asymmetrical distribution of deaths according to age showing two modes or peaks in infancy and old age

Where $\bar{x}$ = mean
Med = median
and s = SD of the distribution.

When this calculated quantity is positive, it indicates that the skewness is to the right and when negative, it indicates skewness to the left.

SAMPLING

Common terms used: population; sample. The word 'population' or 'universe' means an aggregate of all 'elementary units', each unit may be animate or inanimate, about which an information is required.

Universe or whole population may be 'finite' (e.g. 100 kgs of rice in a sack or all the inhabitants of a city) or it may be 'infinite' (e.g. stars in the sky, etc.). Universe may be 'homogeneous' i.e. made up of uniform class (e.g. polished rice in a sack; all Hindu women of reproductive age in the city, etc.) or it may be 'heterogeneous', made of dissimilar classes of persons or animals or objects.

It is not possible for any scientific study to cover the whole population because of the cost, time and practicability. So a representative portion of the universe is taken for the study. It is called a 'Sample', e.g. a handful of rice from a sack of 100 kg rice, a group of people attending a public meeting, etc. The observations made out of a representative sample is then applied to the universe at large, but generalization is valid, only if the sample is sufficiently large and representative.

Sampling is a procedure, adopted for selection of a representative units of the universe units. The sampling procedure can be adopted with the help of 'Sampling frame', which consists of a list of 'enumeration units'.

When the investigation is carried out for the entire population it is called the 'Census enumeration' and when it is carried out for the sample, it is called 'Sample enumeration'.

Suppose a sample is selected by selecting only those units of the population, so that it suits a specific purpose as per the desire of the investigator, it is called as 'Purposive sampling'. This method serves only a limited purpose. Suppose a sample is selected in such a way that the characteristic of the population is represented, it is called as 'Representative sampling'.

Characteristics of a Representative Sample

- It is selected by a sampling technique from the universe or population it represents.
- Usually it does not differ from the universe in composition. If it differs, it is solely by chance.
- Each member of the universe from which it is taken has an equal opportunity of being selected.
- Bias has been ruled out and the sample will give an estimate of the attribute under study, almost equal to the population value called 'true value'.
- It is chosen according to a rule that is independent of the observations to be made on the sample.
- Sample should be sufficiently large in size to represent population from which it is drawn.

Census Enumeration v/s Sampling Enumeration

Census enumeration	Sampling enumeration
Investigation is carried out for the entire population (all units)	Investigation is carried out only for a sample
Useful when detailed information is required	Useful when overall information is required
Organization is costly and consumes more time	Organization is cheap and consumes less time
Greater attention cannot be paid for each unit because of the vastness of the population	Greater attention can be paid for each unit because of relative smallness of the sample
Difficult to achieve a complete and accurate study	Easy to achieve a complete and accurate study
Requires more personnel for study	Requires less personnel for study

Sampling Designs (Sampling Methods; Sampling Techniques)

Types of Sampling Techniques

The methods (techniques) of sampling may be classified into 2 categories, namely probability and nonprobability sampling methods, based on the concept of random selection or nonrandom selection (deliberate selection).

1. Probability sampling methods (Random sampling methods)
   a. Simple random methods (Unrestricted random sampling)
   b. Systematic random sampling
   c. Stratified random sampling
   d. Multistage random sampling
   e. Cluster random sampling
   f. Multiphase random sampling
2. Nonprobability sampling methods
   a. Accidental or incidental sampling
   b. Judgement sampling or purposive sampling or deliberate sampling

c. Quota sampling
d. Convenience sampling
e. Sequential sampling.

Simple Random Sampling

The principle in this method is that every unit of population has an equal chance of being selected. Random sampling can be easily done by using 'Tippets Random Number Table' (Annexure-II) of chapter 25. This method is also called as 'Unrestricted random sampling'.

This method is fairly applicable when the population is small, homogeneous and readily available such as a village, a household or an individual in a community or patients coming to hospital or lying in the wards.

Example: To select a random sampling of 25 students (n) from a class of 75 students (N).

Procedure

- Unit of selection is decided, i.e. a student. All the 75 students are arranged in an order say in the alphabeticals order of their names and they are numbered from 1 to 75. This is known as the 'Sampling frame'.
- Twenty units from the serial numbers are obtained as detailed below, by referring Tippets Random Number Table, which has 50 columns of single digit numbers, in each table. Out of these a row and a column are selected at random. Say the 8th row and 6th column core selected. The number corresponding to the crossing of this row and column is 6.
- The total population size is two digits, i.e. 75 and hence two adjacent columns are to be clubbed together, i.e. 6th and 7th columns are clubbed together and is read as two digit numbers, which becomes the starting number. In the table it corresponds to 61 (If total units are 3 digits, three columns are clubbed together).
- Starting from this number 61, the numbers in the list are read downwards. All the numbers less than or equal to 75 are noted down.
- When the last row of these columns is reached, then the corresponding number of next two columns, i.e. 8 and 9 are taken and the procedure is continued till 25 unduplicated numbers (the desired sample) are obtained (all the duplicated numbers are deleted).
- The numbers so read are:
  61, 62, 02, 31, 51, 11, 56, 64, 21, 01, 16, 39
  06, 38, 26, 34, 08, 65, 22, 52, 07, 29, 30, 14 and 18.
  These units constitute the sample.

Another way of drawing the sample is by noting the serial numbers of students on 75 cards and shuffled them well. One card is drawn out and the number is noted. The card is replaced, reshuffled and second card is drawn. The process is repeated till 25 numbers are drawn. The card drawn for the second time is rejected. The 25 students bearing the card-number constitute the sample. Similar procedure is followed to select the control group in Case-Control study.

If the Table of Random Numbers is not available, currency notes can be used. The numbers printed on them are considered. Depending upon the number of digits of the universe or population (two digits in the above example 75) first two, or middle two or last two digit numbers are recorded. The subjects (units) having the corresponding numbers are included in the sample.

Grid system: This system is employed for selecting samples of an area. For that, first an area map is prepared. Then a screen with squares is placed upon the map and the areas falling within the selected squares are taken up as samples.

Systematic Sampling (Systematic Random Sampling)

This method is preferred when the population (universe) is large, scattered and not homogeneous such as number of houses in a village or town. No prenumbering is necessary as in random sampling.

As in the above example of drawing 25 (n) out of 75 (N), 'N' is divided by 'n' to get a quotient 'r' (75 ÷ 25 = 3). Then one unit of N is selected at random and the other units are subsequently selected by the addition of this quotient 'r' to the previous selected number. Since 'r' being 3, any one number (unit) is drawn between 1 and 3, say 2, then the sample will be made up of students with numbers 2, 2+3 (5), 5+3 (8), 8+3 (11), and so on. This quotient 'r' is known as 'Sampling interval'.

Suppose there are 210 villages in a community development block and 40 villages are desired to be selected, then N/n = 210/40 = quotient is 5, remainder is 10. Then a random number is selected out of 10, say 6, which becomes the first number. Then the quotient 5 is added to 6 and so 11 will be the second number. Again 5 is added to 11, so 16 becomes the third number and so on.

Hence, the serial numbers of the villages to be selected will be 6, 11, 16, 21, 26, 31 ..... so on up to 40 numbers.

Stratified Random Sampling

In this method, the entire population (universe) is divided into certain homogeneous sub-groups (or strata) depending upon the characteristics to be studied (the basis for status stratification being age-group, sex-group, area-wise, socio-economic status, etc.) and simple random sampling is drawn independently from each sub-group or strata. This technique gives more representative sampling than a simple random sampling in a given large population.

This type of sampling is used when the population is heterogeneous with regard to the characteristic under study or when the characteristic is influenced by the different sections of the universe. As an example, if it is known that the

prevalence of a particular disease is different in different age group, the population (universe) is stratified into different sub-groups as children, adults and old persons and samples are drawn from each strata; the number of people in each age group may not be equal in the population.

By this type of sampling, the precision of the estimate of the characteristic under study is increased and also due representation of the population is maintained. Another advantage is that the estimate of the characteristics under study can be made for each strata separately. It also ensures that all strata are adequately represented.

Multistage Sampling

As the name implies this method consists of sampling procedure carried out in several stages, using random sampling techniques.

This is convenient when the population of entire district (or state or country) is to be studied, within limited resources. To bring down the cost involvement the size of the sample is reduced progressively in stages, till a conveniently representative sample is obtained.

First random numbers of districts are chosen from the states. Then random numbers of *talukas* are chosen. Followed successively by villages and houses.

Example for hookworm survey in a district, 10 percent of *talukas* are chosen, followed by 10 percent of villages. Then all persons in 10th house is subjected for stool examination.

Advantages

- This method introduces flexibility in sampling, a feature lacking in other techniques
- It enables the use of existing divisions and sub-divisions and thus saves the extra labor involved in independent enumeration or census.
- It permits available resources to be concentrated on a limited number of units of the frame, which results in a lower cost per unit of the enquiry and in preparing a complete sampling frame.

Disadvantages

- Sampling error is usually increased.
- Sampling units will be of unequal size at various stage, resulting in analytical difficulties.

Cluster Sampling

In this case the enumeration (sampling) units are not individuals but clusters such as families in a village, villages in a district, schools and wards of a city, etc. A sample of clusters proportionate to their size is randomly drawn. Either every one in the sample is studied or only a certain number of subjects with specified age or age-group is examined.

Cluster sampling is employed for carrying out evaluation survey of immunization coverage. In addition, it is used when the list of sampling units is not available.

Point or Line Sampling

On the map or aerial photograph of the area to be studied random horizontal and vertical lines are drawn. The points where these lines intersect are included in the sample. People at these points are examined.

Biased Sampling

Following are the convenient method but not correct method of sampling.

- *Alphabetic sampling:* This consists of a sample of persons whose name begins with a particular alphabet.
- *Chunk (opportunistic) sampling:* This consists of a group of persons attending a cinema show or public hall or found at the market place, etc.
- *Volunteers:* It consists of those volunteers who have come for examination following an advertisement in a paper.

Multiphase Sampling

In this method, study is carried out in several phases. Suppose a cross sectional study on nutrition has to be carried out, all the families in the original sample is covered for KAP study (Knowledge, Attitude and Practice) in the first phase. A sub-sample of the families is then surveyed for dietary intake in the second phase. Then a sub-sample of the family members covered in the second phase, are subjected to anthropometric examination in the third phase. A further sub-sample of the members covered in the third phase are subjected to biochemical examinations the nutrients in the fourth phase. Thus in multiphasic sampling the number of subjects/units gets reduced in every succeeding phase, thereby reducing the magnitude of the complicated and costly procedure reserved for the last phase. Thus multiphasic sampling procedure makes the studies less expensive, less time consuming, less laborious and more purposeful.

Nonprobability Sampling

- *Accidental or incidental sampling:* This consists of selecting a group of people among those who have assembled in one place with a common interest.
  For example, suppose diabetic survey has to be done among the people above 40 years of age by doing urine test, we have to go to a place, where people having common interest have assembled, to see football or cricket match. This is called as 'Chunk or Opportunistic' Sampling.
- *Judgement sampling (Purposive or deliberate sampling):* In this method, the sample selection depends upon the judgement of the person, who is entrusted with the job, which in turn depends upon his knowledge and attitude.
- *Quota sampling:* This is a stratified random sampling minus randomization. For example, suppose, in a town, there are 50 percent farmers, 25 percent small businessmen and 25 percent workers and a sample of this has to be drawn, that sample should have the same percentages of these groups. But randomization is not done.

- *Convenient sampling:* In this method, the sample is obtained from an available source like that of telephone directory, automobile registers, stock exchange directory, etc. conveniently.
- *Sequential sampling:* In this method, number of sample lots are drawn one after another from an universe depending upon the results of earlier samples. So this is used as quality control.

Size of the Sample

Always an optimum size of the sample, has to be considered, keeping in view of the time, cost and the feasibility of the study.

The estimation of the sample size involves the following factors:

- The approximate idea of the estimate of the characteristic under observation is required and that is obtained either from previous studies or from pilot study.
- The maximum permissible error that can be allowed should be decided in advance. If the error is large, then a small sample will serve the purpose and vice versa.
- The probability level, with which the desired precision of the estimate is maintained, is also taken into consideration for fixing the sample size. Higher this probability, bigger should be the sample size.
- Availability of the resources such as men, money and material also determine the size of the sample.

Calculation of Sample Size for Qualitative Data

In a field survey to estimate the prevalence of a particular disease, the sample size is calculated by the formula,

$$n = \frac{4pq}{L^2}$$

Where,
n = Required sample size
p = Approximate prevalence rate of the disease obtained from previous studies or from pilot study
q = 1 – p
L = Permissible error in the estimate of 'p'

The above formula has been worked out for a probability level of p = 0.05 (i.e. the prevalence rate will have 5 percent error or 95 percent correct value) in the sample size.

Example: To estimate the prevalence rate of ascariasis in a community, where it is approximately known to be 40 percent, then the required sample size to estimate the morbidity (ascariasis) with 5 percent error with a probability of 0.05, is calculated as follows:

$$n = \frac{4pq}{L^2}$$

Where,
p = 40%
q = 1 – p = 100 – 40 = 60%
L = Permissible error

$$L = 5\% \text{ of } 40 = \frac{5}{100} \times 40 = 2$$

$$= \frac{4 \times 40 \times 60}{(2)^2} = 2400$$

Ans. 2400 persons are to be examined to estimate the prevalence rate of ascariasis with 5 percent error.

Suppose the error of percentages is increased to 10 percent, then the sample size would be

$$n = \frac{4 \times 40 \times 60}{4 \times 4} = 600$$

$$L = \frac{10}{100} \times 40 = 4$$

For Quantitative Data

The sample size is calculated by the formula

$$n = \frac{t^2\alpha \times s^2}{e^2}$$

Where,
n = Desired sample size
s = Standard deviation of observation
e = Permissible error in the estimation of mean
tα = Value of 't' at 5 percent level from 't' tables.

Example: (a) In a community survey to estimate the hemoglobin level, from the data already available if it is known that the mean Hb percent level is about 12 g percent with a standard deviation of 1.5 g percent then the sample size required to estimate the Hb level with a permissible error of 0.5 g percent on either side is obtained as follows.
s = 1.5 g
e = 0.5 g
$t_{0.05}$ can be taken as 2 (for 1.96; Annexure-III of Chapter 25) as it is conventional to use 5 percent level of significance.

$$n = \frac{2^2 \times (1.5)^2}{(0.5)^2} = \frac{4 \times 2.25}{0.25} = 36 \text{ persons}$$

In clinical trials usually there will be two groups, one experimental and the other control group. In order to

estimate the size of the sample for each group, the difference in the response rates of the two groups is to be taken into consideration and the sample size is estimated from the following formula.

$$n = \frac{2t^2\alpha \times s^2}{d^2}$$

Where,
n = Required sample size for each group
s = Pooled SD of the observation of the two groups
d = Anticipated smallest difference in the estimates for the two groups
tα = Usually taken as 't' at 5 percent level.

Example: An investigator wants to estimate the increase in Hb percent level in anemia cases by administration of a particular drug compared against a known drug. The minimum number of cases in each group to be investigated is calculated as follows:
Suppose d = the smallest anticipated difference in the rise of Hb percent level between the two groups = 2 percent
s = the pooled SD = 3.0 g
t at 5 percent level is taken as 2.

$$n = \frac{2 \times (2)^2 \times (3.0)^2}{(2)^2} = \frac{8 \times 9}{4} = 18 \text{ persons}$$

i.e. 18 persons are to be included in each group.

Errors in Sampling

They are of 2 types—Sampling errors and non-sampling errors.

Sampling Errors

These are due to:
- Faulty sampling method
- Small size of the sample

These errors can be minimized through proper sampling method.

Nonsampling Errors

These are as follows:
a. *Coverage error:* This occurs when all the units in the sample are not covered either due to noncooperation or due to lost to follow-up. This can be reduced by an intensive effort to get complete coverage.
b. *Observational (or experimental) error:* This is due to interviewers bias or due to lack of training. This can be reduced by setting up standards of interview or proper training of the workers.
c. *Processing errors:* This is due to clerical mistake or computational error, which can be reduced by administrative control.

SAMPLING VARIATION

If two or more samples are drawn from the same universe (population), their means (m_1, m_2, m_3.....) may not be equal but will show variation, eventhough they are from the same universe. Such a difference between the means of the different samples, is known as 'Sampling variation.'

The mean of the sample-means (i.e. grand mean) however will be approximately equal to the mean (M) of the universe.

The variation between the sample mean and the universal mean (m_1 and M; m_2 and M and m_3 and M) is known as 'Inherent Sampling Variation.'

The sampling variation, from one sample mean to another, may be by chance, when it is called 'Natural or Biological variability' or due to play of certain factors, when it is called 'Real variability' (e.g. effect of nutrition, vaccine, smoking, etc. Heights and weights in England is more than that in India because of good nutrition; Attacks among vaccinated is lesser than that among unvaccinated; incidence of cancer is more among smokers than among non-smokers, etc.).

Standard Error of the Mean

The means of the samples (m_1, m_2, m_3, etc.) show dispersion around the population mean (M) (or universe mean) symmetrically as in Normal distribution with a central tendency and with a definite standard deviation. The variation in the sample means is measured in terms of a parameter called 'Standard error', which in fact is not an error but is a standard deviation of sample means (or proportions) from that of the universe or population mean (M). This standard deviation of the sample mean with that of the population mean, is called the 'Standard error of the mean', denoted as SE $\bar{x}$ or simply the standard error (SE).

SE defines the limits of variation that occurs mainly due to chance. Variation beyond these limits is significant and is probably due to play of some external factors.

Similarly, the standard error of a proportion gives the standard deviation of proportions of several samples of a qualitative data taken from the same population and is denoted as SEP.

The standard error can be reduced by increasing the size of the sample. To illustrate, if the average number of attacks of diarrhea per child per year is 4 in a particular area, we will not necessarily get an average of 4 per child in a sample of children from an hygienic area, where it may be only 2 per child or from an unhygienic area where it may be 6 per child. These variations in samples are inherent. If we take a very large sample of children from the three areas, included almost equally, the average attacks per child will be more or less 4 per year. Thus by increasing the size of the sample, the variations can be reduced and vice-versa.

On the other-hand, if the variations in means is large, such as 10 attacks in one example and 30 and 40 in others, the standard error will be increased. Thus the SE depends upon 2 factors.

- Standard deviation of the sample, which measures the variability of the observations (i.e. SD of the means)
- Size of the sample (n).

Thus, standard error can be calculated by the formula:

$$SE = \frac{SD}{\sqrt{n}}$$

Thus, it is clear that SE varies inversely with the root of the sample size (n) and directly proportional to the SD of the means.

Since the distribution of the means, follows the pattern of normal distribution **(See Fig. 25.16)**, it is not difficult to visualize that 95 percent of the sample means will lie within the limits of two standard error [Population mean M ± 2SE or $M \pm 2\frac{SD}{\sqrt{n}}$] on either side of the population mean (M). Therefore, the chance that the population mean (M) lies between the limits defined by sample mean ± 2SE is also 95 percent. This is referred to as 95 percent 'Confidence limits' (or Confidence interval) **(Fig. 25.19)**. The confidence of the limits is increased to 99 percent by increasing the number of standard errors to ± 3SE.

In otherwords 95 percent confidence limits or interval which cover the range, mean ± 2SE, includes 95 percent of sample values in normal distribution. Any value lying outside this range will be rare. Its probability of occurrence (p value) by chance will be only 5 percent, i.e. 0.05 or 1 in 20.

Similarly, 99 percent confidence limits or interval cover the range mean ± 3SE, include 99 percent of sample values. The probability (chance) of any value falling outside the range is 1 percent or 0.01.

Significance

'Significance' is opposite of 'chance'. If the (m) mean of one sample differs from that of another sample or of the universe (M) by more than two times the SE (2SE), i.e. lying outside the 95 percent confidence limits, the difference is said to be 'Statistically Significant' at 5 percent level (probably due to play of some external factors and not due to chance) (i.e. p value lesser than 0.05) **(Fig. 25.19)**.

A value lying outside 3SE or 99 percent confidence limits is very rare and the difference is considered to be 'highly significant' (P value lesser than 0.01) at 1 percent level.

This level of significance is expressed as 'p' value (i.e. probability value). If the p value is less than 0.05 (or 5%) it is said to be significant and if less than 0.01 (1%) it is highly significant. 5 percent level of significance is also called as 'Critical level of significance'.

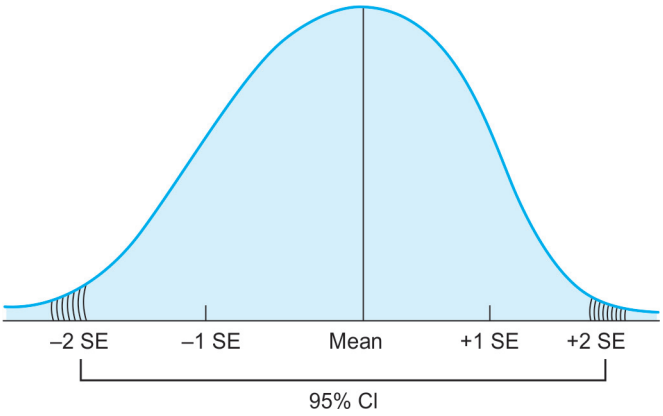


Fig. 25.19 Normal curve showing 95% confidence limits. The shaded areas indicate values that fall beyond these limits on either side

Thus, the 'p' value denotes whether the difference in the sample estimates (sampling variation) is due to chance or due to an external (reality) factor.

To illustrate, suppose on weighing 100 mangoes individually and found that 95 percent of them weigh between 435 g and 565 g, we can say that 101st mango has 5 percent chance of weighing either lesser than 435 g or more than 565 g, in either case it means that the mango has lost or achieved a 'significance weight', because that weight is lying beyond 95 percent confidence limits (beyond 2SE). If it is beyond 99 percent confidence limits (beyond 3SE) it is considered 'highly significant'.

NULL HYPOTHESIS (DENOTED AS H_0)

The techniques to know how far the differences between the estimates of different samples are due to sampling variation is known as the 'testing of hypothesis'. This can be worked out by several methods.

The first step in testing of hypothesis (e.g. smoking resulting in cancer, drug resulting in cure of a disease or a vaccine resulting in protection, etc.) is 'Null hypothesis' (H_0) i.e. to study the effect of an external factor (smoking, drug, vaccine) on man in health and disease.

Assumption is made that the external factor plays no role. Such an assumption is called 'Null hypothesis'. Smoking has no relation with lung cancer. Similarly, there is no difference between two drugs or vaccines. Then proceeded to test the hypothesis (e.g. smoking results in lung cancer) in quantitative terms. In such studies 2 groups or samples called experimental group (smokers) and control group (nonsmokers, taken for comparison) are taken. After the period of observation, or at the end of the experiment, the values (proportions or means)

of the two samples or groups, are noted. If the difference between the samples is more than twice the standard error so that the probability of chance occurrence is less than 5 times in 100 experiments, the null hypothesis (of no difference between two drugs or no relation between smoking and lung cancer) is rejected and the hypothesis that 'smoking results in lung cancer' is accepted. That means if the 'p value' is less than 0.05, that means the difference is real (and not due to chance) and the factor under trial is considered to have definitive action on the experimental group. If the probability is more than 5 percent (p value more than 0.05) the null hypothesis is accepted. That means the diffence is by chance. Usually the level of significance (p value) is stated while accepting or rejecting the hypothesis.

In certain conditions the null hypothesis (H_0) is rejected though it should be accepted, when there is no significant difference, i.e. when the observation lies within 95 percent confidence limits. This is stated as 'Type 1 error'.

Similarly, in certain other conditions, the null hypothesis is accepted, though it should be rejected, when there is significant difference, i.e. when the observation lies beyond 95 percent confidence limits. This is stated as 'Type 2 error'.

By increasing the limit or level of significance to 99 percent, type 1 error is increased.

TESTS OF SIGNIFICANCE

These are the statistical tests or mathematical methods employed to measure the probability or chance of occurrence of biological variation, in samples by standard error. It defines the limits of variation by chance and determines the probability of the factor playing the role.

For example, suppose the mean weight gain in 100 children receiving a nutritional supplement was 2 kg after 9 months (increase in mean weight of 15–17 kgs) while the gain in the control group was 1 kg (increase of mean weight of 15–16 kg). Whether this difference of 1kg in weight gain is a chance occurrence of no significance or whether it is attributable to supplementary feeding has to be decided to establish the value of latter.

The test of significance will measure the probability (p value) of increase in weight by chance. If the p value is less than 5 times out of 100 ($p < 0.05$) the difference of wt gain of 1 kg, is significant statistically. That means the difference is due to nutritional supplement in more than 95 percent of such experiments. It is said to be significant at 5 percent level of significance. i.e. the difference occurs by chance in only one in twenty such trials.

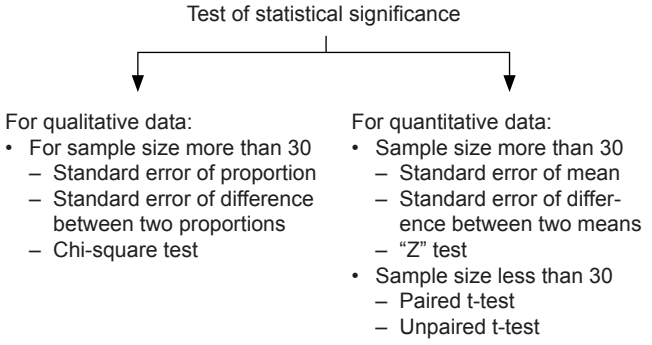
The difference is considered as highly significant, if the p value is less than 0.01.

General Procedures for Testing a Hypothesis

i. A 'Null hypothesis' (H_0), suitable to the problem is set up.
ii. An alternate hypothesis is defined if necessary.
iii. A suitable statistical test, using a relevant formula, is calculated.
iv. The degree of freedom is determined.
v. Then the probability level (p value) is found out, corresponding to the calculated value of the test and its degree of freedom. This can be found out from the tables.
vi. If the p value is less than 0.05, the Null hypothesis is rejected and if the p value is more than 0.05, null hypothesis is accepted.

The different tests employed are:

1. Standard error of the mean
2. Standard error of the difference between two means
3. Standard error of proportion
4. Standard error of difference between two proportions
5. 't' test
6. Chi-square test.



Standard Error of the Mean (SE $\bar{x}$)

Simply denoted as SE, is a parameter, used to measure the variation among the sample means (m_1, m_2, m_3, etc.) (i.e. sampling variation). SE is not an error, but it is the standard deviation of the sample means from the Population mean (M) (explained already). It helps to measure the chance variation or biological variation. [It helps to measure the chance difference between the sample mean (m) and the population mean (M)].

Uses of SE $\bar{x}$

- To find the confidence limits of population mean if standard deviation of the sample is known.
  Population mean (M) = Sample mean (m) ± 2 SE of mean (for 95% confidence limits).

- To tell whether a particular sample is drawn from the known population or not, if the population mean (M) is known. Here the characteristics of the normal curve are used. If the sample mean (m) ($\bar{x}$) lies within the range of M ± 2 SE $\bar{x}$. It is considered as belonging to the known population because 95 percent of the sample means lie within M ± 2 SE $\bar{x}$. If the sample mean is outside this range (beyond 95% confidence limits) then the sample is considered to be from some other population or it is under the influence of some other factor.
- To find the SE of difference between two means to know if the observed difference between the means of two samples is real and statistically significant or it is apparent and insignificant due to chance (i.e. to test the significant difference between two sample means).
- To calculate the size of the sample in order to have desired confidence limits, SD of the population is known, by the formula $SE\,\bar{x} = \frac{SD}{\sqrt{n}}$

Calculation of SE of the Mean

First the SD of means of samples is calculated, by squaring the summation of the difference between sample mean and population mean, by using the formula

$$SD = \sqrt{\frac{\sum(m-M)^2}{n}}$$

But in practice, the SD of means of all samples is not known because only one sample is drawn of which SD and mean are calculated, by the formula $\frac{SD}{\sqrt{n}}$, i.e. SD is divided by the square root of the number of observations.

Example: Mean and SD for the height of 50 boys were 150 and 7 cm respectively. Find SE of mean and 95 percent confidence limits of heights in nature. Could this sample be from the universe with a population mean (M) of 154 cm?

Mean height = 150 cm
SD = 7 cm
n = 50 boys

$$SE\,\bar{x} = \frac{SD}{\sqrt{n}} = \frac{7}{\sqrt{50}} = \frac{7}{7.07} = 0.98$$

95 percent confidence limits (or 2 SE range) in nature will be:

Mean height ± 2 SE
150 ± 2 × 0.98
= 150 + 1.96 = 151.96
and 150 – 1.96 = 148.04

This sample of 50 boys with a mean height of 150 cms is not drawn from the universe with a population mean of 154 cm, because 154 is much more than 95 percent of confidence limit of 151.96 cm.

$$\text{Relative deviate, } Z = \frac{\text{Observation} - \text{mean}}{SE\,\bar{x}}$$

$$= \frac{154-150}{0.98} = \frac{4}{0.98} = 4.08$$

4.08 is more than 4 times the SE.

Since this ratio is more than 3, (i.e. beyond 3 SD), it is considered to be highly significant, i.e. beyond 99 percent confidence limits. So the probability of this sample (with a mean ht of 150 cms) being drawn from the specified universe (with a mean height of 154 cm) is less than 1 percent ($p < 0.01$).

Standard Error of the Difference between Two Means

Denoted as SE ($\bar{x}_1 - \bar{x}_2$). Unlike the SE $\bar{x}$, which measures the chance difference between the sample mean and the population mean (m – M), standard error of the difference between two means (SEDM) measures the chance difference between the means of the two samples (a pair of samples) drawn from the same population.

Two samples (s_1 and s_2) are simultaneously drawn from the universe and their mean heights are recorded. The difference in these two means is noted ($\bar{x}_1 - \bar{x}_2$). It will be plus or minus few cms.

The samples are returned to the universe and two fresh samples (s_3 and s_4) are obtained, their means are calculated, the difference in their means will be ($\bar{x}_3 - \bar{x}_4$) plus or minus few cms. If the procedure is repeated again and again, the mean of the differences in the paired samples would be zero or nearly so.

Moreover, the differences in means of the different sets of twin samples will follow normal frequency distribution. The SD of these differences therefore will define the range within which 95 percent of differences in the means would lie. Such a SD is actually called 'Standard Error of Difference in Means (SEDM), (unlike SE $\bar{x}$ which is the SD of sample means).

In practice it is not possible to find differences of large number of samples and then find SE of these differences. The test is applied to one pair directly if standard deviations of two means are known.

If the observed difference between the two means is more than twice the SE of difference, it is significant at 95 percent confidence limits.

If the observed differences between the two means is greater than three times the SE of difference, it is significant at 99 percent confidence limits. It is real variability in more than 99 percent cases and the chance factor is less than 1 percent.

Apply relative deviate (Z) test for large samples and 't' test, for small samples, for correct estimation of chance limits,

because WS Gosset observed that the normal distribution gives biased results in case of small samples.

SE of difference between two means is denoted as SE $(\bar{x}_1 - \bar{x}_2)$. Mathematically it is the root of the sum of the squares of the standard error of two samples means.

It is already seen that the SE of a sample mean is equal to $\frac{SD}{\sqrt{n}}$.

$\therefore$ SEDM denoted as $S\bar{d} = \sqrt{(SE_1)^2 + (SE_2)^2}$

Substituting $SE = \frac{SD}{\sqrt{n}} = \frac{SD^2}{n}$, $S\bar{d} = \sqrt{\frac{(SD_1)^2}{n_1} + \frac{(SD_2)^2}{n_2}}$

Procedure

- Calculate the two means $\bar{x}_1$ and $\bar{x}_2$, corresponding to the two samples with samples sizes n_1 and n_2 respectively.
- Set up the null hypothesis that the two samples are from the same population and that the difference between the two sample estimates is due to sampling variation.
- Calculate the standard deviation of the two samples and their standard errors (SE1) and (SE2) respectively.
- Calculate the SEDM as $\sqrt{(SE_1)^2 + (SE_2)^2}$
- Calculate the quantity Z

$$= \frac{\text{Difference between sample estimates}}{\text{SE of difference}}$$

- Refer to normal distribution table and corresponding to this calculated value of Z, find the value of probability 'p'.
- If the p value is less than 0.05, (or Z value is > 2 SE) reject the null hypothesis and conclude that the difference between two sample estimates as significant. If the Z value is > 3 SE, ($p < 0.01$) it is highly significant.

If the p value is greater than 0.05, accept the null hypothesis and conclude that the difference between the two sample estimates as insignificant.

Example 1: In a study on growth of children, one group of 100 children had a mean height of 60 cms and SD of 2.5 cm, while another group of 150 children had a mean height of 62 cm and SD of 3 cm. Is the difference between the means statistically significant?

$$\text{SEDM} = \sqrt{(SE_1)^2 + (SE_2)^2}$$

$$= \sqrt{\frac{(SD_1)^2}{n_1} + \frac{(SD_2)^2}{n_2}}$$

$$= \sqrt{\frac{(2.5)^2}{100} + \frac{(3)^2}{150}}$$

$$= \sqrt{\frac{6.25}{100} + \frac{9}{150}}$$

$$= \sqrt{0.06 + 0.06}$$

$$= \sqrt{0.12}$$

$$= 0.35$$

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{SE(\bar{x}_1 - \bar{x}_2)} = \frac{60 - 62}{0.35} = \frac{2}{0.35} = 5.71$$

Since the observed difference is more than 3 times the SE, it is highly significant ($p < 0.01$). The growth is more in the second group than in the first.

Example 2: Pregnant women attending an anganwadi and receiving nutritional supplementation numbering 49 were matched with 64 pregnant women not attending anganwadi and not getting the supplementation. Both groups were followed up. The mean birth-weight of babies born to the former was 3.5 kg with SD 1.4 kg and that of those born to the latter, 3.0 kg with SD 1.6 kg. Is the higher birth weight in the former due to the nutrition supplementation ?

First, the SE of mean for each of the group is calculated as follows:

$$\text{SEDM} = \sqrt{(SE_1)^2 + (SE_2)^2}$$

$$= \sqrt{\frac{(SD_1)^2}{n_1} + \frac{(SD_2)^2}{n_2}}$$

$$= \sqrt{\frac{(1.4)^2}{49} + \frac{(1.6)^2}{64}}$$

$$= \sqrt{\frac{1.96}{49} + \frac{2.56}{64}}$$

$$= \sqrt{0.04 + 0.04}$$

$$= \sqrt{0.08}$$

$$= 0.28$$

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{SE(\bar{x}_1 - \bar{x}_2)} = \frac{3.5 - 3.0}{0.28} = \frac{0.5}{0.28} = 1.78$$

Since the observed difference is less than 2 times the SE, (within 95% confidence limits) it is not significant. That means the difference in mean birth weight is due to chance and not due to nutritional supplementation.

Standard Error of Proportion

The SEM and SEDM are the tests of significance of variation in means of samples (more than 30) of quantitative data. The standard error of proportion (SEP) and the Standard Error of Difference between two proportions (SEDP) are the tests of significance of variation in proportions of samples of qualitative data (more than 30).

In qualitative data, the character remains the same while the frequency variations are dealt with.

If a sample consist of characters of two attributes (positive and negative) only, such as male and female, rich and poor, vaccinated and non-vaccinated, died and survived, successes and failures, etc. it is a sample of binomial classification and if the division of the sample is made into more than two classes such as blood groups A, B, AB and O or WBCs into polymorphs, lymphocytes, eosinophils, etc. the sample is of multinomial classification.

The proportion of individuals, having a specific character or attribute, in a binomial distribution, is expressed as 'p', either as a fraction of 1 or as percentage.

$$p = \frac{\text{Number of individuals having a specific character}}{\text{Total number in the sample}}$$

The remaining proportion of individuals having the other (negative) character, is represented as 'q'.

Arithmatically, q = 1 – p in terms of fraction of 1 or 100 – p in percentage.

Thus, 'p' is the probability of occurrence of a positive attribute and 'q' is the probability of occurrence of the negative attribute (or non-occurrence of the same positive attribute).

To illustrate, suppose there are 80 girls in a class of 200 strength, the proportion of girls and boys, is estimated as follows:

Proportion of girls (p) = $\frac{80}{200}$ = 0.4 out of 1 in the sample

Proportion of boys (q) = $\frac{200-80}{200} = \frac{120}{200}$ = 0.6 out of 1

or q = 1 – p
= 1 – 0.4
= 0.6

For statistical analysis, the proportion of girls (p) and boys (q) are expressed in percentage as below:

$p = \frac{80 \times 100}{200}$ = 40% girls

q = 100 – p = 100 – 40 = 60% boys in the example.

Suppose from the universe (population), multiple samples are drawn, the value of the particular characteristic (otherwise called as proportion) in each sample is represented as 'p' (just like the sample mean, $\bar{x}$), the proportion of the samples (p_1, p_2, p_3 ....., etc.) have a tendency to concentrate around the proportion of the universe or population, represented as 'P' (just like the sample means m_1, m_2, m_3, i.e. $\bar{x}_1$, $\bar{x}_2$, $\bar{x}_3$, ..., etc. have central tendency around population mean M).

The sample proportions are symmetrically distributed around the population proportion, from which the samples are drawn, i.e. it gains the shape of a normal curve.

This distribution of the sample values (proportions) around the population proportion (P), is expressed arithmetically interms 'Standard Error of proportions' (SEP). In otherwords, SEP is the standard deviation of the sample proportions (just like SEM is the SD of the sample means).

The binomial confidence limits are as follows.

- 68 percent of sample proportions will lie within the range P ± 1SE of proportion.
- 95 percent of values lie within the range of P ± 2SEp. (95 percent confidence limits).
- 99 percent of values lie within the range of P ± 3SEp. (99% confidence limits).

Standard Error of Proportion is defined as a measure of variation occurring by chance between the sample proportion (p) and the population proportion (P) in a qualitative data.

This test of significance is employed to find the efficacy of a drug or a vaccine or a surgical procedure, etc. To illustrate, if 35 percent cases died in previous epidemic and 30 percent in the present epidemic, whether this reduction of 5 percent is due to better treatment or increased immunity or decrease virulence of the pathogen or by chance is determined by calculation of SE of proportion.

Formula:

$$SEP = \frac{p \times q}{n}$$

Where,
p = Percentage of positive character (proportion)
q = Percentage of negative character (100 – p)
n = Number of observations (size of the sample)

The significance of difference is found by relative deviate (Z) test.

$$Z = \frac{\text{Observed difference}}{SEP}$$

Example 1: The proportion of blood group A among Indians is 30 percent. Find SEP and the 95 percent confidence limits. Could this sample be from an universe, in which the prevalence of blood group A is 40 percent?

p = 30; q = 100 – 30; n = 100

$$SEP = \sqrt{\frac{p \times q}{n}} = \sqrt{\frac{30 \times 70}{100}} = \sqrt{21} = 4.58$$

95% confidence limits = p ± 2SE
= 30 + 2 × 4.58 = 30 – 2 × 4.58
= 30 + 9.16 = 30 – 9.16
= 39.16 = 20.84

Since the proportion 40 is outside the 95 percent confidence limits, we can say with 95 percent confidence that the sample is not drawn from the universe having 40 percent prevalence of blood group A.

Example 2: What size of the sample will you take for assessing diabetics in an urban population where the prevalence was given as 3 percent in age group above 15 years?

$$SEP = \sqrt{\frac{p \times q}{n}}$$

$$0.3 = \sqrt{\frac{3 \times 97}{n}}$$

For finding the suitable size of the sample, the assumption made is that SEP does not exceed 10 percent (or 1/10th) of the positive character, in a qualitative data.

$\therefore$ 1/10 of 3 = 0.3

$\therefore$ $(0.3)^2 = \frac{3 \times 97}{n}$ (sq. root is removed, n = sample size)

$\therefore$ $n = \frac{291}{0.3 \times 0.3} = \frac{291}{0.09} = 3233$ persons

Uses of Standard Error of Proportion

- Standard error of proportion (SEP) is used to find the confidence limits of population proportion (P) if sample proportion (p) is given.
- To tell whether the sample drawn from the known population or not.
- To find the standard error of difference between two proportions, to know if the observed difference between proportions of two samples is real and statistically significant or due to chance and insignificant.
- To find the size of the sample if SEP and the proportions are known.

Standard Error of Difference between two Proportions

The difference in the pairs of proportions of each set of twin samples drawn from the sample universe, follow normal distribution, so that their SD will be the yardstick to determine the range of the attribute, within which 95 percent of differences in proportions will lie.

Standard error of difference between two proportions (SEDP) measures the chance between the sample proportions of paired samples drawn from the same population or universe.

If the observed difference between the two sample proportions (p_1 and p_2) is more than twice the standard error of difference, it is significant at 95 percent confidence limits and if more than 3, it is significant at 99 percent confidence limits.

The significance of difference is found by relative deviate 'Z' test.

SEDP is calculated by the formula,

$$SE\ (p_1 - p_2) = \sqrt{\frac{p_1 q_1}{n_1} + \frac{p_2 q_2}{n_2}}$$

Where p_1 and p_2 are the estimates of the proportions of the two samples.

q_1 and q_2 = $(1 - p_1)$ and $(1 - p_2)$ respectively. (i.e. $100 - p_1$ and $100 - p_2$ in terms of %).

n_1 and n_2 = are the numbers of observations in the two samples.

$$Z = \frac{\text{Observed difference between two sample proportions}}{\text{SE of difference between two proportions}}$$

Then p value is found by referring to normal distribution table corresponding to Z value.

If the p value is less than 0.05, null hypothesis is rejected and concluded that the difference between two sample estimates is significant and vice-versa, i.e. if the p value is more than 0.05, the null-hypothesis is accepted and concluded that the difference between the sample estimates is insignificant.

Example 1: In an epidemic of gastroenteritis in an area, the number of cases reported in two populations consuming water from two different sources were as follows:

Source of water	No. of people consuming water from the source	No. of cases
Tap water	800	35
Hand pump water	2400	120
Total	3200	155

Find out whether the difference in the proportion of cases in the two groups is significant.

Ans: i. The null-hypothesis in this case is that the difference is insignificant.

ii. p_1 = Proportion of cases among tap water consumers
= 0.044 (i.e. 35 ÷ 800 = 0.044)
$q_1 = 1 - p_1 = 1 - 0.044 = 0.956$
n_1 = No. of tap water consumers = 800.

iii. Standard Error of proportion p_1 (SE_1)

$$= \sqrt{\frac{p_1 q_1}{n_1}} = \sqrt{\frac{0.044 \times 0.956}{800}}$$

$$= \sqrt{0.0000525}$$

$$= 0.0072$$

iv. p_2 = Proportion of cases amongst hand-pump water consumers
= (120 ÷ 2400) = 0.05
$q_2 = 1 - p_1 = 1 - 0.05 = 0.95$
n_2 = Number of hand-pump water consumers = 2400.

v. Standard error of proportion p_2 (SE_2)

$$= \sqrt{\frac{p_2q_2}{n_2}} = \sqrt{\frac{0.05 \times 0.95}{2400}}$$

$$= \sqrt{0.0000197}$$

$$= 0.0044$$

vi. Difference between two proportions = $P_1 - P_2$

$$= 0.044 - 0.05$$

$$= 0.050 - 0.044$$

$$= 0.006$$

vii. Standard error of difference

$$= \sqrt{(SE_1)^2 + (SE_2)^2}$$

$$= \sqrt{0.0000525 + 0.0000197}$$

$$= \sqrt{0.0000722}$$

$$= 0.0085$$

viii. $$Z = \frac{\text{Difference between the proportions}}{\text{Standard error of difference}}$$

$$= \frac{0.006}{0.0085}$$

$$= 0.706$$

ix. From the normal distribution table, 'P' corresponding to this value is more than 0.48 (or the 'Z' value is less than 2), the null hypothesis is not rejected and it is concluded that the difference is insignificant.

Example 2: If typhoid mortality in one sample of 100 is 20 percent and in another sample of 100, it is 30 percent, find the standard error of difference between two proportions by both the methods. Is the difference in mortality rates significant?

Formula A:

$p_1 = 20, q_1 = 100 - 20 = 80, n_1 = 100$
$p_2 = 30, q_2 = 100 - 30 = 70, n_2 = 100$

$$SE(p_1 - p_2) = \sqrt{\frac{p_1q_1}{n_1} + \frac{p_2q_2}{n_2}}$$

$$= \sqrt{\frac{20 \times 80}{100} + \frac{30 \times 70}{100}}$$

$$= \sqrt{16 + 21}$$

$$= \sqrt{37}$$

$$= 6.08$$

Formula B:

$$P = \frac{p_1 + p_2}{n_1 + n_2} \times 100$$

$$= \frac{20 + 30}{100 + 100} \times 100$$

$$= \frac{50 \times 100}{200}$$

$$= 25\%$$

$$Q = \frac{q_1 + q_2}{n_1 + n_2} \times 100$$

$$= \frac{80 + 70}{100 + 100} \times 100$$

$$= \frac{150 \times 100}{200}$$

$$= 75\%$$

$$SE(p_1 - p_2) = \sqrt{P \times Q\left(\frac{1}{100} + \frac{1}{100}\right)}$$

$$= \sqrt{25 \times 75\left(\frac{2}{100}\right)}$$

$$= \sqrt{\frac{25 \times 75 \times 2}{100}}$$

$$= \sqrt{\frac{75}{2}} = \sqrt{37.5} = 6.09$$

$$Z = \frac{\text{Observed difference}}{\text{SE of difference}} = \frac{30 - 20}{6.09} = 1.6$$

Conclusion

Since Z value is less than 2, it is insignificant at 95 percent confidence limits.

The above test is applicable in case of large samples. For small samples of qualitative data, the Chi-square test is usually applied. However, the results of both the tests are the same. And for small samples of quantitative data, of less than 30, the significance of difference between two means or proportions is tested by 't' test.

't' Test (Student's "t" Test)

WS Gassett observed that with small samples, the sampling variations will be large and the estimate of standard error will be inconsistent from sample to sample and as such it will not be accurate and gives biased results. He demonstrated that the ratio of observed difference between two values to the SE of difference (i.e. Z value in large samples) follows a distribution called 't' distribution and such a ratio is denoted as 't' (for small samples). Thus, 't' corresponds to 'Z' value, but the probability of occurrence of this value is determined

by referencing to 't-table' (Fisher's 't' table) (Annexure-III) opposite to appropriate 'degree of freedom' and not by normal confidence limits.

This 't-value' was derived by 'Student' in 1908. 't' is calculated as a ratio of difference between two means or proportions to the standard error of the difference.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{SE} = \frac{\text{Mean difference}}{\text{SE of mean difference}}$$

The Fisher's table of 't-values' covers the various degrees of freedom and gives the probability levels for the calculated values of t_1 at each degree of freedom. The probabilities (p) are given in decimal fractions as 0.01, 0.05, 0.1 and so on upto 0.9 and the same is converted into percentages as 1 percent, 5 percent, 10 percent, and so on upto 90 percent. If the numerical values exceed 5 percent significant limit for the appropriate degree of freedom, the null hypothesis is to be rejected and the factor under study is likely to be playing part.

If the observations are made on two independent groups, like control group and treated (experimental) group and their means are compared for their significant difference, it is known as 'unpaired comparisons'.

If the observations are made on a single sample and the values of a certain characteristic is noted before and after the treatment with a particular drug, such comparison of values of observations is known as 'paired comparisons'. Other examples are—comparison of efficacy of two types of BP apparatus,—estimation of Hb by Talliquist and Shali's method, on the same group.

Thus, 't-test' is an accurate method of deciding whether the difference between the means or proportions of small samples is significant or not.

Degrees of Freedom

Degrees of freedom are calculated as follows:

1. In unpaired 't-test' of difference between the means, degrees of freedom (DF) = $n_1 + n_2 - 2$, where n_1 and n_2 are the number of observations in each series. In paired 't-test' DF = n – 1.
2. In Chi-square (x^2) test, for independence of two classifications, DF = (r – 1) (c – 1) where 'r' and 'c' are the number of rows and number of columns in the table.
3. In testing the significance of correlation, DF = n – 2, where n is the number of paired measurements.

However, there are exceptions to each of the above rules.

In paired or unpaired series, if the estimated or calculated 't'-value is higher than the table value of "t", the difference is statistically significant, if it is less, the difference is insignificant.

Formula:

i. The unpaired sample,

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\text{SE of difference between means}}$$

$$= \frac{\bar{x}_1 - \bar{x}_2}{SE(\bar{x}_1 - \bar{x}_2)}$$

ii. For paired samples,

$$t = \frac{\bar{d}}{\text{SE of d}}$$

Where d = difference in the two values for each pairs (total number of pairs being n) (Standard error of differences)

$\bar{d}$ = mean of the n-values for d (mean of differences).

It may be remembered here that SE of $d = \frac{\text{SE of d}}{\sqrt{n}}$

Chi-square Test (χ^2 Test)

'χ' is a Greek letter, not equivalent of English letter 'X', written as 'chi', pronounced as 'Kye' and typed as 'χ'.

This test involves the calculation of a quantity, called 'χ^2' in a qualitative data. χ^2-test was developed by Karl Pearson.

Applications of χ^2 Test

1. It is an alternate method of testing the significance of the difference between two proportions.
2. As a test of goodness of fit :
   By χ^2 test we can find whether the observed frequency distribution fits in a hypothetical or theoretical distribution of a qualitative data. The χ^2 test determines whether the observed frequency distribution differs from the theoretical distribution by chance or the sample is drawn from a different population.
   (Theoretical distribution such as normal, binomial or Poisson).
   If the calculated value of χ^2 test of the sample is higher than the table-value, it is significant (Null hypothesis is rejected) and vice-versa.

Example: The ratio of male to female births in nature is 1:1. If 52 male and 48 female children are born in a small town, could this difference be due to chance?

	Male	Female
Observed frequencies (O)	52	48
Expected frequencies (E)	50	50

$$\chi^2\,(a) = \frac{(O-E)^2}{E} = \frac{(52-50)^2}{50} = \frac{4}{50}$$

$$\chi^2\,(b) = \frac{(48-50)^2}{50} = \frac{4}{50}$$

$$a+b = \frac{4+4}{50} = \frac{8}{50} = 0.06$$

Degree of freedom = 1

χ^2 table value, with a DF at 5 percent level of significance = 3.841 (Annexure IV).

Since the calculated value is much less than the table value, it is insignificant. That means the observed sex difference is by chance.

3. To find any association between two attributes (e.g. smoking and lung cancer), is real or by chance.
   Similar examples are association between blood group and incidence of leprosy, age and blood pressure, nutritional status of the mother and weight of the newborn, obesity and diabetes, etc. There are only two possibilities, either the attributes are associated or not associated. The χ^2 test measures the probability of association by chance.

According to Null hypothesis, the assumption of no association between two characters is made (No relation between smoking and cancer). If the χ^2 value is higher than the table value of χ^2 (Annexure IV) against a probability of 0.05, for the particular degrees of freedom, the Null-hypothesis is rejected and the association is not apparent but real, at 5 percent level of significance.

The χ^2 test can also be applied to find the association in two classes or groups, as in multinomial samples (or a sample with multiple characters, e.g. a group with < 10 smokes/day, 11 to 20, 21 to 30, > 30 smokes per day and the incidence of lung cancer).

Steps

1. First, a table is prepared out of the qualitative data. Actual observed frequencies of 2 sets of events are entered in a two-way table, which is also known as 'Contingency table'. (Latin, con = together; tangere = to touch). Since this table also helps to know the association between two sets of events, the table is also called as 'Association table'. Because there are only two events and two groups or classes, it is called 2 × 2 or four-fold or four-cell contingency table.
2. Null hypothesis is set up stating there is no association between the events.
   χ^2 text can also be applied when there are more than two classes or groups, such as social classes I, II, III and IV among smokers and non-smokers.
3. Then expected frequency for each cell is calculated on the assumption of no association, using the formula

$$E = \frac{\text{Row total} \times \text{column total}}{\text{Grand total}}$$

4. Then the difference between the observed and the expected frequencies for each cell is found (i.e. O–E).
5. χ^2 value for each cell is calculated by using the formula

$$\chi^2 = \frac{(O-E)^2}{E}$$

6. Then the total of χ^2 for all the four cells is calculated by the formula (Summation of all 4 cell χ^2 values)

$$\text{Total } \chi^2 = \sum \frac{(O-E)^2}{E}$$

   Alternate formula for $\chi^2 = \frac{(ad-bc)^2 \times G}{(a+b)(c+d)(b+d)(a+c)}$

   Where, a, b, c and d are observed frequencies of 4 cells and G is the sample total (or grand total).
7. Next the degree of freedom (DF) is calculated by using the formula, DF = (c – 1) (r – 1), where c = no of columns, r = no of rows.
8. Lastly to know whether the calculated χ^2 value is significant or not, (i.e. whether the relation between the events smoking and cancer, for example, is by chance or a real one) we have to refer to 'Fisher's χ^2 table' (Annexure IV) for a particular degree of freedom, for a probability of 0.05, 0.01, etc. If the calculated value is higher than the table-value, it is concluded that it is significant and the Null hypothesis is to be rejected and accept the hypothesis (for example no association between smoking and lung cancer is ruled out and accept the hypothesis that there is significant association between smoking and cancer). If the calculated χ^2 value is lower than the table value Null hypothesis is accepted.

Example 1: Apply χ^2 test to find efficacy of a drug from the data given below:

Outcome (Result) of treatment with drug and placebo:

Group	(Efficacy of the drug) Result		Total	
	Died	Survived		
A. Control (no placebo)	(O) 10 (a) (E) (5.25)	(O) 25 (b) (E) (29.75)	35	(a + b)
B. Experimental (on drug)	(O) 05 (c) (E) (9.75)	(O) 60 (d) (E) (55.25)	65	(c + d)
Total	15 (a + c)	85 (b + d)	(G) 100	

The above values are all observed values.

The null hypothesis that the drug has no effect (Drug and placebo are same) (i.e. there is no difference between the sample proportions and the population/universe proportion of 100).

The expected (E) value and χ^2 value is calculated for each cell as follows.

a. Expected number and χ^2 value of 'died' in the control group

$$E_a = \frac{\text{Row total} \times \text{Column total}}{\text{Grand total}}$$
$$= \frac{35 \times 15}{100} = 5.25$$
$$\chi^2 = \frac{(O-E)^2}{E} = \frac{(10-5.25)^2}{5.25}$$
$$= \frac{(4.75)^2}{5.25} = \frac{22.5625}{5.25} = 4.29$$

b. Expected number and χ^2 value of 'survived' in the control group.

$$E_b = \frac{85 \times 35}{100} = 29.75$$
$$\chi^2 = \frac{(O-E)^2}{E}$$
$$= \frac{(25-29.75)^2}{29.75} = \frac{(-4.75)^2}{29.75}$$
$$= \frac{22.56}{29.75} = 0.76$$

c. E number and χ^2 value of 'died' in the experimental group

$$E_c = \frac{15 \times 65}{100} = \frac{39}{4} = 9.75$$
$$\chi^2 = \frac{(O-E)^2}{E}$$
$$= \frac{(05-09.75)^2}{9.75} = \frac{(-4.75)^2}{9.75}$$
$$= \frac{22.56}{9.75} = 2.31$$

d. E number and χ^2 value of survived in the experimental group

$$E_c = \frac{85 \times 65}{100} = 85 \times 0.65 = 55.25$$
$$\chi^2 = \frac{(O-E)^2}{E} = \frac{(60-55.25)^2}{55.25} = \frac{(5.25)^2}{55.25}$$
$$= \frac{22.56}{55.25} = 0.408$$

$\Sigma\chi^2$ = Total χ^2 value of all 4 cells
$= 4.29 + 0.76 + 2.31 + 0.41$
$= 7.77$

$DF = (c-1)(r-1) = (2-1)(2-1) = (1 \times 1) = 1$

Where DF = Degree of freedom
c = Number of (vertical) columns
r = Number of (horizontal) rows

On referring to Fisher's χ^2 table, with 1 DF, the tabulated χ^2 value, corresponding to probability of 0.05 (at 95% significance level) is 3.84.

Since the calculated value (7.77) is more than the table value (3.84), the null hypothesis is rejected, accepting the alternate hypothesis, i.e. the assumption that the drug is not efficacious (no difference between drug and placebo) is ruled out and accepted that the drug is efficacious (i.e. the difference between the two death rates is significant).

(*Note*: If the calculated value becomes lesser than χ^2 table values, null-hypothesis has to be accepted).

Yate's Correction

When the expected frequency in any cell of the four-fold (2 × 2) table is less than 5, a correction suggested by Yates, known as 'Correction for continuity' or Yate's correction, should be applied, for the calculation of χ^2, to obtain a more accurate value of Chi-square, by using the formula

$$\chi^2 = \frac{[(O-E) - ½]^2}{E}$$

Alternate formula $\chi^2 = \frac{[(ad-bc) - G/2]^2 \times G}{(a+b)(c+d)(a+c)(b+d)}$

Example 2: In a case-control study of oral contraceptive use and risk of myocardial infarction, it was found that out of 156 women with myocardial infarction, 23 were oral contraceptive users at the time of their hospital admission. Of the 3120 control women without myocardial infarction, 304 were current oral pill users.

A. Construct an appropriate 2 × 2 table
B. Calculate the measure of association between the oral contraceptive use and myocardial infarction.
C. Interpret the results

A. *Construction of the appropriate 2 × 2 contingency table*

		Disease (MI)		Total
		Case (Disease present)	Control (Disease absent)	
Oral pill users	Yes	23 (a)	304 (b)	327 (a+b)
	No	133 (c)	2816 (d)	2949 (c+d)
Total		156 (a+c)	3120 (b+d)	(G) 3276 (a+b+c+d) = G

B. *Null hypothesis:* There is no association between oral pills and myocardial infarction.

$$\text{Expected (E) value} = \frac{\text{Column total} \times \text{Row total}}{\text{Grand total}}$$

$$E_a = \frac{156 \times 327}{3276} = 15.50$$

$$\chi^2 = \frac{(O-E)^2}{E} = \frac{(23.0-15.5)^2}{15.5} = 3.62$$

$$E_b = \frac{3120 \times 327}{3276} = 311.40$$

$$\chi^2 = \frac{(304-311.4)^2}{311.4} = 0.17$$

$$E_c = \frac{156 \times 2949}{3276} = 140.40$$

$$\chi^2 = \frac{(133-140.4)^2}{140.04} = 0.39$$

$$E_d = \frac{3120 \times 2949}{3276} = 2808.50$$

$$\chi^2 = \frac{(2816-2808.5)^2}{2808.5} = 7.50$$

$$DF = (c-1)(r-1) \qquad \Sigma\chi^2 = 11.68$$
$$= (2-1)(2-1)$$
$$= 1$$

χ^2 value (table value with 1 df at p value 0.05 is 3.841).

C. *Results:*

i. Since the observed or calculated value 11.68 is more than the table value 3.841, null hypothesis (H_0) is rejected and the alternate hypothesis is accepted that there is significant association between ($p < 0.05$) oral pills and myocardial infarction.

ii. Odd's ratio $= \frac{ad}{bc} = \frac{23 \times 2816}{304 \times 133} = 1.6$

Oral contraceptive users are 1.6 times at a greater risk of getting myocardial infarction than nonusers.

iii. Exposure rate among cases and controls are compared.

Exposure rate among cases $= \frac{a}{a+c} = \frac{23}{156} = 0.15$

Exposure rate among controls $= \frac{b}{b+d} = \frac{304}{3120} = 0.09$

Since the exposure rate among the cases is greater then that of controls, there exists a relation between the oral pills and the myocardial infarction.

Example 3: χ^2 test for tables with more than two rows and columns. The following data in the table shows the distribution of the nonleprosy, lepromatous leprosy and nonlepromatous leprosy patients according to blood groups A, B, AB and O. Find out whether there is any association between the blood group and the disease leprosy.

Data: Distribution of leprosy and nonleprosy groups according to blood groups.

Blood group	Nonleprosy	Lepromatous leprosy	Nonlepromatous leprosy	Total
A	30	49	52	131
B	60	49	36	145
O	47	59	48	154
AB	13	12	16	41
Total	150	169	152	471

i. *Null hypothesis (H_0)*: There is no difference (relation between the blood groups and the disease leprosy. (i.e. blood group distributions are same in all the 3 groups of people).

ii. Expected frequencies are calculated for each cell (for different groups)

Blood group	Nonleprosy	Lepromatous leprosy	Nonlepromatous leprosy
A	$E = \frac{131 \times 150}{471} = 41.7$	$= \frac{131 \times 169}{471} = 47.0$	$= \frac{131 \times 152}{471} = 42.3$
B	$E = \frac{145 \times 150}{471} = 46.2$	$= \frac{145 \times 169}{471} = 52.0$	$= \frac{145 \times 152}{471} = 46.8$
C	$E = \frac{154 \times 150}{471} = 49.0$	$= \frac{154 \times 169}{471} = 55.3$	$= \frac{154 \times 152}{471} = 49.7$
AB	$E = \frac{41 \times 150}{471} = 13.1$	$= \frac{41 \times 169}{471} = 14.7$	$= \frac{41 \times 152}{471} = 13.2$

iii. χ^2 value is then obtained for each cell by the formula

$$\chi^2 = \frac{(O-E)^2}{E}$$

χ^2 values for each cell

Blood groups	Nonleprosy	Lepromatous leprosy	Nonlepromatous leprosy	Total
A	3.28	0.09	2.22	5.59
B	4.12	0.17	2.49	6.78
O	0.08	0.25	0.06	0.39
AB	0.00	0.50	0.59	1.09
Total	7.48	1.01	5.36	13.85

The summation of all the χ^2 values of all the cells = 13.85

DF = (c – 1) (r – 1)
= (3 – 1) (4 –1)
= 2 × 3
= 6

The table value of χ^2 at DF 6 for the p 0.05 is 12.592.

Result

1. Since the calculated χ^2 value 13.85 is greater than the table value 12.59, Null hypothesis is rejected and the alternate hypothesis is accepted. For example, the relation between the blood groups and leprosy disease is statistically significant.
2. In order to understand which of the blood groups are more prone to leprosy, the contribution to the total χ^2 from each cells is to be examined. From the table it is seen that the maximum contributions are from B and A groups.

Further test among each series will help to understand the problem more precisely.

ANALYSIS OF VARIANCE

It is observed that 't' test is applied to know whether the differences in the mean values of two groups of observations are arising out of sampling variation or the two groups are coming out of a homogeneous population.

But when there are more than two groups to be tested, we have to test in terms of two means at a time. However, a comparison of three or more series of observations can be made by 'Analysis of Variance'. This analysis is based on the assumption that the total variation present in a set of observations may be partitioned into a number of components associated with the classification of the data.

For example, when the Hb levels of antenatal mothers in three villages are to be compared, it can be seen that the total variability in the hemoglobin values of the antenatal mothers is measured as 'sum of squares of deviation of the Hb values of all the observations'.

However, there may be two types of variabilities, responsible for this total variability, one type is due to differences between mothers within each village (intra-village difference) while the second type is due to differences in the mothers between the three villages (inter-village difference). When these types of variabilities are combined together to get the total variability of the observations, this estimate will be bigger than the sum of two components. By an analysis of variance, the total variability can be partitioned into two components one between the villages and the other within the villages. Using this partitioned components, one can test the hypothesis whether the mean hemoglobin levels of antenatal mothers in three villages are different from the overall mean or not.

The above example is a two way classification and the analysis of variance is applicable to more than two way classification also.

NONPARAMETRIC TESTS

When the variables are distributed normally, tests like t test and χ^2 tests are applied to test the hypothesis. But at times, there are variables like rankings, which do not conform to any probability distribution. In such situation the above tests may not be applicable but the so called 'Nonparametric tests' may be applicable. These are the Sign test, the Wilcoxon's signed rank test and Mann-Whitney test.

Sign Test

This is applied under the following circumstances, for example, there are two diagnostic procedures of a disease, which are to be tested for their difference or significance. The two procedures are applied on a random sample of patients of the disease. The observations are categorized as follows.

It is categorized as 'one' when a person is considered as a patient of that particular disease or as 'Zero' when not considered as a patient, based on the diagnostic procedure. Thus there are 2 sets of ranks, is terms of 'one' and 'zero'.

The difference between one and zero correspond to the two test procedures, applied on a single individual.

The significance of difference between the two procedures can be tested using the usual χ^2 test.

Wilcoxon's Signed Rank Test

This test is useful for testing the significance of difference in paired observations (e.g. serum fibrinogen degradation product in mg/ml among 12 patients were noted before and after prostate operation). The difference in the paired values of each unit/patient is ranked according to the size of the difference and the signs of the original differences are also assigned to the ranks. Under the null hypothesis, it is equally likely that any difference can have + or –. The sums of all ranks with + 'sign and –ve sign are obtained separately.

The smaller sum out of the above two is referred to Wilcoxon's table, without considering the sign, against the number of pairs observed.

When the calculated smaller rank sum is less than the tabulated value, at 5 percent level, conclusion is made that the difference between the two groups of observations, is significant at 5 percent level.

Suppose there are more than one pair of common values for the differences, they are 'tied values'. Then each of the tied difference is assigned the average of the ranks that would be assigned if there is no tie. When the number of pairs exceeds 16, which is the limit of number of pairs in the tables given

by Wilcoxon, the normal approximation for getting the probability of rejection of null hypothesis is obtained by the formula.

$$Z = \frac{[(1\mu - T) - ½]}{\sigma}$$

Where,

T = Smaller rank sum
$\mu = n(n + 1)/4$
n = Number of pairs of observations

$$\sigma = \frac{\sqrt{(2n+1)\mu}}{4}$$

P is obtained from the normal distribution table corresponding to the value of calculated Z. As a rule of thumb Z > 1.96 signifies rejection of the null hypothesis at P < 0.05.

Mann-Whitney Test

The test is useful for testing the difference between unpaired observations (e.g. control and experimental group). The observations of both the groups is arranged in the order of magnitude. Tag is made for the common observations in both the groups separately. Ranks are assigned to the observations. When there are common observations, average of the ranks is given to them, as in case of Wilcoxon's test. Then the sum of ranks of each of the samples (groups) is calculated separately.

The smaller rank sum out of the above two is referred to Mann-Whitney table, which gives the maximum sum of ranks required for rejection of null hypothesis, under different probability levels.

Whenever the calculated smaller rank sum is less than the tabulated value, the null-hypothesis is rejected.

CORRELATION AND REGRESSION CORRELATION

Interpretation of Bivariate Data

Often two variables or attributes are simultaneously recorded (i.e. bivariate data) to know whether one influences the other, e.g. Height and weight, age and blood pressure, weight of pregnant mother and weight of the newborn, temperature and pulse, etc. The purpose of such study is to know whether change in one variable is associated with the change in the other variable. If there is a change like that, then it is assumed that there is a 'correlation' between the two variables and the degree of this correlation is measured in terms of 'Correlation Coefficient'.

Correlation is the linear relationship or mutuality of association of two variables; it is independent of the units of measurements (where as χ^2 test indicates the presence or absence of relationship between the qualitative data but not the degree of association).

Scatter Diagram

Suppose, the correlation of height and weight of 100 children has to be studied and correlation coefficient is to be calculated, the extent and type of the relation between the two variables has to be known by plotting the variables into a scatter diagram, wherein one variable (X_1) is represented on X axis and another variables (X_2) on the Y axis. Each pair of observation is plotted as a dot. The diagram will be a scatter of dots (each dot represents height on one axis and weight on another axis).

There are 5 types of scatter diagrams **(See Figs 25.10 A to C and Figs 25.20A and B)**.

Diagram 1: Positive correlation or direct correlation: In this type, the variables denoted on X and Y axis are directly proportional. That means as the x value increases, the y-value also increases. The 'regression line', which is in the center of the plots, ascends toward the right. *Example*: Ht and Wt of growing children, temperature and pulse.

Diagram 2: Negative correlation or indirect correlation: In this type, the variables are inversely proportional to each other, i.e. when one x variable increases, the other y decreases and vice-versa. The regression line ascends toward the left. For example, socioeconomic status and incidence of tuberculosis; income and malnutrition.

Diagram 3: No correlation: In this type, the variables are different and independent. The dots are haphazardly distributed, leading to conclusion that there is no relation. The regression lines are two, inclined on one another, but they are parallel to corresponding axes. For example, height and pulse rate.

Diagram 4 **(Fig. 25.20A)**: Partial positive correlation : In this type, the regression lines incline on one another and ascend toward right. For example, Age of the husbands and age of the wives; infant mortality rate and overcrowding, etc.

Diagram 5 **(Fig. 25.20B)**: Partial negative correlation: In this type, the regression lines incline on one another and ascend toward left. For example, income and infant mortality rate; age and vital capacity among adults.

Correlation Coefficient

It is an indicator to measure the degree of correlation between the two variables and is represented by the symbol 'r', the value of which ranges from –1 through 0, to +1, as follows.

–1 ——— 0 ——— +1

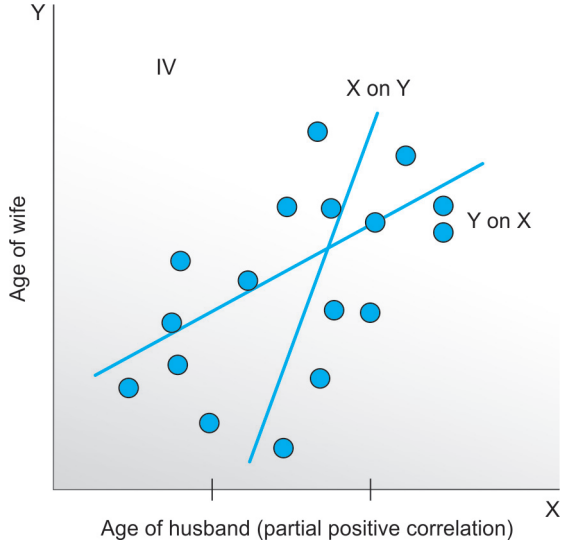


Fig. 25.20A Scatter diagram showing partial positive correlation

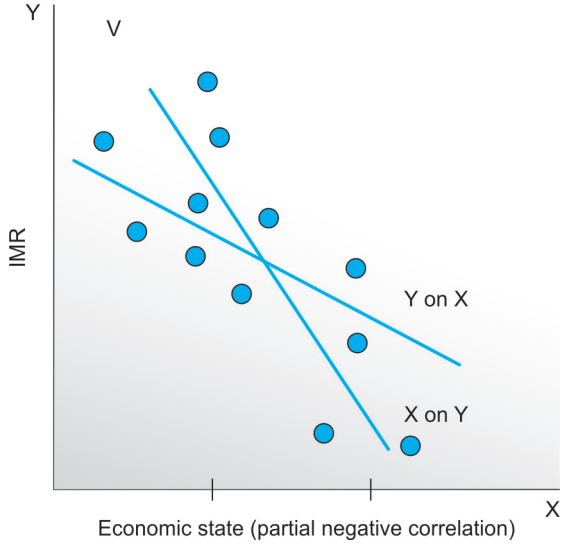


Fig. 25.20B Scatter diagram showing partial negative correlation

The correlation measures only the degree of association but does not tell what caused it. Moreover it does not mean that one variable causes the change in the other. The cause of the change may be due to other factor or factors also.

The formula for the calculation of coefficient of variation is given by:

$$r = \frac{\text{Covariance between two variables}}{\text{SD of first variable} \times \text{SD of second variable}}$$

Where 'covariance' is the amount of covariation between the two variables and the standard deviation gives the variation (variance) of a variable within-itself.

$$\text{i.e. } r = \frac{\sum (X - \bar{x})(Y - \bar{y})}{\sqrt{\sum (X - \bar{x})^2 (Y - \bar{y})^2}}$$

Where X and Y are the two characteristics being measured. (i.e. mean individual variables)

$\bar{x}$ and $\bar{y}$ = means of the two groups of variables.

The value of 'r' varies from –1 to +1. Depending upon the degree and direction of correlation there are 5 types of correlation.

i. If the value is +1, it shows perfect positive correlation.
ii. If the value is '0', it shows absolutely no correlation.
iii. If the value is –1, it shows perfect negative correlation.
iv. If it is between –1 and 0, it shows partial negative correlation.
v. If it is between 0 and +1, it shows partial positive correlation.

Since the correlation coefficient is subject to sampling variation, its value has to be tested for its significance. The significance of r-value can be evaluated by referring to 'correlation table', using the correct degree of freedom.

To apply the test of significance, first the sampling variation is measured by SE of correlation coefficient (SECC)

$$\text{SECC} = \sqrt{\frac{1 - r^2}{n - 2}}$$

Where
'r' = Correlation coefficient,
n = Number of pairs of observations.
't' test is applied when the sample is very small (i.e. test of significance for correlation coefficient).

Formula is $t = r \times \sqrt{\frac{(n-2)}{1-r^2}}$ with n – 2 DF

'p' value can be found out by referring to t distribution table. (correlation coefficient table).

Example for Calculation of Correlation Coefficient

Example: Height and weight of 18 female medical students, recorded in cms and kgs respectively and presented as Ht/Wt was observed as under.

160/55, 160/51, 157/65, 165/61, 165/45, 168/51, 158/49, 162/53, 165/40, 159/70, 159/65, 159/66, 158/55, 162/45, 157/55, 165/50, 155/56 and 161/51.

Height			Weight			
X (cm)	$X-\bar{X}$	$(X-\bar{X})^2$	Y (kg)	$Y-\bar{Y}$	$(Y-\bar{Y})^2$	$(X-\bar{X})(Y-\bar{Y})$
160	–0.8	0.64	55	+0.4	0.16	–0.32
160	–0.8	0.64	51	–3.6	12.96	+2.88
157	–3.8	14.44	65	+10.4	108.16	–39.52
165	+4.2	17.64	61	+6.4	40.96	+26.88
165	+4.2	17.64	45	–9.6	92.16	–40.32
168	+7.2	51.84	51	–3.6	12.96	–25.92
158	–2.8	7.84	49	–5.6	31.36	+15.68
162	+1.2	1.44	53	–1.6	2.56	–1.92
165	+4.2	17.64	40	–14.6	213.16	–61.32
159	–1.8	3.24	70	+15.4	237.16	–27.72
159	–1.8	3.24	65	+10.4	108.16	–18.72
159	–1.8	3.24	66	+11.4	129.96	–20.52
158	–2.8	7.84	55	+0.4	0.16	–1.12
162	+1.2	1.44	45	–9.6	92.16	–11.52
157	–3.8	14.44	55	+0.4	0.16	–1.52
165	+4.2	17.64	50	–4.6	21.16	–19.32
155	–5.8	33.64	56	+1.4	1.96	–8.12
161	+0.2	0.04	51	–3.6	12.96	–0.72
2895	$\bar{X}=160.8$	214.52	983	$\bar{Y}=54.6$	118.28	–233.16

Calculation of Correlation Coefficient Value

$$r=\frac{\sum(X-\bar{x})(Y-\bar{y})}{\sqrt{\sum(X-\bar{x})^2\sum(Y-\bar{y})^2}}=\frac{-233.16}{\sqrt{214.52\times118.28}}$$

$$r=\frac{-233.16}{\sqrt{2,39,893.42}}$$

$$=\frac{-233.16}{489.79}=-0.48$$

Inference

Since the r value lies between –1 and 0, partial negative correlation exists between the height and weight measurements of female medical students.

REGRESSION

It was observed that the degree of correlation between the two variables could be measured using the correlation coefficient.

In some cases, one variable (known, called independent variable) causes the change in the other variable (unknown, called dependent variable), e.g. change in height (independent) of the child causes change in weight (dependent variable) of the child.

This change of dependent variable with respect to change in independent variable is known as 'Regression.'

Regression Coefficient

Regression means change in the measurements of a variable, on the positive or negative side, beyond the mean. This regression is measured through 'Regression coefficient', a constant, which gives the amount of increase in the dependent variable (e.g. weight) for an unit increase in the independent (e.g. height) variable. This quantity is represented by 'b.' when these variables are plotted on a graph, gives 'Regression-line', depicting that the relationship is linear.

Regression Equation

The relationship between the two variables can be represented by a mathematical equation, known as 'Regression Equation.'

When the relationship is linear, the equation will be of the type y = a + bx

Where,

y is the dependent variable,

x is the independent variable,

b is the regression coefficient,

a represents the value of y for x = 0.

The regression coefficient is calculated by using the formula,

$$b_{xy} = \frac{\sum xy - (\sum x \sum y)/n}{\sum x^2 - (\sum x)^2/n}$$

Where b_{xy} is regression coefficient of independent variable x, upon dependent variable y and usually represented as b.

Nonlinear Regression

Sometimes, it may happen that the dependent variable increases for each change of the independent variable upto a certain value and then it may start decreasing with the change in the independent variable. The reverse process may also happen. In such cases, the regression is said to be 'Nonlinear'. For example, the prevalence rate of tuberculosis in a community rises with the age upto a certain age and then starts decreasing with the increase in the age after reaching a maximum at certain age group. This may be due to immunity attained by the community by the time they reach a certain age.

In such a case, the relationship is said to be quadratic.

Multiple Correlation and Regression

In simple correlation, it is observed that there is one dependent variable and only one independent variable. But it may so happen that there may be more than one independent variable for the causation of the dependent variable. For example, wt of the newborn baby (dependent variable) is related to more than one independent variable such as age of the mother, period of gestation at the time of birth, parity of delivery, health condition of the mother and so on. If the overall correlation of all these independent factors with the dependent factor is considered, then it is known as 'multiple correlation'.

If an equation is fitted to estimate the dependent variable (e.g. weight of the baby at birth) in terms of other independent variables (as in above factors), then the equation is called as the 'multiple regression equation'.

Spearman's Rank Correlation Test

It was seen that for the calculation of correlation coefficient, at least one of the variables is distributed normally. In cases where it is not so or when measurements are in terms of certain ranks and not in exact quantitative terms, then Spearman's rank correlation coefficient is applied to determine whether there is a monotonic relation between the two variables, whether an increase in one is associated with an increase or decrease in the other.

In this case, one of the series is arranged in the order of magnitude and ranked from 1 to n and the other variable also is ranked. Thus the test ignores the actual values. The correlation coefficient [i.e. Spearman's rank order correlation (Rho)] of these two rankings is calculated, using the formula

$$\text{Rho}(\rho) = 1 - \frac{6 \times \sum D^2}{n(n^2 - 1)}$$

Where D is the difference in the ranks of each pair of data, n is the number of pairs of observations.

Note:

- Whenever there is a tie in the ranks, then for each of the tied pairs average of the ranks is assigned.
- The range for rank correlation coefficient is also between –1 and +1.
- One of the applications of this test is in determining whether the pairs formed for conducting a randomized controlled trial are really matched.

Example: The average age-wise systolic blood pressure in a community were as follows:

Age (years)	Blood pressure (mm Hg)
15	120
25	125
30	130
40	130
50	130
60	150

Does age significantly influence blood pressure ?

Step 1: The variables are arranged in the rank. Number 1 is awarded to the lowest numerical figure, 2 to the next higher one and so on. If there are two or more measurements of same value, each of them is given the average of the next two or more numbers.

The above data is ranked as follows:

Step 2: In the next step, the difference (D) in the ranks, for age and corresponding blood pressure is calculated and its square (D_2) is worked out as follows.

Age	Age rank	BP	BP rank	D	D^2
15	1	120	1	0	0
25	2	125	2	0	0
30	3	130	4	1	1
40	4	130	4	0	0
50	5	130	4	1	1
60	6	150	6	0	0

Step 3:

$$\text{Rho}(\rho) = 1 - \frac{6x\Sigma D^2}{n(n^2-1)}$$
$$= 1 - \frac{6\times 2}{6(6\times 6-1)}$$
$$= 1 - \frac{12}{6(36-1)}$$
$$= 1 - \frac{12}{210}$$
$$= 1 - 0.05$$
$$= 0.95$$

The significance of rank correlation coefficient is assessed by referring to Kendall table (Annexure V). According to that table, the value for a sample size of 6 at 5 percent level (p = 0.05) is 0.88. Since the calculated value is more than the table value, age and BP are significantly correlated.

LIFE TABLE

It is a table showing the mortality experience of a group of population of a country, at different ages, when followed every year, starting from their birth until all are dead. Thus it explains the outcome of a specified population in terms of number of deaths, number of surviving at each age, number of person years lived and the average longevity of these persons. In otherwords, it helps to derive at the expectation of life at particular age, e.g. expectation of life at birth, at age of 1 year, 2 years, 5 years, 10 years, 60 years, etc. Expectation of life is defined as the average number of years a person is expected to live after attaining a specified age, exposing/experiencing the current risk of mortality. Thus life table is a 'biometer' of the population.

The life tables are constructed once in ten years, after each census separately for males and females. Usually a specified population of a standard number of 1,00,000 newborn babies, of the same sex, born at the same time are followed through various ages.

To construct a life table, two things are required:

i. Population living at all individual ages in a selected year.
ii. Number of deaths occurring in these ages.

The group with which it is started (cohort group), is known as 'radix' of the life table. When mortality is studied in that group, it is seen that there is reduction in the radix group as age advances. The reduction is high in the early years of life, gradually decreases as age advances till middle age is reached and again increases in older ages because of increased mortality in extremes of ages.

An extract of All India Life Table for females, obtained from WHO world mortality 2002 is depicted in the following table **(Table 25.8)**.

Description

There are different rows and columns in the life table. Each row refers to particular age. Colums are described below.

Column-1 (Age X)

This gives the age group, i.e. the exact number of completed years since birth. It is denoted by X. A detailed life table shows the age at every year (no frequency interval) and an abridged life table shows the age group intervals (as shown in the table). The first one is <1 year, next is 1–4 years, because of different mortality rates in these two groups and then subsequently the group intervals are of 5 years, the last one being 100 and above.

Column-2 (l_x)

The figures in this column show the number of persons surviving at age *x* out of the total number of persons started at age 0 (at birth). At birth it is 1,00,000 newborn babies and at 1 to 4 years it is 93,623 and at 5 to 9 years 90,099 so on. It is represented as l_x.

Column-3 (q_x)

This gives the probability of dying as experienced by the Cohort group 1,00,000 at different ages, i.e. the age specific death rate experienced by the cohort group. Denoted as q_x. In the above table, experiencing the infant mortality rate of 63/1000 live births (i.e. 6377/1,00,000 live births), the number of deaths is 6377 and the survivors are 1,00,000 – 6377 = 93623. These survivors experience the age specific death rate during 1 to 4 years. 3524 (shown as 3525 in the table) would die leaving behind 90,099 as survivors (l_x). This goes on till all are dead.

Column-4 (d_x)

This column shows the absolute number of deaths occurring in the different age groups. It is arrived at by applying the current age specific death rate to the cohort group in the respective age groups. In the above table it is 6377 during infancy, 3525 during 1 to 4 years and so on. It is denoted as d_x.

Column-5 (L_x)

This gives the number of years survived by 93623 individuals. Since all 6377 infants have not died at one point of time, probably each one might have survived on an average of 3 months, contributing to survival period of 638 years, thus the number of years survived will be more than the actual number of survivors. 93623 + 638 = 94261, denoted as L_x.

Table 25.8 Life table for the females in India (2000) (Abridged version)

Age X	l_x	q_x	d_x	L_x	e_x^0
<1	100,000	0.0638	6,377	94,261	62.7
1–4	93,623	0.0376	3,525	366,035	65.9
5–9	90,099	0.0125	1,128	447,675	64.5
10–14	88,971	0.0066	588	443,384	60.2
15–19	88,383	0.0103	907	439,645	55.6
20–24	87,475	0.0139	1,213	434,345	51.2
25–29	86,263	0.0145	1,247	428,194	46.9
30–34	85,015	0.0151	1,281	421,874	42.5
35–39	83,735	0.0159	1,334	415,339	38.1
40–44	82,401	0.0222	1,883	407,421	33.7
45–49	80,568	0.0320	2,577	396,396	29.4
50–54	77,991	0.0440	3,432	381,374	25.3
55–59	74,559	0.0673	5,020	360,243	21.4
60–64	69,539	0.0998	6,937	330,350	17.7
65–69	62,601	0.1514	9,475	289,318	14.4
70–74	53,126	0.2173	11,545	236,767	11.5
75–79	41,581	0.3075	12,786	175,938	9.0
80–84	28,795	0.4262	12,273	113,290	6.9
85–89	16,522	0.5698	9,441	59,080	5.2
90–94	7,110	0.6824	4,852	20,996	3.9
95–99	2,258	0.8300	1,875	5,669	2.9
100+	384	1	384	823	2.1

Column-6 (e0x) (Life Expectancy)

This column shows the expectation of life at the start of a particular age group. This is denoted by e_x^0. The expectation of life at 1 year of age is higher than the expectation of life at birth, because they have passed at the risk of infant rate. This is obtained by dividing the total number of years lived at age X by the number of starters/Cohort group.

Expectation of life at birth =

$$e_x^0 = \frac{\sum L_x}{l_x} = \frac{\text{Total number of years lived}}{\text{Total number of persons living at birth}}$$

$$= \frac{62,68,417}{1,00,000}$$

= 62.7 years

Expectation of life at age 1

$$= \frac{\sum L_x - L_x}{l_x}$$

$$= \frac{62,68,417 - 94,261}{93,623}$$

= 65.9 years

Uses of Life Table

- It helps to estimate the life expectancy of a country, which is an useful indicator to assess the health status which in turn is used for international comparison also.
- Expectation of life at insured age or at retirement age helps in budgeting for social security like life insurance policies, pension benefits, etc.
- Probability of survivors at different ages helps to plan services like school health services for children, services for adolescent girls, etc.
- Modified life table method helps to know the survival rates after treatment of chronic diseases like tuberculosis, cancer, diabetes, hypertension, coronary heart disease, etc.

ANNEXURE - I

Table of Unit Normal Distribution

Normal distribution (Single-Tail). Proportion of area lying to right of ordinate through $Z = \pm (X - \bar{X})/SD$

A	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	00.9
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4052	4.4013	0.3974	0.3936	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2297	0.2266	0.2236	0.2206	0.2177	0.2148
0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
0.1	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.151	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0637
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0022	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
2.6	0.00047	0.0045	0.044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
2.9	2.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0012	0.0011	0.0011	0.0010	0.0010

If mean height X is 160 cm, SD, —4 cm and height X is 166 cm Z will be $\frac{X - m}{SD} = \frac{166 - 160}{4} = 1.5$ corresponding to Z, 1.5 proportion of area comes to 0.0668 or 6.68% heights exceed 166 cm.

Source: Mahajan BK. Methods in Biostatistics, 3rd edn, 1981

ANNEXURE - II

Table of Random Numbers

53 74 23 99 67	61 32 28 69 84	94 62 67 86 24	98 33 41 19 95	47 53 53 38 69
63 38 06 86 54	99 00 65 26 94	02 82 90 23 07	79 62 67 80 60	75 91 12 81 19
35 30 58 21 46	06 72 17 10 94	25 21 31 75 96	49 28 24 00 49	55 65 79 78 07
63 43 36 82 69	65 51 18 37 88	61 38 44 12 45	32 92 85 88 65	54 34 81 85 35
98 25 37 55 26	01 91 82 81 46	74 71 12 94 97	24 02 71 37 07	03 92 18 66 75
02 63 21 17 69	71 50 80 89 56	38 15 70 11 48	43 40 45 86 98	00 83 26 91 03
64 55 22 21 82	48 22 28 06 00	61 54 13 43 91	82 78 12 23 29	06 66 24 12 07
85 07 26 13 89	01 10 07 82 04	59 63 69 36 03	69 11 15 83 80	13 29 54 19 28
58 54 16 24 15	51 54 44 82 00	62 61 65 04 69	38 18 65 18 97	85 72 13 49 21
34 85 27 84 87	61 48 64 56 26	90 18 48 13 26	37 70 15 42 57	65 65 80 39 07
03 92 18 27 46	57 99 16 96 56	30 33 72 85 22	84 64 38 56 98	99 01 30 98 64
62 95 30 27 59	37 75 41 66 48	86 97 80 61 45	23 53 04 01 63	45 76 08 64 27
08 45 93 15 22	60 21 75 46 91	98 77 27 85 42	28 88 61 08 84	69 62 03 42 73
07 08 55 18 40	45 44 75 13 90	24 94 96 61 02	57 55 66 83 15	73 42 37 11 61
01 85 89 95 66	51 10 19 34 88	15 84 97 19 75	12 76 39 43 78	64 63 91 08 25
72 84 71 14 35	19 11 58 49 26	50 11 17 17 76	86 31 57 20 18	95 60 78 46 75
88 78 28 16 84	13 52 53 94 53	75 45 69 30 96	73 89 65 70 31	99 17 43 48 76
45 17 75 65 57	28 40 19 72 12	25 12 74 75 67	60 40 60 81 19	24 62 01 61 16
96 76 28 12 54	22 01 11 94 25	71 96 16 16 88	68 64 36 74 45	19 59 50 88 92
43 31 67 72 30	24 02 94 08 63	38 32 36 66 02	69 36 38 25 39	48 03 45 15 22
50 44 66 44 21	66 06 58 05 62	68 15 54 35 02	42 35 48 96 32	14 52 41 52 48
22 66 22 15 86	26 63 75 41 99	58 42 36 72 24	58 37 52 18 51	03 37 18 39 11
96 24 40 14 51	23 22 30 88 57	95 67 47 29 83	94 69 40 06 07	18 16 36 78 86
31 73 91 61 19	60 20 72 93 48	98 57 07 23 69	65 95 39 69 58	56 80 30 19 44
78 60 73 99 84	43 89 94 36 45	56 69 47 07 41	90 22 91 07 12	78 35 34 08 72
84 37 90 61 56	70 10 23 98 05	85 11 34 76 60	76 48 45 34 60	01 64 18 39 96
36 67 10 08 23	98 93 35 08 86	99 29 76 29 81	33 34 91 58 93	63 14 52 32 52
07 28 59 07 48	89 64 58 89 75	83 85 62 27 89	30 14 78 56 27	86 63 59 80 02
10 15 83 87 60	79 24 31 66 56	21 48 24 93 91	98 94 95 49 01	47 50 38 60
55 19 68 97 65	03 73 58 16 50	00 53 55 90 27	33 42 29 38 87	22 13 68 83 34
53 81 29 13 39	35 01 20 71 34	62 33 74 82 14	53 73 19 09 03	56 54 29 56 93
51 86 32 68 92	33 98 74 66 99	40 14 71 94 58	45 94 19 38 81	14 44 99 81 07
35 91 70 29 13	80 03 54 07 27	96 94 78 32 66	50 95 52 74 33	13 80 55 62 54
37 71 67 95 13	20 02 44 95 94	64 85 04 05 72	01 32 90 76 14	53 89 74 60 41
93 66 13 83 27	92 79 64 64 72	28 54 96 53 84	48 14 52 98 94	56 07 93 89 30
02 96 08 45 65	13 05 00 41 84	93 07 54 72 59	21 45 57 09 77	19 48 56 27 44
49 83 43 48 35	82 88 33 69 96	72 36 04 19 76	47 45 15 18 60	82 11 08 95 97
84 60 71 62 46	40 80 81 30 37	34 39 23 05 38	25 15 35 71 30	88 12 57 21 77
18 17 30 88 71	44 91 14 88 47	89 23 30 63 15	56 34 20 47 89	99 82 93 24 98
79 69 10 61 78	71 32 76 95 62	87 00 22 58 40	92 54 01 75 25	43 11 71 99 31
75 93 36 57 83	56 20 14 82 11	74 21 97 90 65	96 42 68 63 86	74 54 13 26 94
38 30 92 29 03	06 28 81 39 38	62 25 06 84 63	61 29 08 93 67	04 32 92 08 00
51 29 50 10 34	31 57 75 95 80	51 97 02 74 77	76 15 48 49 44	18 55 63 77 09
21 31 38 86 24	37 79 81 53 74	73 24 16 10 33	52 83 90 94 76	70 47 14 54 36
29 01 23 87 88	58 02 39 37 67	42 10 14 20 92	16 55 23 42 45	54 96 09 11 06
95 33 95 22 00	18 74 00 18 38	79 58 69 32 81	76 80 26 92 82	80 84 25 39
90 84 60 79 80	24 36 59 87 38	82 07 53 89 35	96 35 23 79 18	15 98 90 07 35
46 40 62 98 82	54 97 20 56 95	15 74 80 08 32	16 46 70 50 80	67 72 16 42 79
30 31 89 03 43	38 46 82 68 72	32 14 82 99 70	80 60 47 18 97	63 49 30 21 30
71 59 73 05 50	08 22 23 71 77	91 01 93 20 49	82 96 59 26 94	66 39 67 98 60

Source: Rao NSN. Elements of Health Statistics. 1st edn. Reprint 1985

ANNEXURE - III

Table of t Distribution

DF	.90	.80	.70	.60	.50	.40	.30	.20	.10	.05	.02	.01	.001
1.	.158	.325	.510	.727	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2.	.142	.289	.445	.617	.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3.	.137	.277	.424	.584	.765	.978	1.250	1.638	2.353	3.182	4.541	5.841	12.924
4.	.134	.271	.414	.569	.741	.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5.	.132	.267	.408	.559	.727	.920	1.156	1.476	2.015	2.571	3.365	4.032	6.869
6.	.131	.265	.404	.553	.718	.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7.	.130	.263	.402	.549	.711	.896	1.119	1.415	1.895	2.365	2.998	3.499	5.408
8.	.130	.262	.399	.546	.706	.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9.	.129	.261	.398	.543	.703	.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10.	.129	.260	.397	.542	.700	.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11.	.129	.260	.396	.540	.696	.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12.	.128	.259	.395	.539	.695	.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13.	.128	.259	.394	.538	.694	.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14.	.128	.258	.393	.537	.692	.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15.	.128	.258	.393	.536	.691	.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16.	.128	.258	.392	.535	.690	.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17.	.128	.257	.392	.534	.689	.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18.	.127	.257	.392	.534	.688	.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19.	.127	.257	.391	.533	.688	.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20.	.127	.257	.391	.533	.687	.860	1.064	1.325	1.725	2.086	2.845	2.845	3.850
21.	.127	.257	.391	.532	.686	.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22.	.127	.256	.390	.532	.686	.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23.	.127	.256	.390	.532	.685	.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24.	.127	.256	.390	.531	.685	.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25.	.127	.256	.390	.531	.684	.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26.	.127	.256	.390	.531	.684	.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27.	.127	.256	.389	.531	.684	.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28.	.127	.256	.389	.530	.683	.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29.	.127	.256	.389	.530	.683	.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30.	.127	.256	.389	.530	.683	.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40.	.126	.255	.388	.529	.681	.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60.	.126	.254	.387	.527	.679	.848	1.046	1.296	1.671	2.000	2.390	2.660	3.460
120.	.126	.254	.386	.526	.677	.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373
00	.126	.253	.385	.524	.674	.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291

Source: Rao NSN. Elements of Health Statistics. 1st edn. Reprint 1985

ANNEXURE - IV

Table of χ^2 Distribution

DF	.99	.98	.95	.90	.80	.70	.50	.30	.20	.10	.05	.02	.01	.001
1.	.0157	.0628	.00393	.0158	.0642	.148	.455	1.074	1.642	2.706	3.841	5.412	6.635	10.827
2.	.0201	.0404	.103	.211	.446	.713	1.386	2.408	3.219	4.605	5.991	7.824	9.210	13.815
3.	.115	.185	.352	.584	1.005	1.424	2.366	3.665	4.642	6.251	7.815	9.837	11.345	16.266
4.	.297	.429	.711	1.064	1.649	2.195	3.357	4.878	5.989	7.779	9.488	11.668	13.277	18.467
5.	.554	.752	1.145	1.610	2.343	3.000	4.351	6.064	7.289	9.236	11.070	13.388	15.086	20.515
6.	.872	1.134	1.635	2.204	3.070	3.828	5.348	7.231	8.558	10.645	12.592	15.033	16.812	22.457
7.	1.239	1.564	2.167	2.833	3.822	4.671	6.346	8.383	9.803	12.017	14.067	16.622	18.475	24.322
8.	1.646	2.032	2.733	3.490	4.594	5.527	7.344	9.524	11.030	13.362	15.507	18.168	20.090	26.125
9.	2.088	2.532	3.325	4.168	5.380	6.393	8.343	10.656	12.242	14.684	16.919	19.679	21.666	27.877
10.	2.558	3.059	3.940	4.865	6.179	7.267	9.342	11.781	13.442	15.987	18.307	21.161	23.209	29.588
11.	3.053	3.609	4.575	5.578	6.989	8.148	10.341	12.899	14.631	17.275	19.675	22.618	24.725	31.264
12.	3.571	4.178	5.226	6.304	7.807	9.034	11.340	14.011	15.812	18.549	21.026	24.054	26.217	32.909
13.	4.107	4.765	5.892	7.042	8.634	9.926	12.340	15.119	16.985	19.812	22.362	25.472	27.688	34.528
14.	4.660	5.368	6.571	7.790	9.467	10.821	13.339	16.222	18.151	21.064	23.685	26.873	29.141	36.123
15.	5.229	5.985	7.261	8.547	10.307	11.721	14.339	17.322	19.311	22.307	24.996	28.259	30.578	37.697
16.	5.812	6.614	7.962	9.312	11.152	12.624	15.338	18.418	20.465	23.542	26.296	29.633	32.000	39.252
17.	6.408	7.255	8.672	10.085	12.002	13.531	16.338	19.511	21.615	24.769	27.587	30.995	33.409	40.790
18.	7.015	7.906	9.390	10.865	12.857	14.440	17.338	20.601	22.760	25.989	28.869	32.346	34.805	42.312
19.	7.633	8.567	10.117	11.651	13.716	15.352	18.338	21.689	23.900	27.204	30.144	33.687	36.191	43.820
20.	8.260	9.237	10.851	12.443	14.578	16.266	19.337	22.775	25.038	28.412	31.410	35.020	37.566	45.315
21.	8.897	9.915	11.591	13.240	15.445	17.182	20.337	23.858	26.171	29.615	32.671	36.343	36.932	46.797
22.	9.542	10.600	12.338	14.041	16.314	18.10	21.337	24.939	27.301	30.813	33.924	37.659	40.289	48.268
23.	10.196	11.293	13.091	14.848	17.187	19.021	22.337	26.018	28.429	32.007	35.172	38.968	41.638	49.728
24.	10.856	11.992	13.848	15.659	18.062	19.943	23.337	27.096	29.553	33.196	36.415	40.270	42.980	51.179
25.	11.524	12.697	14.611	16.473	18.940	20.867	24.337	28.172	30.675	34.382	37.652	41.566	44.314	52.620
26.	12.198	13.409	15.379	17.292	19.820	21.792	25.336	29.246	31.795	35.563	38.885	42.856	45.642	54.052
27.	12.879	14.125	16.151	18.114	20.703	22.719	26.336	30.319	32.912	36.741	40.113	44.140	46.963	55.476
28.	13.565	14.847	16.928	18.939	21.588	23.647	27.336	31.391	34.027	37.916	41.337	45.419	48.278	56.893
29.	14.256	15.574	17.708	19.768	22.475	24.577	28.336	32.461	35.139	39.087	42.557	46.693	49.588	58.302
30.	14.953	16.306	18.493	20.599	23.364	25.508	29.336	33.530	36.250	40.256	43.773	47.962	50.892	59.703
32.	16.362	17.783	20.072	22.271	25.271	27.373	31.336	35.665	38.466	42.585	46.194	50.487	53.486	62.487
34.	17.780	19.275	21.664	23.952	26.938	29.242	33.336	37.795	40.676	44.903	48.602	52.995	56.061	65.247
36.	19.233	20.783	23.269	25.643	28.735	31.115	35.336	39.922	42.879	47.212	50.999	55.489	58.619	67.985
38.	20.691	22.304	24.884	27.343	30.537	32.992	37.335	42.045	45.076	49.513	53.384	57.969	61.162	70.703
40.	22.164	23.838	26.509	29.051	32.345	34.872	39.335	44.165	47.269	51.805	55.759	60.436	63.691	73.402
42.	23.650	25.383	28.144	30.765	34.157	36.755	41.335	46.282	49.456	54.090	58.124	62.892	66.206	76.084
44.	25.148	26.939	29.787	32.487	35.974	38.641	43.335	48.396	51.639	56.369	60.481	65.337	68.710	78.750
46.	26.657	28.504	31.439	34.215	37.795	40.529	45.335	50.507	53.818	58.641	62.830	67.771	71.201	81.400
48.	28.177	30.080	33.098	35.949	39.621	42.420	47.335	52.616	55.993	60.907	65.171	70.197	73.683	84.037
50.	29.707	31.664	34.764	37.689	41.449	44.313	49.335	54.723	58.164	63.167	67.505	72.613	76.154	86.661
52.	31.246	33.256	36.437	39.433	43.281	46.209	51.335	56.827	60.332	65.422	69.832	75.021	78.616	89.272
54.	32.793	34.856	38.116	41.183	45.117	48.106	53.335	58.930	62.496	67.673	72.153	77.422	81.069	91.872
56.	34.350	36.464	39.801	42.937	46.955	50.005	55.335	61.031	64.658	69.919	74.468	74.815	83.513	94.461
58.	35.913	38.078	41.492	44.696	48.797	51.906	57.335	63.129	66.816	72.160	76.778	82.201	85.950	97.039
60.	37.485	39.699	43.188	46.459	50.641	53.809	59.335	65.227	68.972	74.397	79.082	84.580	88.379	99.607
62.	39.063	41.327	44.889	48.226	52.487	55.714	61.335	67.322	71.125	76.630	81.381	86.953	90.802	102.166
64.	40.649	42.960	46.595	49.996	54.336	57.620	63.335	69.416	73.276	78.860	83.675	89.320	93.217	104.716
66.	42.240	44.599	48.305	51.770	56.188	59.188	59.527	65.335	71.508	75.424	81.965	91.681	95.626	107.258
68.	43.838	46.244	50.020	53.548	58.042	61.436	67.335	73.600	77.571	83.308	88.250	94.037	98.028	109.791
70.	45.442	47.893	51.739	55.329	59.898	63.346	69.334	75.689	79.715	85.527	90.531	96.388	100.425	112.317

For odd values of n between 30 and 70 the mean of the tabular values for n–1 and n+1 may be taken. For larger values of n, the expression $\sqrt{2x^2} - \sqrt{2n-1}$ may be used as a normal deviate with unit variance, remembering that the probability for χ^2 corresponds with that of a single tail of the normal curve (For fuller formulae see introduction).

Source: Rao NSN. Elements of Health Statistics. 1st edn. Reprint 1985

ANNEXURE - V

Kendall's Table

The significance of the rank correlation coefficient is worked out as follows. For samples of size over 10 pairs the significance level of r_{rank} can be calculated similar to that of r but for samples of size 10 or less number of pairs it is given by the following table given by Kendall.

Size of the sample	5% level	1% level
4 or less	none	none
5	1.000	none
6	0.886	1.000
7	0.750	0.893
8	0.714	0.857
9	0.683	0.883
10	0.648	0.794
11	Use tables of significance of r	

Source: Rao NSN. Elements of Health Statistics. 1st edn. Reprint 1985

BIBLIOGRAPHY

1. Ghai OP, Piyush Gupta. Essential Preventive Medicine 1st edn. 1999.
2. Kothari CR. Research Methodology.
3. Mahajan BK. Methods in Biostatistics 3rd edn. 1981.
4. Park K. Park's Textbook of Preventive and Social Medicine 18th edn. 2005.
5. Rao NSN. Elements of Health Statistics. 1st edn. Reprint 1985.
6. Sunderlal, Adarsh, Pankaj. Textbook of Community Medicine 1st edn. 2007.

CHAPTER 26

Social Science

It is the science, which deals with the study of human behavior. This consists of Economics, Political science, Sociology, Social psychology and Anthropology. The last three are collectively referred to as 'Behavioral sciences', because they deal directly with the human behavior, as the three dimensional profile **(Table 26.1)**.

1. *Economics*: It deals with human relationships in the context of production, distribution, consumption of resources, goods and services. It is also concerned with the allocation of the money for the program. Thus, it is concerned with economic health of the people. Health economics is the application of principles of economics in the field of health.
2. *Political science*: It deals with the study of the system of laws and institutions making the laws and also functioning of the legislative, judicial and executive wings of states. The political institutions are *Gram Panchayat*, *Zila Parishad*, Municipal Council, etc.
3. *Sociology* (*Socios* = *society; logos* = *study*): It deals with the study of human behavior and human relationships (behavior of the social groups; social life), i.e. the study of society, social interactions (cultural factors), society institutions and social organizations. It analyzes the social processes determining the group behavior.
4. *Social psychology*: It deals with the study of human behavior in response to collective mentality. It analyzes mental processes determining the group behavior. It includes perception, thought, opinion, attitude and general motivation.
5. *Anthropology*: It deals with the study of primitive man, with reference to physical, social, cultural and medical (ecology) factors. Accordingly anthropology has the following branches:
   a. *Physical anthropology*: This consist of study of human evolution, racial differences, inheritance of body traits, growth and decay of human organisms.
   b. *Social anthropology*: It deals with the study of development and various types of social life.
   c. *Cultural anthropology*: It deals with the study of human culture (thinking, feeling and action) right from the primitive times, which pass onto the generations.
   d. *Medical anthropology*: It deals with the cultural component in the ecology of health and disease.

   Other branches of social sciences are History and Geography.
6. *History*: It is a record of events of the past, which have given rise to a variety of social problems, challenging the survival and well-being of populations over generations.
7. *Geography*: This explains the lifestyle of the people living in different areas like mountains, plains, deserts, forests, sea-shores, etc. Thus, sociology explains the relationship between the geographic determinants and social life.

Thus, sociology needs the support of all the above mentioned disciplines, as they are all social in nature. Sociology cannot thrive in isolation.

Table 26.1 Summary of social sciences

Social science	Sub-groups of relevance to health
I. Behavioral sciences. 1. Anthropology 2. Social psychology 3. Sociology	Physical anthropology Social anthropology Cultural anthropology Medical sociology
II. Other social sciences 1. Economics 2. Political sciences	Health economics

COMMUNITY

Community is a sociological unit of individuals who come together for the common interest of satisfying their day-to-day needs.

Communities are differentiated on the basis of size of the population as Large and Small, on the basis of economic function as Primary, Secondary and Tertiary and also on the basis of whether they are rural and urban depending upon the nature of the occupation of the majority of the population.

In the rural community, the main occupation is the cultivation of plants and maintenance of animals.

A community is called an 'Urban' if:

- Its population is above 5,000
- At least 75 percent of male population is engaged in non-agricultural occupation
- Its population density is at least 400 persons per square kilometer.

CULTURE

It is a learned behavior, consisting of customs, beliefs, laws, religion, moral percepts, arts, skills, etc. acquired through generations, which has a profound influence on health and disease. Such a culture differs from nation to nation (one geographic area to the other) and from religion to religion.

Culture is constantly undergoing a change based on the social, economic and biological needs. The culture binds the individuals in society together.

ACCULTURATION

It means 'culture contact', when there is contact between two persons (or two groups of persons) with different cultural background, there is diffusion (or exchange) of culture both ways, through the means of trade and commerce, education, industrialization, conquest, propagation of religion, etc.

Acculturation has both good and bad-effects, such as changes in food habits, lifestyle of smoking, drinking alcohol, drug abuse, introduction of scientific medicine, etc.

Medias (like TV; cinema; radio, etc.) play an important role in acculturation. The transfer of culture from one geographical area to another area is called 'Transculture'. The psychological tendency of the individual to criticize the culture of other new group is known as 'Ethnocentrism'.

FAMILY SYSTEM

Family is a basic unit of society. It is like a germinal cell from which the society at large develops. A family is a group of individuals related biologically, either by blood or by marriage. The members of the family live together under one roof and share a common kitchen.

Family differs from 'Household', in that all the members of the household may not be biologically related, but live together and share common kitchen. Examples of unrelated households are boarding houses, hostels, residential institutions, rescue homes, jails, ashrams, etc. These are called institutional households.

A family is a primary unit of society in many respects-socially, biologically, economically, culturally, epidemiologically and operationally.

- It is a social unit because the members share a common physical and social environment. The family acts as an instrument of preserving, protecting and propagating the traditional practices of the society.
- It is a biological unit because all the members are related by blood or by marriage and in consequence share a common gene pool.
- It is a cultural unit because the family reflects the culture of a wider society and determines the behavior and attitude of its members.
- It is an economical unit because the earning members pool their income and distribute/share among all the members, depending upon their needs and demands.
- It is an epidemiological unit because the family members share a common genetic, nutritional, social, cultural and economic milieu that influences their health and disease status.
- It is an operational unit because it conforms to the service requirements of family medicine and primary health care.

Family of origin is the family into which one is born and family of procreation is the family which one sets up after marriage.

FAMILY CYCLE

A family is never constant but ever changing. A family undergoes the following phases:

1. *Phase of formation*: This phase starts with marriage and ends with the birth of the first child.
2. *Phase of expansion*: This starts with the birth of the first child and expands with the birth of the successive children. Thus, it is the stage of growth.
3. *Phase of completion*: This ends with the birth of last child.
4. *Phase of contraction*: This occurs when female children (daughters) get married and go to husband's house or sons leave the house in search of the job or separate out eventually and repeat the family cycle. With this there will be reduction in the size of the family. It is also called as 'stage of retraction'.
5. *Phase of dissolution*: This starts when one of the parental couple passes away and total extinction occurs when

the survivor also dies. This is also called 'stage of disintegration.'

Often certain variations and exception occurs such as early death of children or one spouse, divorce, childlessness, etc.

FAMILY TYPES

Nuclear Family (Elementary; Primary Family)

It consists of a couple, with their dependent children, residing under same roof. It is a conjugal arrangement. The relationship is more intimate.

Extended Primary Family

Apart from the couple with their children, it consists of sibling(s) of the husband or wife, with their spouses and children. Thus, two or more primary families are joined horizontally (Lateral extension of primary family).

Three Generation Family

This consists of couple with their children and parents. It consists of members of three generations. Thus, there are two primary families, joined vertically (i.e. vertical extension of primary family).

Joint Family (Joint Extended Family)

In this type, there are two or more couples, all the men being related by blood of patrilineal descent and the ancestral property is held jointly by all the male members of the family. (i.e. several married sons staying together with their spouses and children). There may be variations such as presence of unmarried brothers and sisters living in a joint family or lateral extension of primary family (explained above). Most common type of 'joint family' found in India is really a joint extended family in which husband and wife live together under the same roof, alongwith their married children. It is a 'consaquinous arrangement' (compared to nuclear family).

Broken Family (Broken Home)

In this type, either of the parent is absent, or separated because of death or divorce or imprisonment or enrollment in the war. Even if both are present, father or mother is considered as absent because of drunkenness, chronic disease, mental deficiency or drug-addiction. The social hazards are explained subsequently.

Problem Family

It is the one in which the standard of life is below the minimum and the members of the family are unable to discharge the minimum family obligations due to constant quarrel leading to negligence of children, substandard housing and excessively hostile neighborhood. The home life is utterly unsatisfactory. All the broken families are the problem families. Such families are due to emotional instability, character defects, marital disharmony associated with poverty. Children of broken and problem families go astray and become the victims of prostitution, crime and vagrancy. Such children will also have the risk of retardation of growth and development, suffering from mental deprivation, later they may show psychopathic behavior, subnormal intelligence, and even immature personality. They may also develop antisocial behavior, committing crimes, etc. Social offence is also common among them.

Differences between Joint Family and Nuclear Family System (Table 26.2)

Table 26.2 Differences between joint family and nuclear family systems

Joint family system	Nuclear family system
• Consists of two or more couples, all men related by blood of patrilineal descent	Consists of a single couple and their children
• All the property is held in common and there is division of labor	It is a by-product of industrialization and westernization
• Common in rural India	Common in urban India
• Fast disintegrating	Fast growing
• All the authority is vested on the senior male member of the family	Husband usually plays a dominant role
• It propagates social values among the youngsters, thereby the moral and religious basis are upheld	There is erosion of religious and cultural values resulting in secular outlook
• The strength lies in preservation of social values (sympathy, affection, co-operation, tolerance, sacrifice, etc.)	The strength lies in promoting economic independence, and female emancipation
• Its weakness lies in retarded development, lack of freedom, irresponsible procreation and associated clashes and conflicts	Its weakness lies in fragile unity, erosion of values, and limited leisure

FAMILY FUNCTIONS

Homely Life

The family provides a home with homely life with cardial relations with each other, providing safety and security. Such a home is a cherished possession of man. It is an identification and an address denoting an appropriate placement of the individual in the society. The homely comfort unwinds the tension of the hard-working day and thus provides relaxation physically and mentally.

Economic Security

All the income of the family is pooled and shared, thus providing security to all the dependent members also, in terms of food, clothes, shelter and other necessities of life, such as education, marriage, health care, etc. The inherited property is also controlled by the family. There is division of labor.

Reproduction

A family originates after marriage. The biological urge of mating and procreation (reproduction) transforms the couple into parents, giving more meaning to life. Parents take optimum care for growth and development of children and also their education. Thus, procreation results in new addition to the family and community at large. The sexual gratification is the basic human need.

Education

A home is a temple of learning and mother is the first teacher. There is an atmosphere of love, care and personalized attention. The child learns the language, religion, morals, manners, habits (including health habits) and other elements of culture. The child also learns traditional practices and religious beliefs. As they grow, they realize their rights, duties and responsibilities.

Socialization

By celebrating festivals and participating in social ceremonies and also by cultural and traditional practices the children undergo socialization and enculturation in the family. The children truly become members of the society, in which they are born and there is stabilization of the adult personalities. The process wherein the child gets training of desirable characteristics like love, cooperation, obedience, giving respect to others, etc. and also training in social customs, norms, values and sanctions is called 'Socialization.'

Emotional Support

Family provides emotional support to its members at critical life events like failure in the examination, a mishap or an accident, an illness, bereavement, loss in the business or retirement. It provides support during pregnancy, child-birth, marital conflicts, divorce and widowhood. Thus, family extends emotional support to all the members, by acting as a 'buffer' or 'shock absorber' in the events of stress and strain.

Social Care

The family gives a status in the society to all its members, e.g. use of the surname or family name. The family protects the members from insult, defamation, etc. The family also regulates sex-relations through incest-taboos.

Support

Family gives economic and social support to its members especially weaker individuals like elderly/old persons, handicapped individuals, children, widows, etc. Thus, family carries out social duty.

Bridging the Generation Gap

There is exchange of knowledge and culture from old generation to new generation, while the new generation brings out new knowledge.

Job Distribution

Traditionally, the responsibility for earning the livelihood is the responsibility of adult males in the family, while the female members have the responsibility of child rearing.

ROLE OF FAMILY AND CULTURAL FACTORS IN HEALTH AND DISEASE

Health Perception

A traditional, rural, Indian family perceives health as a token of divine benevolence and disease as a curse or punishment from God. The illness among children is considered as a result of a spell cast by an 'evil eye.' The ignorance and misbeliefs

such as disease due to impurity of blood, breech of a taboo, etc. are deeply rooted among rural and tribal families. The solutions sought are also equally odd and illogical such as appeasement of gods and spirits by performing *poojas* and homas by giving 'prey'. Such irrational beliefs result in stigmatization of diseases like leprosy and interfere with control measures. Diseases like epilepsy and hysteria are regarded as due to a spirit or intrusion of ghost into the body.

Housing Condition

A poor housing condition with ill-ventilation and ill-lighted rooms, often associated with over-crowding and with live-stocks (animals), with lack of drainage facilities, lack of sanitary latrine, lack of clean water supply, kitchen without smoke-vent, infested with cockroaches, rodents and flies, etc predispose to airborne, and vehicle-borne infections.

Personal Hygiene

Certain traditional practices like oil-bath, women massaging with turmeric and other ingredients possessing a beautifying effect, is a healthy practice. Brushing the teeth with 'neem-twig' is believed to promote oral hygiene. Indigenous tooth powders containing charcoal, salt and other ingredients are used to clean teeth and gums. Nevertheless, certain practices like chewing 'pan' with tobacco, smoking or snuffing tobacco seriously undermine oral hygiene. Similarly, consumption of local drinks often leads to devastating consequences, due to adulteration. Certain religious practices such as circumcision and also belief that coitus during menstruation is sinful, etc. are justified on hygienic grounds.

Child Rearing

The child rearing practices has a profound influence on the health of the growing children, such as breastfeeding practices, eating habits, feeding habits, sleeping habits etc. The child care determined by tradition, varies, from society to society. Child care in the West is more rigid and is followed by a set of rules. Traditional practice of treating diarrhea by restriction of breastfeeding, branding the skin to treat illness are brutal practices. However, oil massage and exposing to sun are healthy practices. Applying *Kajal* to eyes may result in conjunctivitis.

Socialization

This is transfer of civilization including culture, beliefs, traditional practices, general codes of conduct, healthy habits, etc. from parents to children, makes the children into future promising citizens of tomorrow. Punishment to misbehavior and rewards for good behavior are all healthy practices.

Personality Formation

Depending upon the set up of the family, cultural practices, behavior of the parents and siblings, family environment, etc. all lay the foundation in promoting the development of personality and also promotes physical mental and social health of the growing children. The process wherein the child gets the training about social customs, norms and values (like love, affection, cooperation, obedience, respect to elders, etc.) is called 'Socialization'.

Lifestyle

Certain unhealthy, traditional, practices are responsible for prevalence of diseases in the community such as walking barefoot and indiscriminate defecation for ankylostomiasis; defecation on the banks of rivers, lakes, ponds, channels, etc. associated with lack of protected water-supply contribute to prevalence of water-borne diseases, often giving rise to epidemics; poor housing with dampness of floor and walls associated with burning fuel for cooking purposes, increases the prevalence of respiratory infections; sleeping outdoors for malaria endemicity; smoking, alcoholism and chewing *pan* with tobacco are known to result in certain cancers, etc.

Dietary Practices

Many dietary practices in India are responsible for prevalence of malnutrition and its consequences. High-risk groups are mothers and children. Many orthodox families, subsisting purely on vegetarian diet, are deprived of first-class (animal) proteins. Poverty, illiteracy and ignorance associated with food taboos and cooking practices are the social factors. Preferential feeding for earning male members and children, predisposes the women-folks to eat less and left-over food. Food faddism such as consumption of meat, egg or fish during pregnancy produces 'heat', deprives the expectant mothers resulting in protein deficiency. Foods like, milk, curds, vegetables and lemons are considered to cool the body. The practice of fasting during occasions, is another social/cultural practice affecting the nutritional status. Adulteration of milk is another common practice.

Since majority of population live in rural areas the nutritional disorders are more in rural areas and urban slums.

Thus, dietary practice is a subject of widespread customs, habits and beliefs.

Disposal Practices

The habit of accumulating solid waste near dwellings, promotes breeding of flies and attracts rodents and roaches. It promotes insanitation. The habit of open air defecation results

in soil pollution, water pollution and fly breeding. Bathing the animals in lakes and ponds also results in associated risks of water pollution.

Reproductive Behavior

Early marriages for girls is still observed in certain traditional rural families, which predisposes for high fertility and other consequences of teenage pregnancy.

Polygamy (one man marrying several women) predisposes for large family size. Polyandry (one woman marrying several men) can cause reduction in the population size. However, polygamy and polyandry has increased STDs in the community.

Gender preference may expose the women to repeated pregnancies and its consequences.

Men resisting vasectomy and subjecting the women for tubectomy is an example of gender discrimination in India.

Because of universality of marriages in India, there are no problems of unmarried mothers and illegitimate children unlike in the West.

Child marriages are fortunately disappearing.

Care of the Sick and Injured

Mother usually provides the front-line care of the sick and injured persons in the family. She provides home remedies and nursing care depending upon her knowledge.

Pregnancy and childbirth being the recognized periods of dependency, they are provided with financial help, maternity leave, nutritional supplements and decreased responsibilities by the society and also they are taken special care by the family members.

Aged and handicapped people are also taken care of, but in the joint families.

Stabilization of Adult Personality

The stress of modern life is associated with mental illness and behavior disorders. The stress could be injury, illness, births, deaths, tension, emotional stress, worries, anxiety, economic insecurity, etc. The family acts as a good 'Shock absorber' to the stress and strains of life. The hazards of stress are peptic ulcer, hypertension, bronchial asthma, which are called 'psychosomatic' diseases.

SOCIAL PROCESS

The important social processes are socialization, role, acculturation, social controls, social change and social stratification.

Socialization

It is a process of acquiring culture and norms of the family and becoming a member of the society. Explained already.

Role

It is the behavior of an individual in an expected way when he/she is in a certain position.

Roles are of two types. 'Ascribed role' is given to that individual by virtue of age, sex, birth, etc. 'Achieved role' is acquired by the individual by virtue of certain characteristics like education, qualification, experience, etc. Professional roles like doctor, nurse, lawyer are examples of achieved roles.

When a person is trained for a particular role, the process is called 'role induction'. Example, professional training of doctors and nurses.

Acculturation

Acculturation means culture contact between individuals of different types of culture. Explained already.

Social Controls

Sociologists consider that social behavior should be subjected to certain constraints and regulations. There are two types of social controls—formal and informal.

- *Formal controls*: Laws and enactments of the Parliament/ Assembly are examples of social formal controls. Small institutions like hospitals also have their own formal controls.
- *Informal controls*: These are not in the form of laws but they serve as pressures exerted on the individuals for desired behavior. Thus, there is no formal law which states that a mother should take care of her child. Oath of Hippocrates is another example of informal social control, which guides the behavior of doctors.

Social controls can be used to bring a desired change in the behavior of the people. Example, the monetary and other benefits offered for couples undergoing tubectomy/ vasectomy operation is an example of use of social control for desired change.

Social Change

It is a complex process that involves change in:

a. Aggregate attributes of the population—such as changes in age-sex composition, occupation, literacy, etc.
b. Social behavior of the population—such as suicides, homicides, juvenile delinquency, etc.

c. Social structure of the population—such as changes in family structure, rise and fall of institutions, changes in social control mechanisms, etc.
d. Cultural patterns of the population—such as changes in customs, values, knowledge, expressive symbols, etc.

Improvement in health is one aspect of social change. Doctors can play an important part in bringing this change by the following roles:

i. *By providing impetus*: Doctor can demonstrate why an epidemic has occurred and how it can be prevented.
ii. *By forming peer group*: Doctor can mobilize the resources like nurses or other professionals. He can also motivate the identified individuals in the community for desired changes.
iii. *By identifying the social controls*: Doctor can handle a situation tactfully and motivate the couple to accept contraceptive method, thus bringing a desirable change.

Social Stratification

Social stratification means division of the society into various strata based on age, sex, marital status, place of birth, citizenship, occupation, type of activity, language, income, religion, caste, literacy level, etc.

Sociologists study the process of stratification to find out its association with health and disease, for example, a close association existing between low socioeconomic status and diseases like malnutrition, diarrheal disease, respiratory disease, vitamin deficiency diseases, etc. is well known. Similarly an association also exists between higher economic status and diseases like hypertension, coronary artery disease, diabetes, peptic ulcer, obesity etc. With this association between the economic status and the disease, it helps the epidemiologist to identify the 'at risk' groups (susceptible groups) for a particular disease, so that measures can be undertaken to protect that group.

The characteristics commonly employed for social classification are education, occupation and income. The social status associated with higher or lower caste is gradually diminishing.

- *Education*: 'Any person, who is able to read and write with understanding in any language' is considered as literate. It is well known that higher the literacy level, poorer the morbidity and mortality and vice versa in general. Example, lower the educational status of mother, higher the maternal mortality and infant mortality in India.
- *Occupation*: Registrar General of England has grouped occupation into five classes Cl I-Professionals; Cl II-Managerial; Cl III - Clerical and skilled; Cl IV—Semiskilled and Cl V—Unskilled. Occupation not only determines the income but also the life-style of the individual.
- *Income*: This is the most important determinant of health and disease because it determines the living condition, cleanliness, education, lifestyle, etc.

Socioeconomic Status

The three variables namely, education, occupation and income together determine the socioeconomic status of the individual/family.

Classification of Socioeconomic Status

There are many methods of assessing the S-E status namely BG Prasad's method, Kuppuswamy's method, Pareek's method, Kulshreshta's method, etc.

A. *Prasad's method*: BG Prasad (1961) employed 'per capita family monthly income' as an indicator and classified the status into five classes. This is useful for social classification of the family and not individuals. Since the value of rupee is coming down, it is necessary to update the value of rupee by applying appropriate 'Correction factor' (CF). The original classification and updated version as per value of rupee as per All India Consumer Price Index (AICPI) of rupee for April 2012 is given in **Table 26.3**.

Correction factor is obtained by multiplying AICPI by 4.93 percent (i.e. 0.0493) as suggested by Kumar. This is preferred for rural areas. This is modified BG Prasad's social classification.

= Per capita family monthly income of 1961 as suggested by BG Prasad × Correction factor (CF)

$$\text{Where, per capita monthly income} = \frac{\text{Total monthly income of the family}}{\text{Total members of the family}}$$

CF = Value AICPI (which is variable and it was ₹949 in April 2012) multiplied by 0.0493, which is a finite number/multiplier (linking factor).

Therefore, CF during April 2012 was 949 × 0.0493 = 46.78 (≈ 47).

Table 26.3 Assessment of socioeconomic status by modified BG Prasad's classification

BGP classification of 1961 based on per capita monthly income × CF	Modified by BG Prasad classification for the year 2012 (April)	Socioeconomic class status
₹ 100 and above × 47	₹ 4700 and above	I
₹ 99–50 × 47	₹ 4699–2350	II
₹ 49–30 × 47	₹ 2349–1410	III
₹ 29–15 × 47	₹ 1409–705	IV
₹ 14 and below	₹ 704 and below	V

Source: Kumar P. Indian Journal of Community Medicine. 1993;18:2

N.B.:

i. ₹100 during 1961 is equivalent to ₹4700 during April 2012.

ii. Per capita family monthly income of today (as assessed by the above formula) has to be fitted in the second column and assessed accordingly.
iii. AICPI is variable.

Thus, classification can be derived for any period by referring AICPI of that period.

B. Kuppuswamy B (1962) prepared a socioeconomic scale for use in urban areas by employing three major characteristics namely education (literacy level), occupation and monthly income of the individual.

A weighted score is given for each of the three characteristics and the total score is calculated and the individual is assigned the appropriate social class. As in Prasad's method, in this method also income should be updated by applying appropriate correction factor.

Modified Method

The original method is for classification of individuals. The income characteristic is based on monthly income. A modified version is used for classification of families, **(Tables 26.4 and 26.5)** and not individuals based on per capita monthly income and updated by applying appropriate correction factor. The parameters modified are education and occupation of the head of the family and the income of the whole family pooled from all the sources.

Table 26.4 Socioeconomic status scale of Kuppuswamy (Urban, 1976) Updated for June 2012

Score card		
A.	Education 1. Professional or honors 2. Graduate or postgraduate 3. Intermediate, post-high school diploma 4. High school certificate 5. Middle school certificate 6. Primary school or literate 7. Illiterate	Score 7 6 5 4 3 2 1
B.	Occupation 1. Profession 2. Semi-profession 3. Clerical, shop-owner, farmer 4. Skilled worker 5. Semiskilled worker 6. Unskilled worker 7. Unemployed	Score 10 6 5 4 3 2 1
C.	Family Income per month (in Rs)* (updated for June 2012) 1. >30,375 2. 15188–30374 3. 11362–15187 4. 7594–11361 5. 4556–7593 6. 1521–4555 7. <1520	Source 12 10 6 4 3 2 1

Contd…

Contd…

Score card			
	Total score 26 to 29 16 to 25 11 to 15 5 to 10 < 5	 Middle Lower 	Socioeconomic class Upper (I) Upper middle (II) Lower middle (III) Upper lower (IV) Lower (V)

Source: Indian Journal of Pediatrics. 2003;70:3
This is to be updated for the current year.

Table 26.4 shows how index and base year have seen changes for reference index and has been used to calculate inflation based conversion factor.

Table 26.5 Year-wise reference indices

Year	Reference index
1960	100 (base)
1976	296
1982	490–100 (new base, applied by Mishra et al., for updating in 1998)
1998	405
2001	458–100 (new base, applied by Kumar et al., for updating 2007)
Price index by old base for 2001 = 458 Assuming, price index by new base for 2001 = 100 Price index by old base for 1998 was 405 Price index by new base for 1998 = $\frac{100}{458} \times 405 = 88.42$	

Kuppuswamy's scale used index for 1960 as 100, increased to 296 in 1976 and 490 in the year 1982. Here the need for conversion factor arose, because it takes into account of hike in original price index as well as its change of base value as 100. Therefore, conversion factor needs to be derived every year using current price index for industrial workers (CPI IW) and base year for that index. This can be understood by the following exercise done for few years in serial **(Table 26.6)**.

Table 26.6 Current price index for industrial worker (CPI IW)

Year	CPI (IW)	Conversion factor
2008	147	147 ÷ 88.428 = 1.66
2009	169	169 ÷ 88.428 = 1.91
2010	181	181 ÷ 88.428 = 2.05
2011	185	185 ÷ 88.428 = 2.09
2012	198	198 ÷ 88.428 = 2.24

Multiplying this factor yields the inflated rates in different income groups in Kuppuswamy's socioeconomic scale for different years. **Table 26.7** shows the update done in 1998 and on yearly basis since 2007.

Table 26.7 Kuppuswamy's socioeconomic scale: Update of income range

1998	2007	2008	2009	2010	2011	2012	Score
>13500	>19575	>22410	>25785	>27675	>28215	>30375	12
6750-13499	9788-19574	11205-22409	12892-25784	13837-27674	14107-28214	15188-30374	10
5050-6749	7323-9787	8383-11204	9645-12891	10352-13836	10555-14106	11362-15187	6
3375-5049	4894-7322	5602-8382	6446-9644	6919-10351	7053-10554	7594-11361	4
2025-3374	2936-4893	3361-5601	3867-6445	4151-6918	4233-7052	4556-7593	3
676-2024	980-2935	1122-3360	1291-3866	1386-4150	1413-4232	1521-4555	2
<675	<979	<1121	<1290	<1384	<1412	<1520	1

Source: Neeta Kumar. Kuppuswamy's Socioeconomic Scale. Updating income ranges for the year 2012. IJPH 2012;56:103-4

With the increasing price, the income grading can be updated by using this submission.

C. The assessment of SES developed by Pareek and Kulshrestha is based upon nine variables as follows:
   - Caste, occupation of the head of the family, education of the head of the family, level of social participation of the head of the family, land holding, housing, farm power (owning animals like bullocks, camel, elephant, horse or even tractor, etc.), material possessions and type of the family. Each characteristic is given a score.

     The total score is graded into five SES categories like upper, upper-middle, lower middle, upper lower and lower classes **(Table 26.8)**.

D. Hollingshed in USA employed three variables viz, education, occupation and residential address for measuring SES.

Below Poverty Line

Planning Commission of 1977 defined below poverty line (BPL) as a cut-off line of per capita monthly income, below which it is not possible to purchase food as to obtain minimum desirable limit of energy, 2400 kcals per person per day in rural areas and 2100 kcals in urban areas. In monetary terms these people fall below the socioeconomic class V according to modified BG Prasad's classification. Accordingly, about 28.6 percent of population in India is living below poverty line (Report, 2003). This was 36 percent during 1990s. BPL population is more in rural areas than urban areas. This provides an estimate of the magnitude of the destitution and also the uneven distribution of national wealth.

The poverty is usually associated with many social factors like illiteracy, ignorance, lack of knowledge, poor living condition, over crowding, lack of sanitation, blind beliefs, taboos, etc. which are all interlinked, predisposing for poor acceptance of health services, contributing significantly for the increased fertility, increased morbidity and mortality and decreased life expectancy in our country.

Thus, BPL families are at risk families with reference to diseases. The diseases are usually severe, due to malnutrition. The poverty leads to sickness and sickness leads to further poverty, constituting a vicious cycle.

Health Hazards of Poverty

- *Communicable diseases*: Water-borne diseases, food-borne diseases, respiratory diseases, STIs including HIV/AIDS.
- *Noncommunicable diseases*: Malnutrition, anemia, rheumatic diseases, vitamin and mineral Deficiency diseases.
- *Social problems*: Prostitution, drug addiction, alcoholism, unmarried mothers, family disintegration, unemployment, under employment, predisposing for antisocial behaviors like beggary, violence, delinquency, terrorism, corruption, burglary, murder, etc.
- *Mental problems*: Depression, loneliness, inferiority complex, suicidal tendencies, etc.
- *Others*: Like scabies, dental caries, pediculosis, etc.

Thus, the social, health and economic aspects are inextricably interlinked among poor people, affecting the progress of the country. Therefore, such people are identified in the community by various parameters like income, landholding, type of house, literacy level, availability of clothes, food sanitation, family size and indebtedness and are issued BPL card (Yellow card). The BPL card holders are provided the following benefits:

- *Janani Suraksha Yojana (JSY)* for pregnant mothers aged 19 years and above up to two living children (Described under RCH-II).
- *National Maternity Benefit Scheme (NMBS)* to provide better diet for pregnant women.
- *Insurance of women workers* the premium per member is ₹ 200, 50 percent of which is paid by social security fund. The insurance benefit is ₹ 20,000 for natural death, ₹ 50,000 for death/disability resulting from accident and ₹ 25,000 for partial disability.

Table 26.8: Pareek's method of socioeconomic classification (rural area)

	Components	Weighted score		Components	Weighted score
A.	**Caste**		**F.**	**Family members**	
	• Scheduled caste	1		• Up to 5	1
	• Lower caste	2		• Above 5	2
	• Artisan caste	3	**G.**	**House**	
	• Agriculture caste	4		• No house	1
	• Prestige caste	5		• Kutcha house	2
	• Dominant caste	6		• Mixed house	3
B.	**Occupation**			• Pucca house	4
	• None	0		• Mansion	6
	• Laborer	1	**H.**	**Farm power**	
	• Caste occupation	2		• No drought (buffalo/cows) animal	1
	• Business	3		• 1-2 drought animals	2
	• Independent profession	4		• 3-4 drought animals	3
	• Cultivation	5		• 5-6 droughts animals or tractor	6
	• Service	6	**I.**	**Material possession**	
C.	**Education**			• Bullock cart	1
	• Illiterate	0		• Cycle	1
	• Can read only	1		• Radio	1
	• Can read and write	2		• Chairs	1
	• Primary	3		• Improved agriculture equipments	2
	• Middle	4		• None	0
	• High school	5		**Socioeconomic class**	
	• Graduate and above	6		*Total score*	*Grading*
D.	**Land**			Score more than 43 (Upper)	I
	• No land	0		Score 33-42 (Upper middle)	II
	• Less than 1 acre	1		Score 24-32 (Lower middle)	III
	• 1–5 acre	2		Score 13-23 (Upper lower)	IV
	• 5–10 acre	3		Score less than 13 (Lower lower)	V
	• 10–15 acre	4			
	• 15–20 acre	5			
	• 20 and above	6			
E.	**Social participation**				
	• None	0			
	• Member of one organization (like Panchayat member, Nambardar, etc.)	1			
	• Member of more than one organization	2			
	• Office holder in such organization	3			
	• Wider public leader	6			

- *Bhagyalakshmi scheme* ₹10,000 deposit will be made for each of the first two female children, which will be returned with interest, after the child attains 18 years of age.
- *Social assistance* such as old age pension scheme, family benefit scheme, widow pension scheme (widow should be 18 years old).
- *Prasooti araike*: This scheme is to promote antenatal care by giving ₹1,000 at 6th month of pregnancy and another ₹1000 at 9th month, total of ₹2000.

Social Class Difference in Health and Disease

The health and disease are not equally distributed among the people of different social classes. The people of upper socioeconomic class have better health and lesser morbidity, mortality than those of lower social class.

The factors which influence the prevalence of increased morbidity and mortality among the people of lower socio-economic class are:

- Size of the family, which is usually bigger, resulting in overcrowding.
- Early marriages, resulting in more frequent pregnancies depleting the maternal reserve.
- Utilization of health services, which is less frequent.
- Beliefs, such as diseases due to curse or punishment from God.
- Physical environment, such as poor housing with poor lighting and ventilation, lack of protected water supply, etc.
- Illiteracy and ignorance.
- Genetic endowment, i.e. tendency for consanquincous marriages.
- Attitude to disease which is usually indifferent, etc.

Thus, the aim of community medicine is to reduce the social class differences in health and disease.

SOCIAL FACTORS IN HEALTH AND DISEASE (SOCIAL PATHOLOGY)

Just like human pathology deals with the study of morbid structure of the body organs, so also social pathology deals with the study of defects (social problems) in the society. These social problems can be grouped into three categories: social constraints, social evils and social deviance.

Social Constraints

These are the restrictions or impediments, which prevent the prosperity and progress of the people of the community predisposing for increased morbidity and mortality. These are:

Poverty

It is a state of poor economical status, opposed to richness. The poor are those who are below the poverty line, i.e. socio-economic class V, whose per capita daily consumption of food is less than 2400 kcals in rural and 2100 kcals in urban areas (destitution).

Poor and destitute population in India is more than 300 million.

Poverty impedes progress and undermines all factors of human life such as housing, sanitation, getting health care services, dietary intake, etc. resulting in increased, morbidity, mortality and high fertility of the afflicted population.

Affluence, opposite of poverty is also not free from harmful health effects. Obesity, hypertension, diabetes mellitus, heart diseases and cancers of prostate, breast and uterus are commoner among the rich than the poor.

Illiteracy and Ignorance

Illiteracy means inability to read and write with understanding (a person who can read but not write is treated as literate). Ignorance means lack of awareness or knowledge about the rules of healthy living. Highly educated persons can be ignorant.

Illiteracy goes hand in hand with poverty. Illiteracy and ignorance are the root causes of poverty in India, resulting in unhealthy lifestyle.

Ignorance plays an important role in disease causation as shown below **(Table 26.9)**:

Table 26.9 The role of ignorance

Ignorance about	Disease causation
Dangers of promiscuity	STIs, HIV/AIDS.
Heat and electricity	Injuries and burns
Poisonous mushrooms	Food poisoning
Treating wounds with soil, dung, etc.	Tetanus
Vaccination after dog-bite	Rabies
Warning signals of cancer	Incurable cancer.

Migration

Migration is the movement of the people, from one place to another, within or outside the country with the intention of settling down for a protracted period of time. Whereas travel is the movement of the people from one place to another and coming back after some time.

Migration of the people usually takes place from rural to urban areas because of job opportunities, facilities available for education, healthcare, communication, recreation, etc. Such migrants usually settle in peri-urban slums, where the living conditions are poor and they suffer from a host of air-borne, water-borne, soil-borne, dust-borne, contact-borne

and vector borne diseases. They are also exposed to traffic hazards and social evils of various kinds. Migrants may also contract man made malaria.

Laborers migrates to places, where dams or multi-storied buildings are being constructed or railway line is being laid or other large projects are undertaken, resulting in eruptions of slums and above mentioned hazards.

Traveling from one place to another also results in the spread of diseases including international spread of diseases, resulting in the birth of 'emporiatrics' (the science dealing with the study of prevention of international spread of diseases.)

Travel is also associated with the risk of injuries and accidents.

Industrialization and Urbanization

This not only generates a huge demand for manpower but also leads to environmental pollution like air pollution, water pollution, soil pollution and noise pollution. The population at risk includes not only the industrial workers but also the local population residing in that area.

Rapid and unplanned industrialization and urbanization leads to variety of problems which are identified as follows:

- Population problems—needs of water supply, sanitation, waste disposal, housing, land tenure, communication facilities, law and order facilities, education, health and social facilities, etc.
- Industrial problems—consists of environmental and industrial hazards.
- Health problems—result from poor housing, overcrowding and in sanitary arrangements, etc. resulting in infectious diseases, deficiency diseases, stress related diseases and accidents.
- Social problems—include evils like smoking, alcoholism, drug abuse, prostitution, gambling, burglary, juvenile delinquency, etc.

Social Evils

These over undesirable practices resulting in multiple social problems eroding the social fabrics of the society. These are as follows:

Smoking Tobacco and Drinking Alcohol

Smoking tobacco in the form of cigarette, *beedee*, *hookah* or *chutta* (home made cigar) or tobacco consumption in the nonsmoking form such as tobacco laden *paan* or snuff preparations, results in untoward effects due to nicotine and carbon monoxide. The health hazards of smoking are grouped as follows:

- Malignant diseases like cancer of lung, larynx, pharynx, esophagus and Ca-rectum.
- Nonmalignant diseases like chronic bronchitis, emphysema, peptic ulcer, coronary artery disease and stroke.
- Obstetric problems like intrauterine growth retardation, spontaneous abortion, prematurity, still-births, neonatal deaths and sudden infant death syndrome.
- Passive smoking irritates the mucosa of the eyes, nose and throat of nonsmokers, besides increasing the risk of coronary heart disease and lung cancer.
- Tobacco used in smokeless form is a major cause of oral cancer.

While smoking is not associated with any undesirable social consequences, alcoholism is associated with development of addiction and adverse behavior outbursts. Consumption of the adulterated country liquor claims many innocent lives. Presence of food in the stomach delays the absorption of alcohol.

Health hazards of alcoholism are:

- Malignant diseases like cancer buccal cavity, cancer pharynx, cancer larynx, cancer esophagus.
- Nonmalignant diseases like gastritis, hepatitis, cirrhosis of liver, hypertension, cardiomyopathy, cardiovascular accidents, etc.
- Behavior problems like violent outbursts, family conflicts, divorces, assault, rapes, domestic accidents, traffic accidents, occupational accidents, drowning deaths, burglaries, hooliganism, etc.

Caste and Casteism

Caste system is the most uncompromising, vertical division of Hindu society. While social stratification permits movement of individuals from one class to another by dint of socioeconomic change. Caste system does not allow intercast movement on any account. A caste is a permanent attribute of an individual from birth to death.

This caste system has divided the Indian society into bits and pieces, arresting the human progress by disallowing free movement of the people. It encourages group rivalries, which the politicians utilize for their election. Caste system is an indelible scar on the face of Indian society. Casteism vitiates the administrative set-up, erodes the fundamental three principles of Indian politics—secularism, socialism and democracy. It threatens the unity and integrity of the country and arrests the socioeconomic progress and prosperity.

Gender Bias and Gender Discrimination

This is a social evil and inhuman practice of favoring the males and disfavoring the females. It is more predominant in traditional families.

Gender discrimination is reflected in sex ratio of the population, life expectancy, literacy rate, morbidity and mortality rate, school enrollment, school dropout, job opportunities, economic and political participation of the people.

Gender discrimination is a life-long process that starts virtually from womb and ends at the tomb. It threatens the growth and survival of female fetus, female infant, girl child,

adolescent girl and the adult female at the hands of their own kith and kin, not excluding their parents.

With a view to restore the status of women, several legislative reforms were undertaken in India after independence. The constitution of India confers equal rights and status to women. Several acts have also been passed, such as Hindu Marriage Act, 1955; Hindu Adoption and Maintenance Act, 1956; Hindu Minority and Guardianship Act, 1956, etc.

Child Neglect and Child Abuse

Child neglect means depriving the child of basic necessities such as love, care, affection, attention, food, cloth, shelter, education, etc. either due to extreme poverty or due to the presence of antisocial practice in the home such as prostitution, crime, drug-abuse, gambling, alcoholism, smuggling, death or disease of the parents, divorce of parents, etc.

Child abuse by parents occur due to physical injury to the child by hurting them using hands, sticks, or any available object, etc. Child abuse is an outcome of frustration and intolerance on the part of the parents, especially when they are under the influence of drugs or alcohol.

Sexual child abuse like rape is not unusual. Incest is a family-related abuse, in which sexual relationship develops between the two individuals who are too close to marry; father-daughter incest is the most predominant form.

Child Labor and Child Abandonment

The children who should have been at school at that age are condemned to labor due to poverty of the family, and in the process, they suffer from exploitation, discrimination, and deprivation of love, security, nutrition, education, care, etc. Working under precarious conditions results in retardation of growth and development, occupational hazards and accidents, arresting the personality development, missing the opportunities of fun, play and other recreations.

Child abandonment is seen in problem families leading them to move to the streets, making them beggars, porters, street vendors, news-paper hawkers, shoe-shine boys or hotel waiters. When exposed to inhuman and unhealthy environment, they may do antisocial activities like crime, prostitution, assault, theft, rape, burglary, etc. and may develop hatredness for regular employment and an organized way of life.

Stress and Stress Behavior

Stress is a disturbance in the harmony of an individual due to an internal or external stimulus, originating from personal, familial, social or cultural sources.

Personal stress factors result from the following:

- Physical defects and disabilities
- Personal deficiencies
- Personal failures (in education, business, married life, etc.)
- Personal losses
- Unrealistic expectations, aspirations, unemployment, etc.

Familial stress result from:

- Problem family
- Broken family, etc.

Social stress factors, result when there is a threat to the life of family members, as under the situations:

- Group rivalries
- Imposition of curfew, following violence
- Social evils like corruption, crime, ostracism, etc.
- Threat of attack from the country
- Floods, famine, hurricane, earthquake, etc.

Cultural stress factors include change in lifestyle, etc.

The response to stress may be positive or negative. In positive response, the individual faces the situation with courage, conviction and confidence or by accepting the situation as it is and neutralizes the discomfort of stress by rationalization.

In negative response, he opts to go out of the situation by pretending to be ill or making excuses or seeks the rescues of drugs or alcohol or by blaming others for his failures or by transmitting it to his spouse or children by indulging in spouse abuse and child abuse.

Continued stress predisposes to headache, migraine, nervousness, insomnia, fatigue, hyperacidity, amenorrhea, menstrual disorders and psychosomatic conditions like peptic ulcer, hypertension, asthma, gout, ulcerative colitis, lichen planus, etc.

Prostitution

Prostitution or Harlotry is defined as offering of sexual services for a consideration of money or gift like saree, jewelry, dinner, etc.

Prostitution is a need based profession. It involves males as well as females. It is on the increase all over the world. It is considered as a dirty and immoral profession. It degrades both the prostitute and her client, pointing them as stigma. Abusive language is built around prostitute.

The profession of prostitution is unique in that it does not require any investment, experience or education. She retires from the profession when her youth deserts her.

Female prostitutes are essentially runaways from broken or problem families either for easy money or they are victimized. Such girls pass through a phase of hopelessness and helplessness and accept prostitution as a way of life. They suffer from a sense of guilt, a poor self-image and a feeling of depression.

The male prostitution starting from the teenage, with a high-risk background family, usually comes to an end, once

the boys cross the adolescent age. However, some of these boys become hostile and indulge in antisocial activities. Transvestites (hijras) also exist.

Another variant of female prostitution is 'Devadasi' system existing in Karnataka and Maharashtra. Devadasi (a servant of God) is a sacred prostitute. Devadasi is a girl 'married' to God or Goddess. She performs religious rites and makes offering to the diety. She is generally expert in dance, singing and massaging. She is a community prostitute.

Causes of Prostitution

- Poverty in rural areas and urban slums
- Greed for money and luxury items by girls from urban, middle classes
- Broken homes and problem families
- Glorification of sex in films and television, promoting for prostitution
- Influx of foreign tourists
- Trafficking in women.

Health Hazards

Occupational health hazard being STIs including HIV/AIDS, Alcoholism, drug addiction, infertility, pregnancy complications, depression, loss of self-esteem and social stigma are other common problems. Many of the prostitutes get bruises, cuts and contusions because of sexual and physical abuse by brothel keepers, pimps and police.

Dowry System

This was started as a symbol of love by the parents to their daughter on the eve of her marriage. But now it has grown into a social evil, leading to suicides, homicides, tortures, etc.

Under 'Dowry Prohibition Act,' 1986 the minimum punishment for taking or abetting the taking of dowry has been raised to 5 years of imprisonment and a fine of ₹15,000.

Social Deviance

It is an anti-social behavior occurring among those who have failed to conform to acceptable social norms and adopt a way of life which is against the interest of the society, causing damage to themselves, to the family and to the community at large.

These are:

i. Drug abuse—explained under mental health
ii. Juvenile delinquency—explained under MCH services
iii. Suicide.

Suicide

It is an act usually committed by the individuals who develop disharmony due to stress and are unable to face it because of inadequate coping competence.

The contributing factors are incomplete personality development, lack of skill, training and education, etc.

The precipitating factors to commit suicide include unemployment, extreme poverty to cope up with life, heavy business loss, loss of kith and kin or spouse, disturbed family, impaired health status, pregnancy before marriage, frustration, depression, etc. Such individuals develop poor self-image, feel themselves as a burden to the family and society and commit suicide, as a last resort.

MANAGEMENT OR PREVENTION OF SOCIAL PATHOLOGY

Management of Social Constraints

Developmental Approach

Poverty can be eliminated by the people-friendly government by introducing a balanced national development, ensuring distribution of economic gains with preferential consideration for the poor.

Socioeconomic development should be decentralized so as to discourage rural-urban migration.

Development program to alleviate poverty, to generate employment opportunities, to launch vocation oriented education, family planning are quite useful approaches.

Industrial development should be planned to preserve and protect the ecosystem and to discourage the proliferation of slums.

Educational Approach

Only education can eliminate illiteracy and ignorance. Basic compulsory education, vocation oriented education are useful approaches. Mass health education can dispel misbeliefs.

Legal Approach

Enactment of laws and their enforcement, guides the growth and development of industries on scientific lines, prevents environmental pollution, protects the workers, and the residential population residing in the vicinity of industries.

Management of Social Evils

Developmental Approach

Socioeconomic development of the country can mitigate the social evils like child labor, child abandonment, prostitution, etc. It also reduces stress induced behavioral disorders.

It also narrows the gap between socioeconomic classes and eliminates caste-system.

Educational Approach

Health education programs creating awareness of hazards of alcoholism, smoking, drug abuse, etc. goes a longway in setting a trend towards abstinence of these things.

Parental education on their moral obligations towards their children holds a great promise in controlling social evils like child abuse, child neglect and child labor. Female education is an ideal means of exploding the myth of gender bias and eliminating gender discrimination and induces female empowerment.

Legal Approach

Enactment and enforcement of laws banning social evils like alcoholism, casteism, child-abuse, gender-abuse, child labor, etc. can control these evils.

The legal measures to control hazards of smoking are:

- Banning advertisements on all forms of tobacco use.
- Inserting statutory warnings on cigarette packets.
- Banning smoking in schools, offices, cinema-halls, conveyances, public gathering areas like markets, bus-stops and trains, etc.

Legal measures also help in controlling prostitution and such other crimes like corruption, etc.

Rehabilitation Approach

Mere enforcement of the laws cannot control the social evils specially prostitution, child neglect, etc. unless it is supported by rehabilitation of prostitutes and child-placement procedures. Rehabilitation of victimized individuals is absolutely necessary.

Management of Social Deviance

Educational Approach

School children constitute 'a captive audience' for health education. They are educated about the hazards of smoking and alcoholism and drug in take, involving school teachers.

Parents should try to serve as role models for their children, by refraining from smoking, alcoholism and drug intake. Parents must strive to create a peaceful, relaxed, loving and caring family environment conducive to social and psychological health of their children.

Timely interventions during the crisis affecting the harmony resulting from stress can prevent deterioration and can prepare a healthy personality development.

Rehabilitation Approach

Centers having diversional persuits like sports, games, music, paintings, etc. prevent the deviance of adolescents specially taking drugs by focussing their attention on certain constructive endeavors.

Two kinds of reformatory schools available in India are Borstals (for deviant children above 16 years) and juvenile homes, which rehabilitate the deviant children psychologically and socially.

Legal Approach

Children Act, 1960; provides care, attention and rehabilitation of neglected, handicapped and victimized children.

Juvenile Justice Act, 1986; provides the measures for the prevention, treatment and rehabilitation of juvenile delinquents outside the prison environment.

Legal measures are ineffective without political will and public cooperation.

Social Security

Described under occupational health.

Social Defence

It is a collective, organized, action launched by the society against anti-social activities which are likely to undermine the well-being of the people by polluting the socio-ethical environment.

Such defence movements/actions draws the attention of the government and eventually results in formation of legal measures.

Social defence helps in controlling social evils like alcoholism, gambling, prostitution, drug abuse, child abuse, dowry system, casteism, suicides, etc.

In response to public demand or social defence, Government of India has introduced a variety of legislative measures (Acts) like Hindu Marriage Act, 1955; Hindu Succession Act, 1965; Hindu Adoption and Maintenance Act, 1956; Hindu Minority and Guardianship Act, 1956; Child Marriage Restraint Act, 1978; Child Labor Protection, and Regulation Act, 1986; Prevention of Food Adulteration Act, 1954; Consumer Protection Act, 1986; Environmental Protection Act, 1986; Prostitution and Immoral Traffic Act, 1958, etc.

SOCIAL RESEARCH

It is a research in social medicine to find answers to social problems. It involves making a study of finding out the causation and perpetuation. Social research helps in ascertaining the knowledge, attitude, behavior and practice of people in relation to health. It also helps in planning and programming health services. The important methods employed in social research are interview method, questionnaire method and case-study method. The persons who do social research are called social scientists.

Interview Method

This is a very good method to elicit the social and psychological factors which are recognized dominant factors in the natural history of the disease.

This method consists of face to face interaction between an investigator (or interviewer) and the respondent (or the interviewee).

Aims of Interview

- To secure information by direct contact/interaction.
- To form a hypothesis.
- To collect data from secondary sources.

Types

There are different types of interview methods, depending upon:

a. The unit of interview
b. The purpose
c. The technique
d. The area of enquiry.

a. *Depending upon the unit of interview, there are two subtypes:*
   i. *Individual interview:* Here, the respondent is a single person. This helps to collect the personal information in detail. This is also called 'Unit interview'.
   ii. *Group interview:* Here the respondent consists of a group of people. Since the questions are addressed to the entire group, the group should be homogeneous. This method helps to collect more information in less time with less effort.

b. *Depending upon the purpose, there are two types:*
   i. *Diagnostic interview:* This consists of taking a detail clinical history by the doctor from a patient, which helps to make a provisional clinical diagnosis.
   ii. *Therapeutic interview:* This type of interaction takes place between a psychiatrist and a psychiatric patient, and an attempt is made to educate the patients, build up their confidence and modify their behavior to adapt to the life situation successfully.

c. *Depending upon the technique of interview, there are two types:*
   i. *Direct or structured interview:* In this type, a proforma containing a set of predetermined questions, is prepared in a sequential order and the answers are obtained from the respondent. In this method, the respondent has a limited freedom.
   ii. *Nondirective or unstructured interview:* In this type, there are no predetermined questions. The interviewer collects the information by free discussion, in a relaxed manner. The respondent is free to include or exclude some points.

d. *Depending upon the area of enquiry, there are two types:*
   i. *Focussed or focal interview:* In this type, the researcher tries to focus his attention on a particular problem and tries to gather information, e.g. reaction of a film show or radio program. The investigator does not allow the remarks falling outside the field of interest.
   ii. *Non-directive interview:* In this type the interviewer allows the respondent to talk fully, freely and frankly so that the interviewer achieves a complete assessment of the life and personality of the respondent.

Steps of Interview

a. *Establishing the contact:* Prior appointment regarding the time and place of interview, gives the interviewer a sense of satisfaction and a feeling that his time has been valued.
b. *Appropriate climate:* An interviewer must make an appropriate start and create an appropriate climate for interview. He must introduce himself to the respondent and explain the purpose of interview.
c. *Establishing the rapport:* The researchers should create a friendly atmosphere and gain the confidence of the respondent, thus he should establish a rapport. Gaining the rapport helps to establish a friendly relaxed, courteous and conversational climate. This places the respondent at ease by breaking the communication barrier. He will give complete information. Once the interviewer looses the confidence, it is very difficult to regain.

   The interview should start with casual conversation and as the interaction warms up, the interviewer should gradually switch over to the proper subject.
d. *Appropriate questioning:* This is of crucial importance in interviews. Great care should be taken to see that the respondent goes out of the track.
e. *Appropriate response:* Appropriate response should be obtained from the respondent by encouraging him periodically stating that what he is telling is correct, it is unique, discussion is enlightening, etc. meanwhile the interviewer must be alert in detecting the incomplete or nonspecific answer furnished by the respondent.
f. *Appropriate attitude:* The interviewer must maintain an attitude of professional detachment. That means he should neither give an impression of approving the remarks of respondent nor opposing it. He should maintain an appropriate distance and an attitude of neutrality.
g. *Appropriate direction:* The interviewer must guide the respondent in such a way that the latter does not give irrelevant answer and does not go out of the track. Suppose the respondent gives a vague or incomplete answer, measures are taken to see that proper questions are put. Interviewer should avoid putting leading questions.

h. *Recording:* Only important things should be recorded.
i. *Closing the interview:* The interviewer should bring the interview to a natural close, fluently followed by usual forms of greetings and should not be ended abruptly.
j. *Compilation:* Soon after the interview, the report should be compiled when the mind is still fresh about the interview.

Advantages

- There is 'face to face' contact between the researcher and respondent.
- Interviewer can observe the facial expression of the respondent and also his body language, which is an useful supplement.
- Interviewer acts as a catalyst to get more information.
- In unstructured interview, unpleasant situation can be avoided.

Disadvantages

- Interview method consumes more money, time and energy.
- It requires training, skills, understanding and maturity of the investigator.
- Often the respondent may feel uncomfortable and may withhold sensitive information.

Questionnaire Method

In this method, a pre-structured proforma containing a set of questions is distributed to the respondent, who will read, understand and reply the questions, without seeking anybody's help.

The questionnaires (proformas) are of two types—structured and unstructured.

Structured questionnaires contain close-ended questions i.e., questions having multiple answers and the respondent has to choose the appropriate one.

The unstructured questionnaires, the questions are open-ended. No alternatives are provided. So respondents react on their own terms.

Information can be collected from a long distance, from large number of persons.

Requisites

- The questionnaire should have basic data/particulars of respondents such as name, age, sex, address, occupation, martial status, literacy level, socioeconomic status, contact number, etc.
- The format should have an attractive appearance and the paper should be of good quality with good printing.
- The questions should be of open ended variety. The questions should be arranged in an appropriate sequence called 'Funnel approach', i.e. questions of general nature should be followed by questions of specific nature.
- The questions should be simple, noncontroversial, non-complicated in a simple language and in an acceptable manner. They should not hurt or touch the sentiments.
- The structured questionnaire should consist of questions with multiple choice answers and the unstructured questionnaire should have only such questions which have a precise answer.

Advantages

Questionnaire method is highly cost effective in terms of time, money and energy. It does not require any training or skills on the part of the investigator.

Disadvantages

- The respondent must be literate, co-operative and responsible person.
- Different respondents attach different meanings for the same question.
- In open ended questions, statistical analysis becomes difficult.

Case Study Method

It is an indepth investigation of a complicated social problem. This method is extensively used in behavioral disorders.

Requisites

- All the details that help in understanding the genesis of the problem, should be collected, starting from birth to the date of investigation. Other documents and proofs related to the problem are also collected.
- Important social factors operating at various levels (individual, family or community levels) are also identified.
- It requires repeated visits or interviews.
- Natural history of the problem is then constructed with the detail information obtained.
- This helps in formulating a hypothesis and evolving an action plan.

Advantages

- Such studies help to know the knowledge, attitude, beliefs, perceptions of the people and their role in social phenomena.
- Such studies also help to understand the role of social factors in the development of the disease and also reveal the social dimensions of the disease.
- They also help in the management at family and community levels.

Disadvantages

- Difficult to make statistical analysis. Such studies fail to satisfy the statistical criteria of reliability.
- The inferences, therefore, cannot be generalized.

OPERATIONAL RESEARCH

It is defined as the application of scientific methods of investigation to the study of complex human organizations and services.

The main objective is to develop new methodologies to secure optimum utilization of resources like money, materials and manpower in the service of the community, with the purpose of inducing beneficial changes.

The team of the 'Health operational research' consists of a public health administrator, an epidemiologist, a statistician and a social scientist, in addition to field workers, peons and clerks. The team is headed by a director.

Examples of operational research in public health are population covered by each health worker, or by a health unit, architectural design of a hospital, study of services in teaching and nonteaching hospitals, the effectiveness of a health program or the objectives achieved in a program, investigation of the epidemics, etc. Any procedure related to discovering or recommending a new appropriate beneficial measure, is involved in operational research.

Phases in Operational Research

- Formulation of the problem
- Collection and compilation of the data
- Analysis of the data
- Formulation of hypothesis
- Deriving solutions or mathematical model
- Choosing the optimal solution
- Testing the solution
- Implementing the solution.

MEDICOSOCIAL WORKER

Medicosocial worker (MSW) is a para-medical person (he or she), qualified in sociology with training in health education and is attached to health institution, doing both medical and social work. He/she acts as a link between the heath institution (doctor) and the community (patient) and between the patient and the social welfare agencies. Such posts of MSW are existing in general hospitals, mental hospitals, industries, leprosy clinics, STD-clinic, tuberculosis centers, department of community-medicine and its attached rural and urban training health centers.

Activities

He/she assists the doctor and is of help to the patient, family and community at large.

To the Doctor

MSW provides information to the doctor about the patient's 'social background' (Social history) about the living condition, socioeconomic status, nature of the work, type of family, habits, family interactions, emotional overtones, occupational circumstances, etc. which has an influence on the development of the disease and has an impact on the mind of the patient. This helps the doctor in making a social diagnosis and treatment of the disease.

To the Patient

MSW gives information about the causation of the disease, its consequences, mode of transmission and how it can be cured and controlled. He/she removes the doubts and misconceptions about the importance of taking the treatment correctly, completely and regularly. He/she helps the patient to enter social club or sheltered workshop or special schools etc and helps the patient in matters of social adjustment or social rehabilitation, so that the patient can secure a position in the society and is accepted. Thus he also helps the patient to develop dignity and self-confidence. He/she works like that of a nurse in the medical ward.

To the Family

MSW educates the family about nursing the patient, showing sympathy, extending co-operation towards the patient, etc. which all help in promoting speedy recovery. He/she will also educate the family not to throw the patient out of the family.

He/she also provides emotional support for stress management.

To the Community

MSW gives health education to the public at large by organizing film shows, video-presentations, etc:

- Motivates the couple for family planning.
- Participates in contact tracing and cluster testing of STI-cases and motivates them to undergo clinical examination and treatment.

Miscellaneous Activities

- MSW takes active participation in organizing mass health camps, cataract camps, tubectomy camps, immunization, etc.

- Arranges for financial assistance to the patients from social welfare agencies.
- Participates in the teaching and training activities of the Department of Community-Medicine.
- In case the patient is loosing the job an account of myth, MSW meets the employer, dispels the myths and prevails on him not to terminate the services of the patient.

PERSONAL HYGIENE

It is the science that deals with the rule of keeping the body clean and acquiring habits of healthful living.

Advantages

It promotes the health, prevents the occurrence of many diseases, prevents the spread of the diseases to others, improves the physical appearance of the individual (by physique, grace, personality, etc.), makes him socially acceptable, enables him to do daily activities with self-confidence, it helps him to restore dignity, self-confidence and mental-health.

Thus, it promotes the individual to achieve a state of 'positive health'.

Rules (Principles) of Personal Hygiene

This consists of taking care of the body from head to toe and developing certain healthy habits.

i. *Care of the hairs:* Care of the hairs like short, clean, oiled and combed hairs prevents the development of dandruff, lousiness, ringworm of scalp, etc.

ii. *Care of the eyes:* By keeping the book or the work object about 25 cm away, while reading or doing work;
By avoiding glare or bright light;
By avoiding common handkerchief to clean the eyes;
By avoiding direct viewing of sun or solar eclipse;
By eating diet containing green leafy vegetables and milk;
By undergoing periodical ophthalmic check-up after the age of 40 yr.

iii. *Care of the ears:* Prevents pain and deafness due to accumulation of wax and also suppurative otitis media. Sharp instruments should not be used to clean the ears, because tympanic membrane may be perforated.

iv. *Care of the mouth (oral cavity):* This consists of:
   - Gargling the mouth, cleaning the tongue and brushing the teeth after food
   - Avoiding smoking, chewing *pan* with areca-nut, with tobacco, etc. Care of the mouth prevents stomatitis, aphthous ulcers, thrush, pyorrhea, dental caries and even oral cancer.

v. *Care of the hands and feet:* This consists of cutting the nails short and trimming and washing the hands with soap and water before eating the food and after using the toilet. Unhygienic hands transmit diseases like typhoid, cholera, dysentery, worm infestation etc.

vi. *Care of posture:* Posture should be erect while walking, standing and sitting. Correct posture, specially among growing children prevents orthopedic problems such as scoliosis, kyphosis, visual defects like myopia, etc.

vii. *Care of skin:* A daily bath with soap is essential. Oil bath promotes the health and sheen of the skin. Lack of care of skin predisposes for the occurrence of scabies, dermatoses, fungal infections and even cancer of the skin. Cleaning genitals while taking bath, clears off smegma, which is suspected to be carcinogenic.

Habits Affecting the Health (Lifestyle)

Eating

Meals should be taken at the same time everyday.

Food should not be eaten in a hurry because it causes indigestion. Thorough chewing of food helps in digestion. Food should neither be very hot nor spicy. Such a food predisposes for hyperacidity, duodenal ulcer and even cancer of the stomach. Excess of sweets and fatty foods predispose for obesity, HTN, diabetes, etc.

Drinking

Excess of coffee or tea should be avoided because it causes insomnia, tremors, palpitations and neurocirculatory asthenia. Alcoholic beverages results in gastritis, neuritis, cirrhosis of liver, malnutrition and even liver cancer.

Smoking

Smoking tobacco results in bronchitis, tremors, tachycardia, cough, coronary angina, thromboangitis obliterans and even esopharyngeal and lung cancer.

Chewing

Chewing pan with areca-nut and tobacco predisposes for oral cancer.

Drugs

Drugs should be taken only on the advice of the Doctor. Drugs like pethidin, morphia, cocaine, hemp, heroin, dexedrine, diazepam, alprazolam, such others result in addiction.

Exercise

Regular physical activity builds up muscle tone, improves appetite, cures constipation, improves circulation and prevents obesity. Yoga exercises not only trains the body but also disciplines the mind.

Meditation

Yoga exercises with meditation promotes spiritual health.

Sleep

Adults require 6 to 8 hours of sleep. Children require more and old people less. Adequate sleep keeps the person fresh and active. Mosquito curtain must be used to protect against mosquito-borne diseases. Bed room must be well ventilated.

Relaxation

Relaxation by entertainment, tours and travel, few winks of sleep after lunch, certain hobbies, attending recreation centers, etc. will relieve mental tension and pent up emotions.

Sex

Sex organs must be hygienic. Smegma is known to be carcinogen. Early intercourse must be avoided. Multiple sexual partnership predisposes for acquiring STIs and HIV/AIDS. Homosexuality should not be indulged in. Extramarital and premarital sex should be avoided.

Other Healthful Habits

Avoiding indiscriminate spitting and defecation; closing the mouth and nostrils while coughing and sneezing; cultivation of regular bowel habits; undergoing periodical medical check-up after the age of 45 to 50 years, etc.

BIBLIOGRAPHY

1. Agarwal OP, Bhasin SK, Sharma AK, Chabra P, Agarwal K, Rajoura OP. New Instrument (Scale) for Measuring the Socio-economic status of a family; a preliminary study. In J Com Med. 2005;30(4):111-4.
2. Dhaar GM, Robbani I. Foundations of Community Medicine. 1st edn. 2006.
3. Indian Journal of Pediatrics. 2003;7:3.
4. Kelley. Text Book of Sociology. 3rd edn.
5. Kumar P. Indian Journal of Community Medicine. 1993;18:2.
6. National Institute of Health and Family Welfare. Survey Report NIHFW, New Delhi, 2003.
7. Neeta kumar. Kuppuswamy's socioeconomic scale. Updating income ranges for the year 2012. IJPH. 2012;56:103-4.

CHAPTER 27

Information, Education and Communication

Information, education and communication (IEC) is an important approach to bring about changes in the knowledge, attitude and behavior of the people for betterment of their health and the health of the family and community in which they live.

INFORMATION

This consists of providing scientific knowledge to the people about the health problems and how to prevent them and promote and maintain good health.

It is the right of the people to know the facts about health and disease.

Information brings about awareness in people. It is said to have become successful when the people feel that the unfelt needs become the felt needs and the felt needs become their demand.

EDUCATION

It consists of educating or motivating the people to change their lifestyle or behavior for betterment of their health.

COMMUNICATION

It is a complex process in which a source of information (Sender) gives the information (Message) through various channels (Media) to the audience (Receiver) and in turn gets the feedback to know the effect of the process.

Sender

Is the communicator or originator of the message and should know the audience, the message to be given and the methods or channels to communicate.

The effect of the communication depends upon the efficiency of the communicator.

Message

It is the 'technical know-how' of the information being communicated to the audience. They should understand, accept and act upon. The message should be clear, understandable, interesting, meaningful, related to the objective, specific, precise and acceptable by the audience.

Media

It is the channel which bridges between the sender and the receiver. There are three systems of media.

1. *Interpersonal communication:* (Face-to-face communication) This is very effective.
2. *Mass media:* TV, radio, printed media, etc.
   Advantage: Large number of people can be reached in a short time.
   Disadvantage: Not very effective in bringing about the changes.
3. *Traditional or folk media:* Folk dance, songs, drama, puppetry, harikatha, burrakatha (in AP), nautanki (in UP), etc. These types are close to cultural values and therefore they are very effective.

Audience

The receiver may be a single person or a group of people. If the audience is a homogeneous group and have a common interest, it is called 'Controlled audience.' Otherwise it is called 'Uncontrolled or free' audience (That is a group which has gathered out of curiosity).

Feedback

It is the reverse flow of information or remarks made by the audience about the message to the sender so that the sender can make modifications and improve the communication to make it more effective and acceptable to the audience.

STEPS IN IEC: PLANNING, IMPLEMENTATION AND EVALUATION

Planning

This consists of the following:

- Situational analysis, i.e. studying the existing national policies and the organizational structure for the modifications or the improvement if any.
- Understanding the underlying philosophy, e.g. use of condoms in preventing AIDS.
- Identification of target groups such as only men, or only women or couples or youth or parents or teachers, etc.
- Establishment of objectives, goals and targets (indicators).

Preparatory Activities

Consists of the following:

- Developing linkage with other existing organizations like rotary and lions club, *mahila mandals*, education department, PWD, etc.
- Arranging support activities like advocacy, counseling and getting materials and money.
- Conducting effective training to prepare resources.
- Knowing the needs to the target group, designing the message for the target groups such as posters, matter for TV or radio, etc.
- Choosing the appropriate media or channel for cost-effectiveness.
- Preparing appropriate IEC material.

Implementation of IEC Activities

Planning ways to ensure that the materials reach the target audience.

Monitoring

Regular checking of the programmed activities. This helps to get the feedback for the improvement.

Evaluation

This consists of analyzing the information periodically about the impact of the program to know the effectiveness.

TYPES OF COMMUNICATION

One Way Communication

It is also called 'Didactic method.' In this type, the message flows in only one direction, i.e. from the communicator to the audience, e.g. giving lecture in a classroom. The demerits are that:

- There is no participation from the audience
- There is no feedback
- Information is imposed
- Learning is passive
- Less likely to influence the human behavior.

Two Way Communication

It is called 'Socratic method.' In this type both the communicator and the audience take part. Audience may ask questions and they may give their own suggestions. Thus, the communication become active, effective and 'democratic.' This method is more likely to influence the human behavior.

Verbal Communication

This is giving the information by talk and not by showing written printed matter. It is more persuasive.

Nonverbal Communication

In the type, the message is communicated not by talk but by body movements, postures, facial expressions (smile, sorrow, staring, etc.). Often this is also effective.

Formal Communication

This consists of forms like toys, games, songs, etc.

Informal Communication

It is by rigid courses.

Visual Communication

Consists of charts, posters, pictures, graphs, tables, maps, etc.

Telecommunication and Internet

This is done by using electromagnetic instruments and the communication is done over distance. Example, radio, TV, internet, etc. Telephone, telex and telegraph are known as 'point-to-point' telecommunication system. Launching of satellites is an advanced technology in the telecommunication system.

BARRIERS OF COMMUNICATION

Often there will be certain barriers between the educator and the audience, which will interfere with the communication. These are:

Physiological Barriers

Difficulties in hearing, expression.

Psychological Barriers

Emotional disturbances, neurosis, low level of intelligence, language difficulties.

Environmental Barriers

Noise, over crowding, invisibility.

Cultural Barriers

Illiteracy, customs, beliefs, religion, attitude, poverty, cultural difficulties between rural and urban, etc.

To make the communication successful, these barriers must be identified and removed.

HEALTH EDUCATION

It is a process of bringing scientific knowledge on health to the people to bring about changes in their knowledge, attitude and behavior for the betterment of their health and the health of the community in which they live.

Objectives

- To encourage the people to adopt healthy lifestyles
- To encourage them to make best use of available health services
- To encourage them to change their attitude towards their own health
- To improve the health of the family and the community at large.

Health Education vs Health Propaganda (Publicity)

Health education	Health propaganda
Knowledge is actively acquired	Knowledge is passively acquired
It makes people to think before acting	It prevents thinking because of readymade information
It is mainly concerned with betterment of life	It is mainly concerned with the sale of the products
It appeals to reason	It appeals to consumers' emotions
It aims at improvement of health	It aims to derive profit
It aims at changing the attitude and behavior of the people	Does not aim at changing the attitude and behavior of the people
It disciplines primitive desires	It stimulates the primitive desires
It is behavior centered	It is information centered
It appeals the people with reason	It appeals the people with emotion
It develops reflective behavior	It develops reflexive behavior

APPROACHES IN HEALTH EDUCATION

There are four approaches.

Regulatory Approach

It is a legal approach made by the Government to alter the behavior of the people for the betterment of their health. Such

regulations may vary from prohibition to imprisonment, e.g. Child Marriage Restraint Act, all public health Acts.

Merit

This is the simplest and quickest way to improve the health of the people.

Demerits

- The disease can be controlled but not eradicated by legislation.
- The legislation cannot force the people to act, e.g. to eat balanced diet, to quit smoking or drinking alcohol, etc. This amounts to take away the rights of the people. This is how disastrous sterilization campaign during National Emergency in 1976, led to Congress failure in 1977 elections. Regulatory approach will not be successful unless people are ready to accept the law.

Service Approach

This consists of providing health care service to the individual doors (as in pulse polio immunization), based on the assumption that people would use them to improve their own health.

People may not accept such services even if provided free of cost, unless it is their felt-need, resulting in failure of such approach, e.g. Providing water-seal latrine in rural areas during 1960s was a failure one because they were not habituated to use them, moreover that was not their felt-need. On the other hand, pulse polio immunization is becoming successful.

Health Education Approach

There are many health problems, which can be solved only through health education, e.g. prevention of AIDS, accidents, dental caries, etc. The results are slow but enduring.

Since the attitudes and behavioral patterns are formed early in life, health education must be best started early in school life. Moreover, the behavioral patterns is more easily controlled among younger population than adults.

Primary Health Care Approach

This is radically a new approach, wherein the health care service is basic, essential, utilitarian, provided by the non-medical persons, starting from the people, by the people, of the people and for the people, based on principles like equitable distribution, community participation, intersectoral approach and appropriate technology, thus making the service highly successful, e.g. Role of *Anganwadi* workers under ICDS-Scheme in reducing childhood morbidity or mortality, role of traditional birth attendants in conducting safe delivery and reducing MMR and IMR, etc.

CONTENTS OF HEALTH EDUCATION

It can be of any of these: Human biology, personal hygiene, nutrition, environment, prevention of accidents, prevention of communicable diseases, reproductive health, population control, mental health, etc. Depending upon the content, the health education is referred to by different names as sex education, population education, safety education, nutrition education, parentcraft education, etc.

Principles of Health Education

Following are the principles, which contribute to the success of health education.

- *Credibility*: It is the degree to which the message is perceived as trustworthy. Unless the people have trust and confidence in the communicator, the message will not be perceived.
- *Content (Interest)*: People will listen to those things which are of interest, meaningful and it should be their felt-need. So the educator should find out their real health needs and educate. Then only the people will participate and the program becomes successful. Suppose, the felt need is not known to the people because of illiteracy, the educator should bring about the recognition of the needs and then educate them.
- *Context*: The context in which communication is given should be relevant to the receiver.
- *Clarity*: The message to be given should be in simple terms.
- *Consistency*: The message must be consistent to penetrate into the minds of receiver.
- *Channels*: Existing channels of communication should be used.
- *Capability of audience*: Audience must be capable of understanding what is told.
- *Participation*: No health program will be successful without the participation of the public. For that they must be motivated to participate by the health workers and social workers.
- *Motivation*: It is awakening the desire among the people to learn. They can be motivated easily by giving incentives, which may be negative or positive. Example, If an obese woman is told to reduce her bodyweight because of the complication of coronary artery disease, it may have little effect. On the other hand, if she is told that by reducing her weight she may look more beautiful and charming,

she may accept with pleasure. Motivation is contagious. One motivated person may motivate an entire group. Example, One vasectomised person is enough to motivate a group of unvasectomised persons.

- *Comprehension*: This means educating the people at a level they can understand and preferably in the same language they speak and avoiding difficult and strange words. Teaching should be done within the mental capacity of the audience.
- *Reinforcement*: This means repetition of the same message periodically, preferably in different ways, so that the audience can understand it better and remember longer. Otherwise they may go back to the preawareness stage.
- *Learning by doing*: This makes the person perfect. The Chinese proverb, 'If I hear, I forget, if I see I remember and if I do, I know', illustrates the importance of learning by doing.
- *Known to unknown*: That means the health education is given to the people from a level what they know and understand and then proceeded to new knowledge, however it is a long process.
- *Setting an example*: Educator himself should practice what he preaches. He himself should be an ideal example, for example, if he is explaining the hazards of smoking, he should not be found smoking. Similarly, if he is talking on small family norm and if he himself has many children, it will not be very successful.
- *Good human relations*: Building good relationship with the audience, makes the health education successful.
- *Feedback*: Getting the feedback (or remarks) from the audience is of paramount importance to the educator, so that he can improve himself in communicating next time more effectively.
- *Leaders*: Involvement of local leaders will make the education more easy and effective, because local leaders are respected. If they involve, then the people automatically, passively will participate. So, the local leaders must be identified and convinced first.

PRACTICE IN HEALTH EDUCATION

This consists of audiovisual aids and methods of health education.

Audiovisual Aids

These make the health education process more effective and impressive, by making the concepts clear and the program successful. These bring about understanding where words fail. They avoid monotony. Thus, they occupy the central role. These aids are classified into three groups:

Auditory Aids

Radio, tape-recorder, microphones, earphones, amplifiers.

Visual Aids

Not Requiring Projection: Blackboard and chalk, posters, charts, internet, flannelgraph, exhibits, models, specimens, health-museums, internet, newspaper, etc.

Requiring Projection: Slides LCD (Liquid Crystal Display), filmstrips, transparencies, (Projectors required are slide projectors, epidiascopes, over-head projectors).

Merits of OHP (Over Head Projector):

- Draws the attention of the audience
- Simplifies the education process
- More information can be given in short period of time
- Learning becomes easy.

Demerits of OHP:

- Initial investment is costly
- Recurrent expenditure also occurs due to purchase of transparencies, markers, bulbs, etc.
- Prior preparation is needed
- Needs power supply
- Preparation depends upon the skill and handwriting of the educator
- Fixes the speaker to one place and he cannot move around.

Combined Audiovisual Aids

Television, cinema, (sound-films), video cassettes.

These are most effective compared to above two groups of aids, because of the following advantages:

Advantages of Audiovisual Aids:

- Since they are close to being natural, they create interest among the people
- They make learning easy and permanent
- The pictures are impressed in the mind of the people and stimulates thinking
- People are able to see the things (like surgical procedures, etc.) which they are unable to see otherwise.

Levels in Health Education

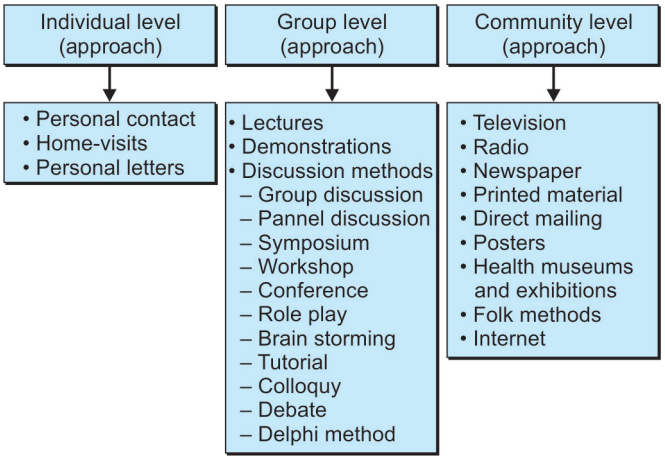
Health education can be carried out at three main levels:

1. Individual and family level.
2. Group level (School children, industrial workers, antenatal mothers, *anganwadi*-workers, diabetic patients, etc.).
3. Community level (general public).

METHODS IN HEALTH EDUCATION

Different methods are adopted at different levels **(Flow chart 27.1)**.

Flow chart 27.1 Methods in health education



Individual and Family Level

Best opportunity occurs for individual level when the patient comes to the doctor with illness. Detail information can be given about the illness such as causation, mode of transmission, complications, treatment, prevention, sanitation, hygiene, etc. Simultaneously, the family members are also given information. Here, the role of the doctor is very high and responsibility is very great because the patient and the family members constitute 'captive audience.' They listen more readily and follow his advice. Similarly, a nurse has also an ample opportunity for educating the patients.

Health education at family level is best given by health-workers and health assistants.

The biggest advantage is that the educator can discuss, argue and persuade the individual to change his behavior.

Disadvantage is that the population covered is small. It is given to those, who come in contact with the educator.

Group Level

There are two broad methods—didactic and socratic methods.

1. *Didactic method*: It is one-way method. It consists of pouring information to the learner. Best example is lecture method.
2. *Socratic method*: It is two-way method of communication. Socrates was a great philosopher and teacher. His method was to allow the students to ask questions. He used to dispel by further questioning and eliciting their answers. Both the communicator and the audience take part. Example, interviews, demonstrations, discussion. The process of learning is 'democratic.' It is more likely to influence the behavior than one way communication.

Different methods and media of group teaching are:
(Method is the procedure and media is the means employed in education).

LECTURE

It is a careful presentation of the facts with organized thoughts and ideas by a qualified person.

Merits: It is simple, accepted, commonly used, one-way method. It can be made more effective by using a chalk and writing legibly on the blackboard. Thus, chalk lends the visual component. This method can be made much more impressive, and effective by using audiovisual aids. However, 'Chalk and talk' is a good old and traditional method of teaching.

Criteria for Good Lecture

- Topic is to be informed well in advance
- Ideal time is morning
- Number of participants should not be more than 30
- Duration of lecture should not be more than 40 minutes
- Topic should be divided into various subheadings
- Should summarize at the end.

Criteria for Good Teacher

- Should be clear about the subject matter
- Should present it clearly and fluently
- Should be clearly audible and visible
- Should explain with examples
- Should stimulate the learner to think
- Should have a good sense of humor
- Should be friendly and skilled
- Should not be nervous but confident
- Should not loose the temper by the behavior of the group.

Demerits

- If the topic is not interesting, audience may get bore
- They may loose the interest halfway
- Learning is passive
- Prevents thinking and so it may fail to influence the health behavior of the people

Following audiovisual aids are employed to make lecture effective and impressive.

Flip Chart

This consists of series of charts or posters, each of about 25 × 30 cm, each with an illustration pertaining to the talk. Each chart is shown before the group and talk is given. It is

then flipped and shown the next chart. These charts help to hold the attention of the group. Message of the chart should be brief and to the point.

Flannelgraph

This consists of a *khadi* cloth, fixed over a wooden board, provides a good background for displaying pictures, cut-outs, drawings, etc. in sequence to maintain continuity.

It is a simple, cheap method, easy for transportation and promotes thoughts and criticism.

Exhibits

Like models, specimens, objects, etc. convey specific but limited message to the viewer. This can be used for mass communication also.

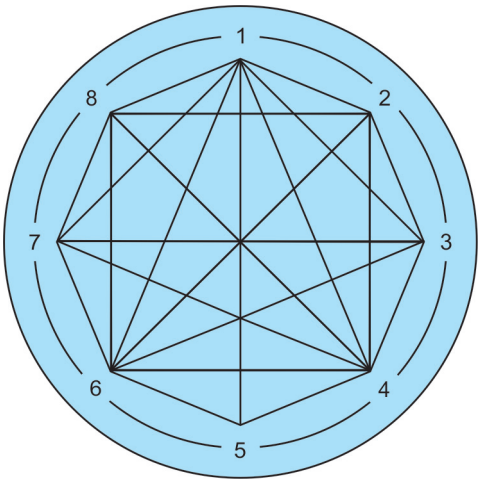


Fig. 27.1 A group discussion

DEMONSTRATION

This means showing by action, stepwise, the procedure to be performed, e.g. preparation of ORS solution, disinfection of a well, etc. before the audience. The audience then learn that skill by doing.

Since this method involves active participation of the audience they develop interest, understand it better and then they change or improve in their behavior.

This method involves the participants in discussion also. Thus, demonstration has high educational and motivational value.

Discussion Methods

Group discussion: For this, the group should comprise of 6 to 12 persons, with common interest and almost of the same educational level. They are all seated in a circle, so that each is visible to the other and there will be 'Face to face' interaction **(Fig. 27.1)**.

There will be a group 'leader', who initiates the subject, help in discussion, prevents side conversation, encourages everyone to participate and finally summarizes the discussion. There will also be a 'recorder' who prepares a report on the discussion and the decision taken.

Rules of Group Discussion

- Only one person should talk at a time and others should listen carefully
- Thoughts must be expressed clearly and concisely
- Interruptions should not be done
- Only relevant remarks should be done
- Criticism must be accepted sportively
- There must be free, frank and fresh discussions
- Should help to reach conclusions.

Group discussion is a very effective method of health education, because it permits free exchange of thoughts and ideas and also the decision taken by the group, tends to be adopted more readily.

DEMERITS

- Those who are shy, do not take active part in discussion
- Some may dominate in the discussion
- Some may make irrelevant discussion.

Panel Discussion

In this educational method, a small group of about 4 to 6 persons, who are experts in a particular topic, get around the table in the presence of audience, one of them being the chairman (or moderator) who opens the meeting, welcomes the audience, introduces the panel of speakers to the group of audience and then introduces the topic briefly and initiates discussion.

The panel members discuss among themselves about the topic relevant to the audience. It is a to and fro discussion among the panel members to touch on all the aspects of the topic and the audience appreciates the same by listening. There is no scope for the audience to participate. However, if there is an arrangement for the audience to throw questions towards the end, then it is called 'Panel discussion forum'. Forum is a good feedback mechanism.

For arranging panel discussion, the experts are informed well in advance about the subject and the time and place.

There is no specific agenda but a topic of interest. There is no order of speaking and no set speeches. The chairman moderates whenever occasion requires. If properly planned, panel discussion is a very effective method of health education.

Advantages

- Helps in exploration of a problem in angles
- Change of speakers maintains attention and interest among the audience
- Establishes informed contact with audience.

Disadvantages

- Panel may not cover all aspects of the topic
- Audience is passive till end.

Symposium

This is one of the modern methods of education. It is also a lecture form but the difference is that different speakers (experts) give lecture on different topics (aspects) of the same subject. The Chairman, who is also an expert, opens the symposium with a brief introduction. He introduces the speakers to the audience and calls upon them one after the other to speak. At the end of each speech and before the next person begins, the Chairman makes some transitional remarks to serve as a link between what has been presented and what is to be followed and also to give his own views if any.

For example, symposium on Tuberculosis will be as follows:

- Anatomist—talks on anatomy of lungs (respiratory system).
- Physiologist—talks on physiology of respiration.
- Pathologist—talks on pathology (changes) in the tuberculosis of the lungs.
- Pharmacologist—talks on the list of antitubercular drugs, doses, etc.
- Physician (Pulmonologist)—talks on the clinical features and complications of TB.
- Specialist in community medicine—talks on prevention and control of tuberculosis.
- District TB officer talks on revised National TB control Programme (RNTCP).

There is no discussion among the experts unlike in panel discussion. Because of more number of speakers, each one speaking on the different topics of the same subject, symposium is more interesting than the lecture or the seminar, given by one person alone. Change of speakers avoids monotony. There is no scope for the audience to participate. However, at the end, the audience may ask questions, doubts for their clarification. It is then called 'Symposium forum'. It is a good feedback mechanism. Chairman makes a comprehensive summary at the end of the session.

Symposium has its limitations. If the speakers do not consult each other beforehand, they may commit repetitions and divergence of opinion.

Symposium is of particular application to a mature group who have the listening attitude and the capacity to appreciate.

Seminar

In this method of health education, one expert will speak about the different components of the same subject, to a group, having a common interest or discipline. These are usually conducted in academic or research institutions to have a high level academic discussions, which will help for research purposes.

There is a coordinator for the seminar. Preliminary planning is essential for seminar. Since seminar requires a long-term preparation and time, it should be conducted once in 3 to 6 months.

Buzz Group or Buzz Session

In this type, a large group is divided into small groups, each of 10 to 12 people and they are given time to discuss a problem. The different groups are allotted different specific problems or the same problem is allotted for all the groups. The collected ideas are brought forth to the original group by the leader of the buzz group. In the plenary session final documentation will be made. This is very similar to the workshop but there are no experts available in the buzz group. This is an informal version of workshop.

Workshop

It consists of group of members, who are subdivided into small groups, each of about 4 to 6, each group having a chairman and recorder, discussing a part of the problem and leave the workshop finally with a plan of action, decided by the group. The guidance is given by the experts, who act as resource persons.

Since, the participants share the knowledge, learning takes place in a friendly and happy atmosphere.

Conference

It is a get together of experts or learned people being held usually once in a year, wherein the recent advances or the research work taken up will be presented before the audience, thereby gives an opportunity not only to meet their colleagues but also to learn recent advances. It is almost a continuing education usually held at State or National level.

Role Playing (Sociodrama)

In this method, education is given by a group in the form of a drama, to make the communication more impressive and effective, specially to school children, illiterate villagers and such others. Role playing is followed by a discussion of the problem.

Brainstorming

In this method, a problem is solved by group discussion by a group of people, 5 to 20 in number, collecting and recording the ideas or suggestions of each of the member and finally the decision is made.

Brainstorming is Done in Four Stages

- *Stage 1:* The problem for which solutions are required, is defined, so that the members should be clear about their suggestions.
- *Stage 2:* The group leader invites the suggestions and records them irrespective of whether it is right or wrong. No discussion is permitted among them.
- *Stage 3:* Now each suggestion is reviewed, so that it is made clear to everyone what the suggestion is and whether the suggestion to be included or excluded for further discussion.
- *Stage 4:* All suggestions are discussed to decide which one to be accepted and to develop the ideas further.

Snowballing

It is also a method of group discussion, wherein every person of the group is involved in discussion. First it is discussed in pairs. Then pairs join to make groups of four. Groups of four discuss and come to common conclusion. It is recorded. Then these two groups join to make groups of eight and so on.

As a final exercise, one of the groups of four try to persuade the members of another group of four as to why their discussion is right and vice versa.

The moderator reviews the discussion and comes to conclusion. Thus, in this method, every participant gets the opportunity to think and listen to the arguments or decisions of other persons.

It is called 'Snowballing' because it is like a snowball gathering more snow as it rolls down the hill and gets larger and larger, the group becomes bigger and bigger. This method is also called 'Pyramidal group method' because participants join together like an inverted pyramid.

Tutorial

A small group of learners are guided by a teacher to help clear the doubts, and confusions, improve understanding of the subject.

Colloquy

In this method of group discussion, the members from the audience initiate discussion by asking questions to the experts on the stage, who will answer on the various aspects. Colloquy is specially useful when there are specific problems to be discussed for solution. One of the experts acts as a moderator. He is also known as 'Interlocutor', who conducts the discussion. The effectiveness of the colloquy depends upon the efficiency of the moderator.

The advantage is that there is a direct participation of the audience. It provides opportunities to extract information from experts. The experts will try to solve the controversial problems also if any.

Debate

In this type of discussion method, 2 sets of speakers talk on 'For' and 'Against' a particular resolution or a statement and give their opinion.

Community Level (Approach)

It consists of educating the whole community (mass approach). It is not possible by one or two persons. It usually employs 'mass media communication.' There are:

- *Television*: It is the most potent of all the media, because it appeals to both eyes and ears. It can mould the attitude and behavior of the people effectively. It is cost-effective.
- *Radio*: This appeals only to the ears. It is the cheapest mass media communication and quite potent also. Radio talk should not exceed more than 10 to 15 minutes.
- *Press materials*: This catters only to the eyes. The most widely disseminated form and most powerful press material is the newspaper. Other materials are posters, pamphlets, books, internet so on. Only demerit is that illiterate persons are not educated through press materials. They can be educated only through first-two methods.
- *Folk medias*: These are the indigenous methods such as keerthan, harikatha, folk dance, folk songs, dramas, puppet-shows, kawali, gazals, etc.
- *Role play (Sociodrama)*: Acting out a situation by a team of members, simulating a real life situation, thereby the audience understand and appreciate the situation and implement in their daily life. Thus, it helps in changing (improving) their knowledge, attitude and behavior of the people.

  Eventhough the community approach is 'one-way' communication, it is effective in reaching millions of people.
- *Health magazines*: Good health magazines are also important channels of communication, e.g. Swash Hind (from Delhi), Herald of Health (from Pune), etc.

- *Miscellaneous methods*: Are health museums and health exhibitions.

Domains of Learning Process

These are cognitive (to gain knowledge), affective (to change the attitude and behavior) and psychomotor (to gain skills).

SOAP Technique

This is a method of evaluation of a case or a student by S—Subjective, O—Objective, A—Analysis and P—Planning methods.

Body Language

This is a nonverbal method of communication. It includes mannerisms, body movements, facial expression, etc. of the communicator. This is unintentional but it reflects more accurately the thoughts and attitudes of the individual.

Anatomy of Lesson Plan

This consists of information about the name of the speaker, topic and its contents, venue, date and time, type of audience, learning objectives, methodology, teaching aids required/utilized and evaluation.

THE DELPHI METHOD

It is a group discussion method in which the experts in the panel are dispersed geographically, deal with a complex problem systematically without interactions among them and form a group judgment. This method was started in 1944.

The method comprises of a series of questionnaries sent to the experts of the panel either by mail or e-mail. The questionnaries are designed to elicit and develop individual responses, thus enabling the experts to refine their views. There is no face-to-face discussion.

The interactions among the panel members are controlled by a panel director/monitor, who maintains the anonymity of the group interactions. In otherwords the comments are not identified as to their originator but presented to the group as feedback for interaction. The monitor identifies the areas of concordance. The areas of discordance are sent as feedback to all of them, without revealing the identity and reactions asked for. Such sessions are continued till a common group judgment is obtained. Thus, ideas are explored and decision is made. Final report/conclusion is then prepared.

Thus, the key elements of the Delphi process are:

i. Structuring of information flow by questionnaries
ii. Feedback to the participants
iii. Maintenance of anonymity.

Pedagogue—means 'to teach'.

Pedagogy—means 'Art of teaching'.

SORC model—is the method of analysis of a program, population, person, etc.

S – Stimulus antecedent variables—events in the life that prompt us to produce a specific behavior.

O – Organism variable—individual differences due to biological factors and past learning that influence our behavior.

R – Responces—it may reflect the intensity of the stimuli that preceded them or the consequences that follow them. It may occur in cognitive, affective or psychomotor domain.

C – Consequences—means the results of behavior.

SWOT Analysis

SWOT is an acronym for strengths, weaknesses, opportunities and threats, involved in a project (or a business venture) and SWOT analysis is a structured planning method used to evaluate the project/program in order to make improvements. It involves the identification of external and internal factors that are favorable and unfavorable to achieve that objective, as shown in the structure.

Structure of SWOT Analysis (Fig. 27.2)

The aim of SWOT analysis is to identify the key internal and external factors and turn the weakness into strengths and threats into opportunities to achieve objectives. The technique is credited to Albert Humphrey (1960).

Strengths: Strengths are the characteristics existing within the organization/project, which provides a competitive advantage.

Weakness: Weakness are the characteristics (weak points) which act as barrier disadvantage to achieve the success. They have to be minimized.

Opportunities: Opportunities are the ones which if properly leveraged, can provide a competitive advantage.

Threats: Threats are the risks involved which erode the competitive advantage and can cause trouble in the program. They have to be eliminated.

SWOT analysis is better explained with example. In immunization camp

Strengths: These are the "plus" (positive) points, such as:

- Proper preparation of the camp in terms of manpower (volunteers), money (budget) and materials (like vaccines, ice packs, syringes, vaccine carriers, etc.)

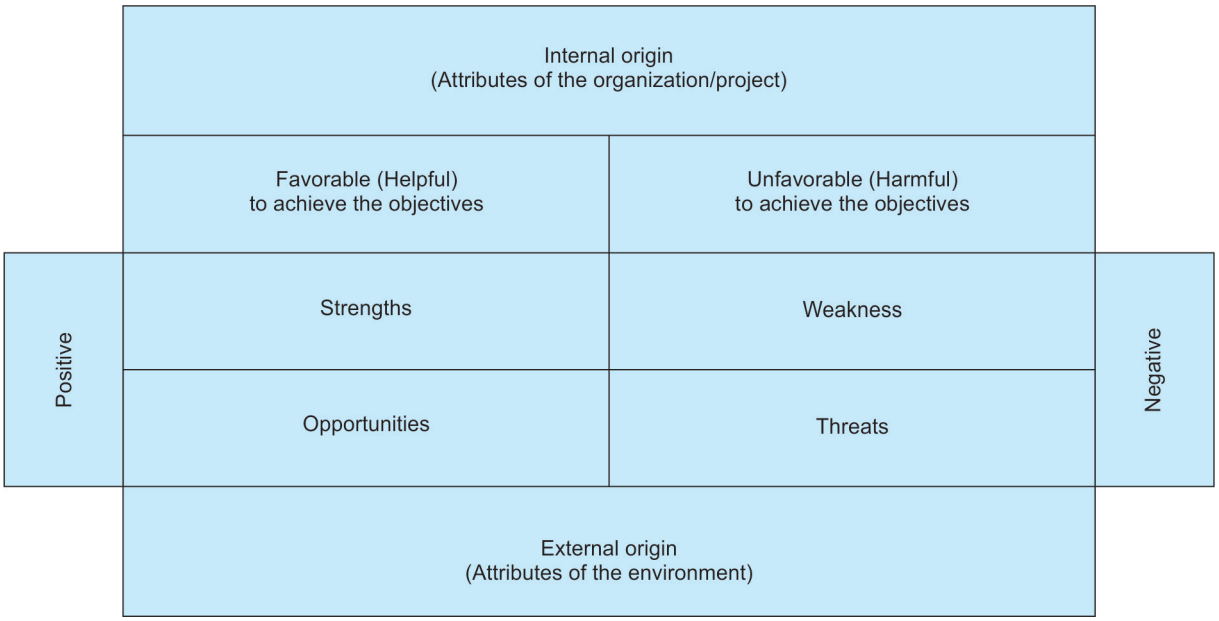


Fig. 27.2 Structure of SWOT analysis

- Active participation by the community. For that, people must be previously sensitized and conviced about the program.
- Acceptance of the program by the people.
- Preparedness for any complication if occurs during the program activity. For example, keeping emergency drugs ready in hand in case of any reactions.

Weakness: These are the negative/week points such as
- Lack of training/orientation of the volunteers
- Lack of budget and materials
- Lack of co-operation by the people, due to illiteracy, ignorance, indifferent attitude, blind beliefs, etc.
- Lack of interest or negligence by the volunteers.

Opportunities: These are the measures for the improvement, such as:
- Sanctioning and release of the budget in time
- Providing training for the concerned persons
- Effective supervision and monitoring
- Involvement of related persons such as private practitioners, medical college staff members, etc.

Threats: These are the risks involved in the program, such as:
- Untimely and inadequate supply of the materials/drugs/vaccines
- Occurrence of adverse reactions like anaphylactic shock
- Delay in the release of the budget
- Sudden shortage of manpower
- Non cooperation by the related sectors/departments, etc.

BIBLIOGRAPHY

1. Hubley J. Communicating Health. An Action Guide to Health Education and Health Promotion. MacMillan Press Ltd, London 1st edn, 1993.
2. http://www.iit.edu/~it/delphi.html
3. IGNOU. Information, Education and Communication. PGD, MCH-1, Preventive MCH, New Delhi.
4. WHO Education for Health. Geneva 1991.

CHAPTER 28

Human Genetics

Genetics is the branch of science that deals with the study of heredity (i.e. transmission of hereditary characters from one generation to another). Human genetics is concerned with the inheritance of the trait (characteristics) resulting in hereditary diseases and their prevention and control.

From the genetic point of view, the cells of an organism fall into two broad categories: Somatic cells and germ cells. Somatic cells constitute the structural and functional unit of the body of the organism. These cells multiply to provide for the growth, development and repair of the body tissues. Each somatic cell (body cell) contains 46 (23 pairs) chromosomes. They are derived from the chromatin network of the nuclei and they appear only at the time of cell division. These chromosomes are species specific. 22 pairs are called 'autosomes', which are all similar and homologous. Last pair is called 'sex-chromosomes'. The autosomes are numbered according to their length, the first pair being the longest and the last pair being the shortest. The 23rd pair, sex-chromosomes are not included in the numbering. They are designated as XX chromosomes (similar and homologous) in female cells and XY chromosomes (heterologous) in male cells, depending upon whether the fertilizing sperm (male gamete) was carrying X or Y chromosome. Accordingly the chromosome constitution of a human sperm is 22X or 22Y and that of an ovum is always 22X. Therefore, it is the male gamete (Sperm-cell) that determines the sex of an offspring. An offspring that shares father's Y chromosome is born as son and the one that shares father's X chromosome is born as daughter. In addition the normal female somatic cell nucleus contains a dark staining area at the periphery of cell nucleus, called a 'Barr body' or 'Sex-chromatin', which is absent in male cells.

The germ cells (Sperms and ova) also have a dual set of chromosomes. They participate in the process of reproduction.

MULTIPLICATION

The multiplication of somatic cells (i.e. cell division) is called 'mitosis', wherein, each chromosome splits into two, with the result that each daughter cell retains the number and structure of the chromosomes of the parent cell, i.e. 23 pairs. (Diploid set) and resembles the parent cell.

The multiplication of germ cells is called 'meiosis', which involves 'crossover' and 'reduction' of chromosomes. Crossover implies mutual exchange of segments between each pair of chromosomes and reduction implies inheriting a single set of chromosomes (haploid set) instead of double set as in mitosis. Thus, the chromosome number is reduced to half, i.e. 23 in each daughter cell. Meiosis takes place in gonads, testes and ovaries, each daughter germ cell is called as sperm and ova respectively and collectively referred to as gamete (male and female). During meiosis, the cell splits into two daughter cells as usual, but the chromosomes do not split. Thus, each daughter germ cell will have only 23 chromosomes but not 23 pairs. The original number of 23 pairs of chromosomes is restored, when the ovum (female gamete) and the sperm (male gamete) fuse (fertilize) to form the zygote.

CHROMOSOMES

These are the rod like condensation of chromatin of the nucleus, appearing only at the time of cell division, occurring in pairs, one member of each pair coming from father and another member from mother. Biochemically the chromosomes are made up of 'Deoxyribonucleic acid' (DNA) and genetically chromosomes consist of 'genes', which are the 'biological units of heredity', which are arranged like the 'beads of a necklace'. A gene is a small segment of DNA molecule. A complete set of genes found in the nucleus of every body cell is called 'genome'. Each chromosome possesses 2000 to 5000 genes. The genes carry the hereditary information encoded in their chemical structure for transmission from generation to generation. Each gene occupies a definite position (or locus) on the chromosomes. As the chromosomes exist in homologous pairs, the genes on them also exist in pairs. The individual genes of such homologous pairs are called 'allele' (allelomorphs). A person is estimated to possess 50,000 genes inherited from father and another 50,000 from mother.

If on a particular locus, the paired genes are identical then that individual is called 'homozygous' for that trait or homozygotes (e.g. AA) and if it is different (e.g. Aa) the individual is described as heterozygote.

A gene is said to be 'dominant' when it manifests its effect both in the homozygous and heterozygous state. A gene is said to be 'recessive' when it manifests its effect only in homozygous state.

Polygenes or multiple genes are a group of genes, whose combined action affects one particular character, for example, 3 genes are responsible for causing muscular dystrophy—an autosomal dominant, an autosomal recessive and a sex-linked recessive gene.

Genes are usually stable. They do not undergo any change. But sometimes a normal gene becomes converted into an abnormal gene. This change is called 'mutation'. Usually this mutation rate is increased following exposure to mutagens such as ultraviolet rays, radiation or chemical carcinogens.

Genotype and Phenotype

The term 'genotype' refers to the genetic constitution of an individual and the term 'phenotype' refers to the outward expression of the genetic constitution. For example, in ABO blood group system, the possible genotypes are AA, AB, BB, AO, BO and OO, but the phenotypes are A, B and O.

CHROMOSOMAL ABNORMALITIES

These may be numerical or structural abnormalities of the chromosomes. However, the cause is not known. They are of the following types:

- *Nondisjunction*: This is an error in the nuclear division. In this type, a pair of chromosomes fail to separate and both are carried to one pole, resulting in an unequal number of chromosomes, i.e. 45 or 47. This numerical abnormality is called 'aneuploidy'.

  If a particular pair of chromosomes has 3 chromosomes instead of 2, it is called 'trisomy' and if there is only one instead of 2, it is called 'monosomy'.
- *Translocation*: During nuclear division, if a portion of one chromosome breaks away and gets attached to another, which is not homologous to the first. This is called translocation.
- *Deletion*: In this type, a piece of chromosome is detached and is lost from the karyotype, resulting in loss of one or more genes. If the loss is severe, it leads to death and still-birth.
- *Duplication*: Sometimes, some genes may appear twice in the same chromosome. This is called duplication.
- *Inversion*: In this type, a segment of the chromosome becomes inverted resulting in the alteration of the sequence of genes.
- *Isochromosomes*: Normally, the chromosomes divide longitudinally. But sometimes, they divide transversely, resulting in structurally abnormal chromosomes.
- *Mosaicism*: In the type, the somatic cells contain 2 or more genetically different chromosomes. This may occur either during mutation or non-disjunction.

The stalwarts in the field of genetics are Mendel and Galton who laid down the basic principles of genetics at the end of 19th century. Mendel formulated certain laws to explain the inheritance of characters, i.e. Law of Unit characters, Law of Dominance and Law of Segregation.

- *Law of unit characters*: All characters are units by themselves and genes control the expression of these characters, during the development of these organisms.
- *Law of dominance*: The genes occur in pairs. One may mask the expression of the other. The character which appears is called 'dominant' and that which does not appear is called 'recessive'.
- *Law of segregation*: When germ cells are formed (sperm and ovum) each cell carries one of the opposed factors and not both.

Thus, Mendel's work provided the basis of the study of inheritance.

DEOXYRIBONUCLEIC ACID

Deoxyribonucleic acid and ribonucleic acid respectively are so called 'nucleic acids' because they were first discovered in the nuclei of cells. They are enclosed inside the chromosomes by a complex packing system. The structural unit of a nucleic acid is a nucleotide. About 100 pairs of nucleotides constitute

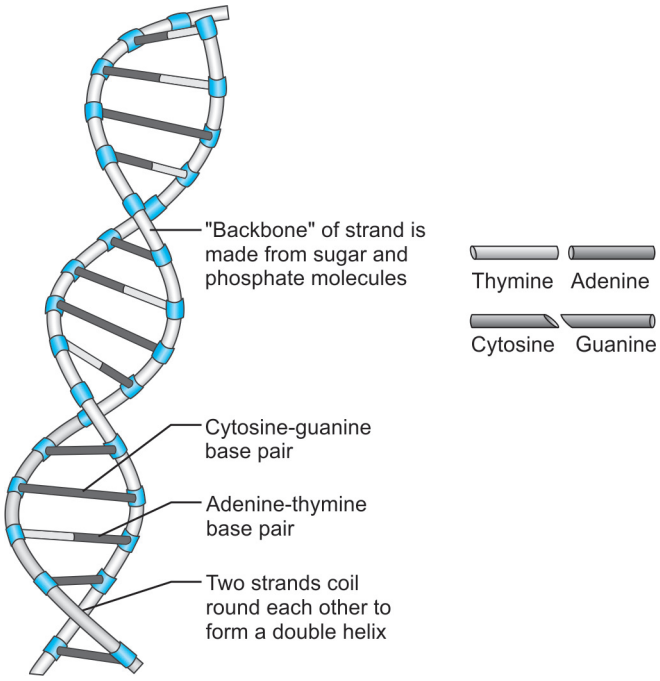


Fig. 28.1 Structure of a DNA molecule

one gene. Each nucleotide has a nitrogen base, a deoxyribose sugar and a phosphate group.

No two genes have exactly the same sequence of nucleotides which provides the basis for DNA-finger printing.

The nitrogen base of the nucleotide is either composed of purines (adenine or guanine) or of pyrimidines (thymine or cytosine).

Structurally, a DNA molecule resembles a double helix or a twisted ladder, having two side strands and multiple cross bars. The side strands of the 'ladder' are formed by alternating components of deoxyribose sugar and phosphate group. The rings (cross-bars) are composed of nitrogenous bases, consisting of one purine (adenine or guanine) and one pyrimidine (thymine or cytosine) component, joined together by hydrogen bonds. Bonding is such that adenine always pairs with thymine and cytosine always pairs with guanine **(Fig. 28.1)**. The strands are linked by these bases.

POPULATION GENETICS

Population genetics is the study of precise structural genetic composition of a population. It is a specialized branch of human genetics.

It is a basic biological science for understanding the endogenous factors in a disease and the complex interaction between nature and nurture.

Study of population genetics include:

- Genes' frequencies
- Factors influencing gene pool
- Long-term consequences.

Genes remain constant from generation to generation.

Various branches are cytogenetics, biochemical genetics, clinical genetics, pharmacogenetics, immune genetics and microbial genetics.

CLASSIFICATION OF GENETIC DISORDERS

These are grouped into three groups:

1. Chromosomal disorders
2. Monogenic disorders (Mendelian diseases)
3. Polygenic disorders.

Chromosomal Disorders

These are due to chromosomal abnormalities, such as 'deletion' (in which there is a loss of a part of chromosome), 'translocation' (in which one chromosome is attached to another), 'monosomy' (in which there is a loss of one chromosome of a pair), and 'trisomy' (in which there is an addition of one chromosome to a pair).

Out of all these, monosomy is a lethal disorder, which usually terminates in intrauterine death. Trisomy is associated with multiple deformities, constituting a syndrome, involving both autosomes and sex chromosomes.

Example relating to autosomes is Down's syndrome. Examples relating to sex chromosomes are Klinefelter's syndrome, Turner's syndrome, XYY syndrome, super female syndrome.

Down's syndrome: It is also called 'mongolism' or 'trisomy-21.' It is so called trisomy-21, because there are 3 chromosomes (extra one) on the 21st pair. Such a disorder is usually associated with advanced maternal age and not father's age. Incidence in 1 in 1,000 among mothers of 20 years of age and 1 in 50 among mothers of 45 years of age.

The child suffers from physical and mental retardation. But they are always cheerful, lively and restless. The features are short stature, small round head, epicanthus with upward slanting eyes (oblique eye position), small malformed ears, small flat nose, furrowed tongue, flat occiput, all together described as 'mongoloid face.' Hands are short and broad with a transverse crease.

Down's syndrome may be associated with congenital heart disease and/or atresia of the alimentary tract.

Autosomal monosomy, with loss of entire one chromose, is rare. The fertilized ovum may not survive. Thus, it is a serious genetic defect.

Klinefelter's syndrome: These are abnormal males. They have normal autosomal set of 22 pairs. But the person will have one or two extra X chromosome to XY chromosome, resulting in XXY or XXXY (i.e. a male with extra 'X' chromosome).

They are normal at birth. But as they attain teenage (adolescence), hypogonadism becomes apparent and secondary sexual characters fail to develop. They are sterile boys (azoospermic) having underdeveloped testes, scanty body hairs and enlarged breasts (gynecomastia). (The growth of hairs on face, axillae and pubes is scanty). They tend to be passive, shy and socially immature. They are tall, yet underweight bearing eunuchoid body shape. Usually they are mentally handicapped.

Incidence is 1 in 1,000 among males at birth.

XYY syndrome: This is a male with an extra 'Y' chromosome. Such persons are reported to have criminal, anti-social and aggressive behavior. However, the relationship is not yet clear. The principal features are exceptional height of 6' and above, serious personality disorder with behavioral disorder.

Incidence is about 1 in 1,000 males at birth.

Turner's syndrome: This is a female with loss of one X chromosome. It is XO instead of XX (45 instead of 46 chromosome) 'O' represents missing chromosome. This is a common chromosomal anomaly. Ninety percent of conceptions abort spontaneously. The remaining 2 percent that reach term, account for an incidence of 1 in 7,500 newborn girls. They have an increased risk of dying in the neonatal period.

They will have loose skin folds in the neck, edema of dorsum of hands and feet and prominent ears. Secondary sexual characters fail to appear at puberty. They are apparently females with underdeveloped sex glands. Turner girls are short statured, having webbed neck, low posterior hair-line, shield like chest, underdeveloped breasts and widely spaced nipples. They are infertile and have primary amenorrhea.

They often will have associated congenital defects such as co-arctation of aorta, pulmonary stenosis, horse-shoe kidney, perceptive hearing defect, and virtually no ovaries.

Usually not associated with mental retardation.

Super female syndrome: There are the females, having extra 2 or 3 or 4 X chromosomes (XXX, XXXX, XXXXX). Higher the number of X-chromosomes, greater the degree of mental retardation and congenital abnormalities, e.g. underdeveloped genitalia, uterus and vagina.

Monogenic Disorders (Mendelian Diseases)

These occur following Mendelian laws. These are grouped into 4 groups:

1. Autosomal dominant diseases
2. Autosomal recessive diseases
3. Sex-linked dominant diseases
4. Sex-linked recessive diseases.

Autosomal Dominant Diseases

An individual with an autosomal dominant trait will produce two kinds of gametes with respect to the mutant gene—half with the mutant gene and half with the normal gene. The offspring of such an individual has 50 percent chance of being affected, provided the other parent is normal. In this situation, there will be only two genotypes and two phenotypes. Thus, they originate in a heterozygous state.

Example, achondroplasia, Huntington's chorea, neurofibromatosis, polyposis coli, Marfan's syndrome, retinoblastoma, polycystic kidney, polydactyly spherocitosis.

Autosomal Recessive Diseases

These diseases occur in some of the offsprings of parents, both of whom are heterozygote carriers of recessive traits obviously not suffering from the disorder. Each offspring has 25 percent chance of being affected. These disorders affect the synthesis of enzyme proteins leading to inborn errors of metabolism.

Example—Phenylketonuria, galactosemia, cystic fibrosis, ataxia telangiectasia, mucopolysaccharidosis, alkaptonuria, hemoglobinopathies, albinism.

Sex-linked Dominant Diseases

These disorders originate when mutant gene carrying a dominant trait is borne on the X-chromosome. The Y-chromosome is not involved. The outcome depends on the sex of the parent who harbours the mutant gene.

If an affected male marries a normal female, daughters are affected and sons escape. But if a carrier female marries a normal male, 50 percent of her daughters will be carriers and 50 percent normal, 50 percent of her sons will be affected and 50 percent normal.

Example, Vitamin D resistant rickets, familial hypophosphatemia

Sex-linked Recessive Diseases

These disorders originate when mutant gene carrying the recessive disorder is likewise borne on the X-chromosome. Y-chromosome plays a passive role in X-linked disorders. The X-chromosome carrying the recessive disorder may belong to male or female parent. The normal X chromosome plays a dominant role so that the X-linked recessive trait finds no expression in its presence. This explains why X-linked recessive disorders affect the male offsprings and spare the female.

Example, Hemophilia, muscular dystrophy, color blindness, G6PD deficiency, hydrocephalus, retinitis pigmentosa, agammaglobulinemia.

Polygenic Disorders

These are also called multifactorial disorders because not only genetic but also environmental factors are involved such as smoking, diet, lack of exercise, obesity, etc. It was Campbell (1965) who stressed that environmental factors and genetic constitutions interact closely, resulting in abnormalities.

The genetic factors involved are the outcome of synergistic interaction of a series of genes. Once the synergistic effect of multiple genes reaches a threshold point, the environmental factors come into play and provide necessary stimulation to bring about a multifactorial disorder. Example, hypertension, ischemic heart disease, diabetes mellitus, schizophrenia, congenital heart disease, mental retardation.

However, in certain polygenic disorders like cleft palate, pyloric stenosis and Hirschsprung disease, the role of environmental factors is uncertain.

PREVENTION AND CONTROL OF HEREDITARY DISORDERS

Health Promotive Measures

Eugenic Measures

These are the measures directed to improve the genetic endowment of the human race, by preventing the births with chromosomal anamolies and genetic defects. Here, the measures are directed to the population at large.

There are two methods of application—negative and positive.

a. *Negative eugenics*: This was practiced by Adolf Hitler of Germany to 'purify' the German race by eliminating (killing) the weak and genetically defectives. People with undesirable, heritable traits were not allowed to marry and they were sterilized. The limitations are that this method can neither arrest mutations, which are the natural phenomenon, nor control marriages occurring between heterozygote partners. Now the civilized world does not approve this.
b. *Positive eugenics*: This is to improve the genetic composition of the human race by encouraging the carriers of the desirable genotype to assume the burden of parenthood.

This also has limitations, i.e. the majority of desirable human traits are not transmitted in simple Mendelian fashion but have a complex inheritance pattern of multifactorial influence. Secondly it cannot be determined, which gene is transmitted.

Euthenics

This also improves the genetic endowment of human race. This consists of improving the quality of human environment, because it has an influence on the genetic potential/development. Example, studies have shown that mentally retarded children (mild) improved in their IQ following exposure to environmental stimulation.

Genetic Counseling

It is a process of offering advice to the individuals, to improve the genetic constitution at the individual family level. Counseling is of two types—prospective and retrospective.

1. *Prospective genetic counseling*: This is offered to individuals or couples who are at genetic risk. Counseling is provided before they develop symptoms or produce their first affected child.
   Example, unmarried heterozygote carriers, who are identified by genetic screening procedures, are explained the risks involved if they marry a heterozygote carrying the same trait. In other words, by avoiding the heterozygous marriages, the prospects of giving birth to affected children will diminish.
   If the heterozygous individuals are already married and not having children, are educated about termination of pregnancy in the event of an unfavorable prenatal diagnosis, confirmed by amniocentesis.
   Disease like thalassemia, sickle cell anemia, G6PD deficiency are prevented.
2. *Retrospective genetic counseling*: This is offered to the couples, who usually report voluntarily after the birth of affected children. Here, the counselor explains the couples the probable risks associated with their further pregnancies. He will discuss about the facilities available for prenatal diagnosis of hereditary disorders and the termination of suspected pregnancies.
   The different methods adopted are contraception, termination of pregnancy in the event of diagnosing a defective fetus by sonography, sterilization of person with harmful trait, *in vitro* fertilization and embryo transfer (tubal pregnancy), avoiding exposure to mutagens such as X-rays, ionizing radiations, etc. treatment of hemophilia with antihemophilic globulin, etc.

Other General Measures

- Prevention of consanguineous marriages (prevents albinism, alkaptonuria, phenylketonuria)
- Avoiding late marriages among women (prevents Down's syndrome).

Specific Measures

- Avoiding exposure to mutagens, such as X-rays, ionizing radiations and chemical mutagens.
- Immunization against rubella before becoming pregnant (preferably during teenage)
- Immunization of Rh–ve mothers with anti-D globulin to prevent erythroblastosis fetalis.

Early Diagnosis and Treatment

This can be done by various screening procedures, applied at prenatal, neonatal and general population levels.

A. Prenatal screening procedures may be carried out by ultrasonography, amniocentesis and chorionic villus sampling procedures.
   - Ultrasonography helps in visualizing fetal malformations and also fetal growth abnormalities. It also helps in monitoring invasive fetal techniques such as chorionic villus sampling and amniocentesis.
   - *Amniocentesis*: This consists of transabdominal aspiration of amniotic fluid from the uterus. It is preferably performed between 14 and 16 weeks of (early) pregnancy. A sample of amniotic fluid is tested for biochemical tests, culture of fetal cells and karyotyping.
     - Biochemical test like elevation of alpha fetoprotein indicates metabolic defects such as neural tube defects, anencephaly and spina bifida.
     - Culture of fetal cells helps in the detection of chromosome aberrations and inborn errors of metabolism.
   - *Chorionic villus sampling procedures*: This is done to obtain fetal trophoblastic tissue. This helps to study not only fetal DNA but also provides information on all the enzymes found in amniocytes. This also helps in detection of biochemical and structural anomalies.

   By amniocentesis, determination of sex also helps in determination of certain sex linked genetic diseases such as muscular dystrophies.

   Note: Before amniocentesis is done specially to detect neural tube defects, maternal serum can be tested for alpha-fetoprotein level. If positive, it can be further confirmed by amniocentesis.

B. *Neonatal screening procedures*: The following different procedures helps in detection of the respective disorders.
   - *Clinical exam:* Congenital dislocation of hip; congenital hypothyroidism.
   - *Biochemical exam:* Phenylketonuria; G6PD deficiency
   - *Hb electrophoresis:* Sickle cell anemia
   - *Immunoreactive trypsin measurement in Guthrie cord:* Cystic fibrosis.

Table 28.1 Some genetic diseases and their treatment

Diseases	Treatment
• Phenylketonuria	Diet low in phenylalanine
• Hemophilia	Factor VIII (antihemolytic globulin)
• Spina bifida	Surgery
• Galactosemia	Restriction of galactose
• Lactase deficiency	Restriction of lactose
• Agammaglobulinemia	Administration of gamma-globulin
• Homocystinuria	Administration of pyridoxine
• Maple syrup urine disease	Administration of thiamine
• Hereditary spherocytosis	Splenectomy
• Familial polyposis of colon	Colectomy
• Adult polycystic kidney disease	Kidney transplantation

Once diagnosed, some of the genetic diseases can be treated completely or partially, as follows **(Table 28.1)**:

C. *General population genetic screening procedures*: This is carried out to identify those individuals who are at risk of developing hereditary diseases and disorders. The objective is to make presymptomatic diagnosis for arresting the progress of such diseases by timely preventive intervention.

Modern technology of analyzing DNA helps in the detection of the genotype of the individuals.

Thus, population based genetic counseling holds great promise in future.

BIBLIOGRAPHY

1. Indian Council of Medical Research. Genetics and Our Health No 20, 1972.
2. Park K. Park's Textbook of Preventive and Social Medicine, 18th edn, 2005.
3. WHO Tech Rep Ser Control of Hereditary Diseases No 865, 1996.
4. WHO Tech Rep Ser No 49, 1972.

CHAPTER 29

Preventive Geriatrics

'Geriatrics' is the science that deals with the study of diseases and their treatment peculiar to old age (clinical gerontology, i.e. the study of pathological aspects of old age). 'Gerontology' is the study of physiological and psychological changes, which are incident to old age (i.e. study of aging process).

There is no standard definition of old age. Aging is a normal, inevitable, biological phenomenon and it is not known when the old age begins. United Nations (1980) considers 60 years as the age of transition to the elderly age group. In India, people aged 60 years and above are treated as old. Old age is often classified into 'early old age' up to 75 years (elderly) and 'late old age' (very elderly) for those above 75 years. In developed countries, people at 65 years and beyond are treated as 'elderly.'

Aging is a physiological process that starts from birth, continues throughout life and ends with death. The process of aging of an individual is assessed by comparing biological age with chronological age.

- If biological age corresponds to chronological age, the aging process is 'normal.'
- If biological age lags behind chronological age, the aging is 'delayed or retarded.'
- If biological age has advanced ahead of chronological age, the aging is described as 'precocious or premature.'

While aging stands merely for growing old, 'senescence' means deterioration in the vitality or lowering of the biological efficiency or feebleness of the body and mind, associated with the process of aging, such as decline in sexual prowess, diminution in the endocrine activity, loss of elasticity of blood vessels and rise in blood pressure. These physiological changes associated with aging are often referred to as 'Eugeric' changes, which are the outcome of interaction between evolution or growth and involution or atrophy, which start from womb to tomb. In early years evolution dominates involution; balance each other during middle age and in the old age involution dominates evolution, resulting in senescence. Eugeric changes are functional as well as structural, manifesting at all levels and affect the cells, the tissues, the organs and even the configuration of the body.

POPULATION OF THE AGED

As the life expectancy is rising, the population of the aged people is also increasing steadily. The world population prospectus released by United Nations in 1998 reveals that the population of the aged at global level is 9 percent (6.7% in less developed countries and 15% in developed countries). Though the proportion of elderly population is more in developed countries, majority of the old people live in developing countries. In absolute numbers, out of about 530 million people, above 60 years, living in the world, about 355 (61.2%) million people live in developing countries. By the year 2020, the world population of old people would be about 1,000 million, of which about 700 million (70%) would be living in developing countries resulting in increasing the burden of diseases associated with old age.

In India, the proportion of aged population was 5 percent in 1971; 6 percent in 1981; 6.7 percent in 1991 and 7.7 percent during 2001. It is likely to increase beyond 8 percent in the next decade.

Japan is the most elderly country in the whole world. The average life spam of Japanese is 82 years.

THEORIES OF AGING PROCESS

Somatic Mutation Theory

According to this, there is progressive accumulation of mutations in the DNA leading to incapacitation of the cells.

Autoimmune Theory

According to this, as the age advances, there is faltering in the process of protein synthesis, resulting in the production of a new protein, which is not accepted by the body resulting in the production of antibodies against it, which is the basis of senescence.

Hayflick's Theory

According to Hayflick, old age sets in, when the body cells exhaust the capacity of undergoing multiplication.

HEALTH PROBLEMS OF THE AGED

These are grouped into physiological, psychological, social and pathological problems.

Physiological Problems

These are normally occurring and are due to aging process (i.e. eugeric changes), resulting in disabilities. These are senile cataract, glaucoma, nerve deafness, bony senses affecting mobility, emphysema, failure of special changes, changes in physical outlook (wrinkles of the skin) and mental outlook.

Psychological Problems

- *Mental changes:* Loss of memory (senile dementia) associated with impaired comprehension and impaired intellectual performance.
- Decline in sexual performance resulting in physical and emotional disturbances.
- *Isolation:* Death of the kith and kin, lack of care by the younger generation, social maladjustment and such other leads to isolation.
- *Depression:* The symptoms of depression are lack of interest in the activities, sadness, unexplained crying spells, irritability, loss of memory, inability to concentrate, confusion, disorientation, thoughts of death or suicide, change of appetite and sleep pattern, persistent fatigue, lethargy, aches, etc. The factors predisposing for depression are isolation, poverty, presence of disease/diseases, suffering, emotional disturbances, lack of happiness, etc. The depression may even lead to suicide.

Social Problems

These are poverty (due to retirement, loss of income, more expenditure due to ill health, etc.), isolation (due to death of family members), maladjustment with younger generation, unhealthy life styles like smoking, alcoholism etc. Idleness and boredom are other social problems.

Pathological Problems

- *Diseases of the heart and blood vessels:* Such as hypertension, atherosclerosis, myocardial infarction, cerebrovascular diseases like stroke. There are two types of strokes: (a) Ischemic stroke is due to sudden block of blood supply to the brain (as in thromboembolic phenomenon) leading to paralysis of one side of the body. This occurs in 85 percent of patients. (b) Hemorrhagic stroke is due to sudden rupture of artery within the brain leading to brain hemorrhagic and paralysis of one half of the body.
- *Cancer, diabetes mellitus, obesity*
- *Diseases of the eyes:* These are cataract, age related macular degeneration (AMD), loss of vision due to refractive errors, retinopathy, etc.
- *Diseases of bones and joints:* These are spondylosis, myositis, fibrositis, osteoarthritis, osteoporosis, gout, rheumatoid arthritis, fractures, etc.

  Osteoarthritis is a chronic, irreversible degenerative condition, due to breakdown of cartilage in joints, causing the affected bones to rub against each other leading to permanent damage.

  Osteoporosis is a silent disease in which the bones become fragile. If left untreated, it progresses painlessly until a bone breaks resulting in fracture, typically in hip, spine and wrist. They are extremely painful and take long time to heal.

  Gout is characterized by accumulation of excess of uric acid in the body, which then accumulates in certain joints, usually the big toe, causing sudden attack of pain, warmth, swelling, redness and tenderness.

  Rheumatoid arthritis is the inflammation of usually the peripheral joints such as hands, fingers and toes, resulting in functional disability, significant pain and joint destruction, leading to deformity and premature mortality.
- *Diseases of the respiratory system:* Common diseases are chronic bronchitis, bronchial asthma, emphysema, etc.

- *Diseases of the genitourinary system:* These are enlargement of prostate, incontinence of urine, dysuria, nocturia, urinary infection, fecal incontinence, etc.
- *Diseases of the nervous system:* Common are Alzheimer's disease and Parkinson's disease.

  Alzheimer's disease is a slow, progressive degenerative disease of the brain, leading to mental deterioration beginning from that part of the brain which controls memory. As it spreads to other parts of the brain, it affects greater number of intellectual, emotional and behavioral abilities. There is no known cause. Older the age, greater the risk of developing the disease. After 60, the risk is one in 20, but after 80, it is one in 5.

CARE OF THE AGED

Ideally, this should begin much early right from childhood. The promotive measures undertaken during childhood and adolescence constitutes 'pregeriatric care' and when continued during old age, the objective would be to 'add life to years' and not just years to life (i.e. to reduce disability and improve the quality of life).

Primary Prevention

Health Promotion

These are the measures to remain healthy in old age. These are:

- Control the blood pressure, weight and diabetes if any.
- Avoid smoking and limit alcohol intake to lead healthy life style.
- Regular, moderate, physical exercise, which unlocks the stem-cells of the muscles and rejuvenate old muscles. Endurance exercise improves the levels of spontaneous locomotion. Exercise also wards off dementia and mental decline.
- Avoidance of drug abuse and self-medication.
- Well balanced diet, low in saturated fats, refined sugars and fast foods. Add calcium rich diet, fruits vegetables and greens. Tomatoes can save from high cholesterol and hypertension because of a pigment, lycopene, which has antioxidant property. It is also found in watermelon, guava and papaya.
- Cultivation of interest in reading, writing, listening to music, doing puzzles, playing chess games, hobbies, social work, pet keeping or such other diversional activities, which can keep them busy and give exercise to the brain.
- Avoid loneliness by engaging in recreational activities.
- Drink enough water to keep away from chances of renal stones and urinary problems.
- Periodical screening for blood pressure, vision and hearing.
- Plan for future financial, housing and disease security.
- They should build up a large circle of friends and well wishers by selfless behavior, kindness and social service, which will prove useful to them.
- Yoga exercises and meditation goes a long way in promoting the health.

Specific Protection

All aged people must be immunized against diseases such as influenza, pneumococcal pneumonia, tetanus and hepatitis B. They must also be immunized selectively against, hepatitis A, meningococcal meningitis, Japanese encephalitis and rabies.

Secondary Prevention

Early Diagnosis and Treatment

Since most of the diseases of the old age are predictable, they can be identified by periodic screening for health and start treatment. Timely detection and intervention can preserve the quality of life.

The elderly people are educated about the 'danger signals' of cancer.

Women are educated regarding self-palpation of breasts for presence of lump.

Exfoliative cytology of vaginal/cervical smear (Pap smear) examination of all those women, who have attained menopause and complain of vaginal bleeding to rule out cancer cervix.

Tertiary Prevention

Disability Limitation

This consists of giving an intensive treatment in the hospital for those who come in the advanced stage of the disease.

Rehabilitation

This consists of training and retraining the patients with the remaining capacity so that they can build up self-confidence to take care of themselves. The various measures of rehabilitation are:

- Cataract surgery, provision of spectacles
- Hearing aids, artificial limbs, ear moulds, prostheses, etc.
- Physiotherapy, vocational therapy, psychological and social therapy depending upon their functional capacities.
- Deaddiction counseling for those who have become addicts.

Improvement in the quality of life is done by the following measures in the community:

- Organization of cultural programs like *harikathas, bhajans*, etc.
- Arrangement of the picnics and tours.
- Establishment of old age clubs, where the members are given training in yoga, meditation, philosophy, etc.
- Establishment of old age homes for the destitute elderly persons.
- This could be done on the basis of some payments.

OLD AGE SOCIAL AND INCOME SECURITY

Introduction

Aging is a development issue. It is a matter of time that everyone gets older. Healthy older persons are a resource for all. They make major contributions to the society. Older people play a critical role through volunteer work, promoting knowledge, helping the community and families by sharing their experiences towards building a strong nation. The development can only be ensured if older persons enjoy healthy, happy and contented life.

Since the joint family and traditional support structure of the family is breaking down, the children are unable to take care of their parents, millions of elderly face destitution. They are trapped in misery through a combination of low income and poor health.

Background

- The population of aged 60 and above is increasing (It was about 6.7% in 1991 and will be about 8.9% in 2016 and 13.3% in 2026).
- Today they are expected live beyond 75 years of age. So an Indian worker must have adequate resources to support himself for approximately 15 years after his retirement.
- The economic security provided by the Government through pension provision has been a serious drain on Government finances.

Most individuals are myopic during their earning lifetimes with regard to saving for their old age and may thus be reluctant to save adequately for their old age income security in a purely voluntary environment.

Government of India realizes that poverty alleviation programs directed at the aged alone cannot provide a complete solution to the problem. In this background, the project Old age social and income security (OASIS) took birth during 1999 under the Ministry of Social Justice and Empowerment. The basic mandate of the project is to make concrete recommendations for action, which the Government of India can take today, so that every citizen can genuinely build up a stock of wealth through his/her working life, which would serve as a shield against poverty in old age.

Since there is already existence of Provident Fund system, the challenge is therefore not to ask the workers to save more but to convert high savings rate into old age security. So the project recommends the following:

- Limit early withdrawals
- Deploy superior financial portfolio management information system so as to obtain higher rate of returns
- Expand the coverage of existing provident fund system as to reach more workers
- Improve customer service of the existing provident fund system.

Thus, OASIS is a project of national importance. The Providend Fund (PF) Act was introduced way back in 1925 itself. There is also Public Providend Fund (PPF) scheme for self-employed. This is confined to large cities only.

The OASIS project has two phases. First phase covers the existing mechanisms for social security—PF, PPF and pension scheme, which should be further improved. The second phase covers other issues including a new voluntary pension system, individual choice of diverse funds and fund managers, regulatory authority for the pension fund industry and need for a Redistributive pillar, i.e.:

- Noncontributory Government pensions (Central and State Government plans, Railway, Armed forces, Post and Telegraph).
- Occupational and Private Pension Plans.
- Contributory pension, provision for uncovered workers, farmers, etc.
- Strengthening the existing social welfare schemes.

Social Security Net

Indira Gandhi National Old Age Pension Scheme

Objective: The objective is to disburse pension to the destitute old age persons.

Assistance provided: ₹400/- per month.

- *Beneficiary:* Beyond 65 years of age, belonging to BPL (below poverty line) and 60 years and above for persons affected by leprosy, blindness, insanity, paralysis and loss of limb.
- *Other benefits:* One free *dhoti* for male and one free *saree* for female, supplied twice a year for Deepawali and Pongal festivals.
- All pensioners are supplied daily with free nutritious meal. 2 kgs of rice per month to those who are taking nutritious

meal and 4 kgs of rice per month for those who are not taking nutritious meal, are supplied at free of cost.

- *Procedures to apply:* Applied in a prescribed form obtained from Taluk office or in a plain paper duly filled up and sent to Tahsildar/Special Tahsildar (Social Security Scheme).

Grievances to be reported to Revenue Divisional Officer/ District Collector.

Annapurna Scheme

- *Objective:* The objective is to ensure food security to the old age pensioners.
- *Assistance provided:* It is 10 kgs of rice or wheat per month, supplied free of cost to the destitute senior most citizens among National Old Age Pension Scheme beneficiaries.

Separate cards labeled, 'Annapurna' are issued to the beneficiaries, collected from District Collector.

This new scheme is yet to be implemented.

HELPAGE INDIA

It is a secular, nonprofit, largest voluntary organization, registered under the 'Societies Registration Act of 1860'. It was set up in 1978 and since then it has been working for the cause and care of disadvantaged old people. It has been raising resources to protect the rights of India's elderly people and provide relief to them through various interventions.

- It brings about various policies that is beneficial to the elderly
- It promotes better understanding of aging issues
- It creates awareness about rights of the elderly
- It helps them to play an active role in the society
- It supports the following programs for them:
  - Free cataract operations
  - Mobile medical care units
  - Income generation and micro-credit
  - Old age home, day care centers, etc.
  - Cancer and Alzheimer's projects.

NATIONAL POLICY ON OLDER PERSONS

National Policy on Older Persons (NPOP) was formed in January 1999, under the Ministry of Social Justice and Empowerment. It seeks to assure older persons, above 60 years of age, that their concerns are national concerns and they will not live unprotected, ignored and marginalized. The goal of the National Policy is the well being of older persons. It aims to strengthen their legitimate place in society and help older persons to live their last phase of life with purpose, dignity and peace.

The NPOP visualizes that the State with extend support for financial security, health care, nutrition, shetter, provision of appropriate concessions, rebate, discounts, etc. for all senior citizens and special attention to protect and strengthen their legal rights so as to safeguard their life and property. This policy is operated by National Council for Older Persons.

The policy provides broad framework for collaboration and cooperation between Governmental and Nongovernmental agencies.

BENEFITS GIVEN TO SENIOR CITIZENS OF INDIA

1. *National Policy on Older Persons:* Explained already.
2. *Ministry of Rural Development:* Under National Old Age Pension Scheme, Central Assistance of ₹75/- per month is granted to destitute older persons above 65 years.
   Under Annapurna Scheme, free food grains (wheat or rice) up to 10 kg per month are provided to destitute older persons above 65 years of age who are eligible for old age pension but not receiving it.
3. *Ministry of Finance:* Union Budget 2011–12.
   Section 88 of the Finance Act 1992 provides income tax rebate up to ₹15,000/- or actual tax whichever is less to senior citizens, who have attained the age of 65 years at any time during the relevant previous year.
   Senior citizens are excluded from 'One by Six' scheme for filling the Income Tax Return underprovison Section 139(1). The deduction in respect of Medical Insurance premium is up to ₹15,000/- under section 80 D, w.e.f. 2000–01.
   Reserve Bank of India has permitted 0.5 percent higher rate of interest on fixed deposits in the bans.
4. *Ministry of Health and Family Welfare:* Separate queues are provided to senior citizens in the hospitals for registration and clinical examinations.
5. *Ministry of Railways:* Railway budget 2010–11.
   Concessions to senior citizens are hiked from 30 to 40 percent for men above 60 years and for women above 58 years, for booking/cancellation of railway tickets.
6. *Ministry of Civil Aviation:* Fifty percent discount on basic fare for all domestic flights in Economy Class for above 65 years of age and in Sahara India Airlines for above 62 years of age, for both men and women.
7. *Ministry of Road Transport and Highways:* The benefit is given after 65 years of age for both men and women.
8. *Department of Post Office:* A new scheme called 'Senior Citizen Saving Scheme' has been notified w.e.f. August

2, 2004. The maturity period of deposit will be five years, extendable by another three years, in designated post offices throughout the country.

Under this scheme, people above 60 years are eligible to invest minimum of ₹1000/- and in multiples of ₹1000/- subject to a maximum of ₹15 lakhs, with single or joint account with spouse only.

Those who have taken voluntary retirement at 55 years of age, are also eligible, subject to specified conditions. The deposit will carry an interest of 9 percent per annum, taxable. Premature withdrawl after one year is allowed subject to some conditions. The investment is nontransferable and nontradable. However, nomination facility will be available. Non-Resident Indians and Hindu undevided families are not eligible to invest in this scheme.

BIBLIOGRAPHY

1. http://www.senior indian.com/OASIS_htm.
2. http://www/tn.gov.in/schemes/swnmp/social securty-net.pdf.
3. http://www/helpage india.org/aboutus.php.
4. ICMR. Health Care of the Elderly. Bulletin 1996;26(5).
5. Lal S. Adding Life to Years. Ind JL of Com Med 1999;24(4):143-6.
6. Voluntary Association of Health India. Health Problems of Specialized Groups. Chapter 14, 1997.

CHAPTER 30

Mental Health

Mental health is one of the components of health as defined by World Health Organization (WHO). A person is said to be mentally healthy, when the individual has a perfect state of balance with the surrounding world, having harmonious relation with others, the intelligence, memory, learning capacity, judgment are normal, not having any internal conflicts, accepts criticism sportively, has got good self-emotional control, solves the problems intelligently, has full self-confidence, well adjusted with others and is satisfied with what he has possessed. He is cheerful and calm.

Mental health status of an individual can be assessed by his attitude and behavior.

MAGNITUDE OF THE PROBLEM

Mental illness is a global problem. It causes considerable disability, imposing a heavy burden of suffering and economic loss. It constitutes 8 percent of global burden of all diseases, measured in Disability Adjusted Life Years (DALY).

The prevalence of mental illness is estimated to be about 10 per 1000 population. During the whole lifetime, about 25 percent of persons suffer from one or the other form of mental illness. About 25 percent of the patients attending hospital will have a psychological basis.

Eighty percent of the mental illness are found in the developing countries, 30 percent of which occur among children below 15 years.

Globally there are about 40 million cases of severe mental illness, 20 million cases of epilepsy and about 200 million cases with minor mental illness and neurological conditions. In India, the situation is as follows:

Serious mental disorder — 10 to 20 per thousand (10-12 million)
Minor mental disorder — 20 to 60 per thousand
Emotional problems — 200 per thousand

Thirty percent of the cases occur among children below 15 years, majority of those cases being mental retardation.

In India, about 2.5 lakhs new cases are added per year and this has been gradually increasing.

CAUSATIVE FACTORS

The etiology of mental health is very complex and not well understood. A large group of mental disorders are still called 'Functional' because no pathological, biochemical or hormonal changes are discovered with the present investigative techniques.

Various etiological factors are as follows:

1. *Heredity*: A child born to both the schizophrenia parents has 40 times higher risk of having schizophrenia than a child born to normal parents.
2. *Physical factors (Organic conditions)*: Conditions like infections, toxins, tumors, vascular injury, nutritional deficiency, metabolic defects and degenerative and autoimmune processes, endocrine diseases and chronic diseases also result in various types of organic mental disease. Senile dementia is Alzheimer disease.
3. *Socio-environmental factors*: There are worries, anxieties, emotional stress, tension, frustration, unhappy marriages, broken homes, poverty, economic insecurity, drug addiction, lack of cooperation during crises by the dear ones, sexual starvation, sexual assault, cruelty, etc.

TYPES OF MENTAL DISORDERS

Following are the types of mental diseases:

Mental Deficiency or Mental Retardation

Depending upon the intelligent quotient (IQ), mentally retarded individuals are classified into mild, moderate and severe (vide under handicapped children). Mild mental retardation (MR) cases are educatable and trainable. Children with mild MR even though educatable, they remain 2-3 years behind their healthy counter-parts. It is better to have special schools for such children. Otherwise they may develop inferiority complex. MR children may have other psychiatric associated disease.

Moderate MR cases are not educatable but trainable. They can attain partial independence if properly trained.

Severe MR cases are neither educatable nor trainable. They remain completely dependent.

Behavioral Disorders

Among children these are common. These are manifested as bed-wetting, tantrums, stealing, tellinglies, aggressiveness, playing truant from school, etc.

This also includes antisocial behavior such as juvenile delinquency.

Mental Diseases

These are grouped into five sub-groups:

1. *Acute brain disorders*: These are usually temporary and reversible.
   For example, delirium, acute alcoholic intoxication.
2. *Chronic brain disorders*: These are usually permanent.
   For example, cerebral syphilis, senile dementia (Alzheimer's disease).
3. *Psychotic disorders*: These are major mental illnesses. These are also called 'psychoses'. In this type, the person is 'insane' and out of touch with reality. He is lunatic with unsound mind. The major illness (psycho-ses) are of three types:
   i. *Schizophrenia (Split personality)*: In this type, the patient lives in a dream world of his own.
   ii. *Manic depressive syndrome*: In this type, the symptoms vary from heights of excitement to depths of depression.
   iii. *Paranoia*: The person will have undue suspicion on others.
4. *Neurotic disorders*: These are also called 'Psycho-neuroses'. These are minor illness. The person is not insane or lunatic. But he is unable to react normally to life situations. Nevertheless exhibits certain peculiar symptoms such as morbid fears, compulsions and obsessions. They are characterized by anxiety which may be overt or subconscious. Hysteria falls in this category.
5. *Personality disorders*: These are characterized by developmental defects.

Psychosomatic Disorders

These are the diseases with physical manifestations, having psychological factors as the underlying cause.

For example, allergic disorders, such as asthma, eczema, urticaria.

- Thyrotoxicosis
- Hypertension
- Coronary artery disease
- Duodenal ulcer
- Rheumatoid arthritis.

PREVENTION AND CONTROL OF MENTAL ILLNESS

This can be described under three levels—primary, secondary and tertiary.

Primary Prevention

The aims of primary prevention are:

- To reduce the incidence of new cases of mental disorders
- To promote emotional robustness specially among the vulnerable high-risk groups (to avoid the onset of emotional disturbance).

The strategies of primary prevention are educational, nutritional and social, as follows:

- Universal iodization of common salt is the best method of preventing cretinism and mental retardation.
- Industrial safety measures prevent lead encephalopathy and mercurial erethism.
- Early diagnosis and treatment of conditions like hypertension, syphilis, diabetes during pregnancy will prevent mental defects in the offspring.
- Prevention of infections like syphilis, rubella, encephalitis and HIV.
- Prevention of nutritional deficiencies like pellagra, beriberi, and anemia.
- Early diagnosis and treatment of genetic diseases like phenylketonuria (by diet low in phenylalanine), hypothyroidism (by maintenance of thyroxin level in the blood) and hydrocephalus (by ventriculostomy).
- Other general measures which can provide security, love and affection, specially among children, are good

housing, child-placement services (like adoption, foster homes, orphanages, etc.). Other measures include welfare services for refugees, disaster survivors, etc.

- Miscellaneous measures are:
  - Personality development measures – like disciplined environment both at home and at school. Scout, NCC, Air-wing, etc. foster team spirit and good personality also helps in adjusting to adverse situations. School authorities are cautioned against overburdening the children with classes and home-works. High school children are made aware of the dangers of alcohol, smoking and drug abuse.
  - Youth welfare services will save frustration and disappointment among youths, who are at the threshold of adult responsibilities.
  - Social welfare measures such as amelioration of poverty, ignorance and illiteracy and provision of proper education and job opportunities will reduce mental tension and frustrations.
  - Avoiding late marriages and consanguineous marriages.
  - Legal measures such as prohibition of sale of uniodized salt, ban on the manufacture and sale of psycho-active drugs, etc. also constitute primary preventive measures.

Secondary Prevention

This consists of early diagnosis and treatment of mental illness through screening procedures specially among the susceptible and vulnereable groups of population in the schools, industries, antenatal clinics, etc.

Family based health services have a greater role. The family service agencies identify emotional problems and help family members to cope up with the family stress, mainly by counseling, specially among those with marital conflicts, disturbed parent – child relationships and such others.

Treatment is through specific drug therapy, general measures and electroconvulsive therapy.

Drugs are diazepam for anxiety states, imipramine for depressive psychosis, lithium for maniac state and chlorpromazine for schizophrenia.

General measures include *yoga* and meditation therapy, relaxation therapy, social support therapy, etc.

Tertiary Prevention

The aim is to reduce the duration of mental illness, to minimize disability and to rehabilitate the patient as an useful member to the family and to the community at large. The different measures are:

a. *Day care programs*: This is for those patients, who have undergone hospital treatment. They spend their time in a structured way, which helps them to learn social skills for living.
b. *Half-way-homes*: These are set-up between the hospital and patient's family. Patients with unequivocal recovery are placed for few weeks to few months depending upon the case, where they live like a family with other patients. They manage their daily needs independently with some support from social workers. They are popular in the West. They are established in one or two cities in South India. It is a kind of social-rehabilitation.
c. *Self help groups*: These are the groups of parents having mentally retarded children. They share their problems among the co-parents and resolve the problems by formation of welfare associations, special schools or training centers for mentally retarded children.
d. *Family service programs*: They offer professional counseling services for the affected families. Not only they sort out problems within the family but also provide vocational training, care for the chronically ill patients and the aged.
e. *Industrial therapy centers*: In this, the patients are grouped according to their abilities and skills and are given specific work assignments with salary and prepared for open employment in the community. One of its kind functioning is in Chennai.
f. *Vocational training centers*: It is a cost-effective method of rehabilitation of not only mentally handicapped persons but also for physically handicapped individuals.
g. *Rehabilitation in family*: This constitutes the home care for the mentally ill persons, which is one of the most preferred way because the patient feels more comfortable. The joint family system provides a better opportunity than the nuclear family. But the family members need to be motivated for accepting these patients. It is also a very cost-effective method, specially for psychosocially disabled persons.

Rehabilitation of psychosocially disabled persons are neglected by the society and health planners. Therefore there is a need to develop models of psychosocial rehabilitation which are implementable, actionable and affordable.

BIBLIOGRAPHY

1. Lal L, Vashist BM. Moving Away from Medical Institutions towards Community Mental Health Care. Ind J Com Med 2002; 27(4):147-50.
2. NIMHANS. Mental Health Manual for Health Workers. Bengaluru 1990.
3. WHO Mental and Neurological Disorders. Fact Sheet 265. Geneva 2001.
4. WHO Strengthening Mental Health Promotion. Fact Sheet 220. Revised Geneva 2001.

CHAPTER 31

Adolescent Health

The term 'Adolescence' is derived from a *Latin* word 'Adolescere' meaning 'to grow', 'to mature'. It is a period of transition from childhood to adulthood. This transitional stage extends from 10 to 19 years. It is characterized by rapid physical growth and significant physical, psychological, emotional and spiritual changes.

Adolescents are often thought of as a healthy group. Nevertheless, many adolescents do die prematurely due to accidents, suicides, violence, pregnancy-related complications and other illnesses that are either preventable or treatable. Many more suffer chronic ill health and disability. In addition many serious diseases in adulthood have their roots in adolescence. For example, tobacco and alcohol use, sexually transmitted infections (STIs) including HIV, poor eating and exercise habits lead to illness or premature death later in life.

The adolescent period is grouped as follows:

Adolescence:	10 to 19 years
Early adolescence:	10 to 13 years (growth spurt and secondary sexual characteristics)
Middle adolescence:	14 to 16 years (new relation with opposite sex and desire for experimentation)
Late adolescence:	17 to 19 years (distinct identity, well formed opinion and ideas)
Youth:	15 to 24 years
Young people:	10 to 24 years.

CHANGES DURING ADOLESCENCE

- Physical (biological) changes—onset of puberty
- Cognitive changes—emergence of more advanced cognitive abilities
- Emotional changes—self-image, intimacy, relationship with adults and peer group
- Social changes—transition into new roles in the society.

IMPORTANCE

- Adolescence is a formative period of life
- It is a crucial period because major physical, psychological, (emotional) and social changes take place
- It is an impressionable period of life
- It is a period to take major decisions, including responsible parenthood. Thus transition from dependence to relative independence
- Adolescents constitute a great human resource for the society
- They are the citizens of tomorrow and thus are responsible for the progress and development of the country
- Their nutritional requirements are more like iron, iodine and calcium
- They are sexually active
- There is suboptimal support at family level leading to social frustration.

Key Facts

- Most young people are healthy. However, they are exposed to the risks and vulnerabilities at the same time
- They constitute nearly 23 percent of the population in India
- Half of the group is sexually active before marriage
- Fertility rate is high in this group

- More than 2.6 million young people aged 10 to 24 die each year globally mostly due to preventable causes
- Low level of knowledge among young women about family planning and healthy sexuality has predisposed for the social consequences such as unplanned pregnancy, unwed motherhood, unsafe abortion, illegitimate children, victims of sexually transmitted infections, etc. emergence of HIV has worsened the situation
- Teenage pregnancy increases the risk of MMR and IMR. About 16 million girls aged 15 to 19 give birth every year. Majority occurring in developing countries
- Young people of 10 to 24 years account for 40 percent of all new HIV infections among adults (in 2009). Everyday nearly 2400 young people get infected with HIV and globally there are more than 5 million young people living with HIV/AIDS
- In any given year about 20 percent of adolescents will experience mental health problems, most commonly depression or anxiety
- An estimated 150 million young people use tobacco
- Approximately 430 young people aged 10 to 24 years die everyday through interpersonal violence
- Road traffic injuries cause an estimated 700 young people to die everyday
- Nearly half of them suffer from nutritional anemia and about 59 percent boys and 37 percent girls are stunted
- Many are not immunized against tetanus
- Adolescence period is the best time to correct the growth deficiency if any
- Protecting healthy practices is critical to the future of country's health and social infrastructure
- An important framework for young peoples' health are Millennium Development Goals (MDGs)
  - MDG 5 aims to achieve universal access to reproductive health
  - MDG 6 aims to halt the spread of HIV/AIDS.

CHALLENGES IN ADOLESCENT HEALTH IN INDIA

- 45 percent of girls are undernourished
- 20 percent of boys are undernourished
- Early marriage:
  - 26 percent among girls below 15 years
  - 54 percent among boys below 18 years
- 30 percent of boys and 10 percent of the girls are sexually active.
- 59 percent of adolescents know about condoms
- 49 percent of adolescents know about contraceptives
- 4.5 percent are drug abusers
- 50 percent of all HIV-positive new infections are in the age group of 10 to 25 years
- Adolescent abortion varies from 1 to 4 million
- Traffic accidents, violence, fire-related incidents, drowning and such other injuries contribute significantly for the increased deaths among the adolescents.

IMPACTS OF ADOLESCENCE

- Lack of formal and informal education
- School dropouts and childhood labor
- Malnutrition and anemia
- Early marriage and teenage pregnancies
- Habits and behavioral changes developed during adolescence, will continue in future life
- Lot of unmet needs regarding nutrition, reproductive health and mental health
- Lack of safe and supportive environment
- Desire for experimentation
- Sexual maturity and onset of sexual activity
- Ignorance about sex and sexuality
- Social frustration
- Lack of school education about adolescent health.

ADOLESCENT HEALTH PROBLEMS

Malnutrition

Because of growth spurt, there is increased demand and decreased intake of diet leading on to malnutrition. The major problem being anemia, more so among girls because of menstrual loss, bleeding disorder, associated infections and infestations like ancylostomiasis. Conversely overweight and obesity are also increasing because of changes in lifestyle and foot habits.

Teenage Pregnancy

This results in 'Child In Child'. This is associated with illegal abortion, increased IMR and MMR. This is due to sexual maturity, sexual activity associated with ignorance about sex and sexuality, predisposed by family traditions of early marriage.

Risk Behavior

Because of inquisitiveness and desire for experimentation, the teenagers want to experience the effect of smoking, alcoholic

drinks and even sexual intercourse, without knowing the adverse effects and often become the victims.

Sexually Transmitted Infections

Because of high-risk behavior of sexual activity, predisposed by the effects of media like television, pornographic books, etc. the incidence of STIs including HIV is increasing among teenagers.

SERVICES IN ADOLESCENT HEALTH CLINICS

- Periodical general examination for assessing the growth and development and also to screen for various disorders
- Nutrition advice mainly to prevent malnutrition and anemia
- Reproductive health services such as preconceptional education about menstruation, pregnancy, planned parenthood, family welfare methods, RTI/STI detection and treatment and also HIV detection and counseling
- Sex education including hazards of early marriage and problems associated with menstruation
- Genetic counseling
- Stress management
- Deaddiction
- Medical termination of pregnancy.

RECOMMENDATIONS

- Formulation and enforcement of laws that specify a minimum age of marriage, community mobilization to support these laws and better access to contraceptive information so that too early pregnancies can decrease.
- Young people should practice safe sex by using condoms to protect themselves from STIs including HIV/AIDS.
- Adequate nutrition, healthy eating habits and moderate physical exercise are foundations for good health in adulthood.
- Building life skills in children and adolescents are providing them with psychosocial support in schools and other community settings can help promote mental health.
- Banning tobacco advertising, raising the prices of tobacco products and laws prohibiting smoking in public places reduce the number of people who start using tobacco products. That also increases the number of young people to quit smoking.
- Banning alcohol advertising and regulating access to it are effective strategies to reduce alcohol use by young people.
- Promoting nurturing relationship between parents and children early in life, providing training in life skills and reducing access to alcohol and lethal means like firearms help prevent violence.
- Advising young people on driving safely, strictly enforcing laws that prohibit driving under the influence of alcohol and drugs and increasing access to reliable and safe public transportation can reduce road traffic accidents in young people.

Table 31.1 Operational framework for adolescent reproductive and sexual health (ARSH) at various levels

Level of care	Service provider	Target group	Flow of service delivery activities	Services
Subcenter	Health worker female	Married (F) Unmarried (F) Married (M) Unmarried (M)	During routine sub-center clinics	Enroll newly married couples Provision of spacing methods Routine ANC and institutional delivery Referral for easy and safe abortion STI/HIV/AIDS prevention, education Nutrition counseling including anemia prevention
Primary Health Center Community Health Center	Health Assistant (F) Medical Officer	Unmarried male and female	Once a week teen clinic will be organized at PHC for 2 hours	Contraceptives Management of menstrual disorders RTI/STI prevention, education management Counseling and services for pregnancy termination Nutritional counseling Counseling for sexual problems

Table 31.2 Logical framework for ARSH

Purpose/outcomes	Objectives/Outputs level		Activity/Input level	
	Objectives/Outputs	OVIs/MOV	Activity/Input	OVIs/ MOV
Improved reproductive health status of adolescent girls and boys	To increase utilization of reproductive health services by adolescent and young girls and boys	• Teenage pregnancy rate • Prevalence of STIs/RTIs • Use of condoms during the last sex among age group 15–19 years • Incidence of anemia in girls age 15–19 years • Mean age at marriage • Incidence of anemia among pregnant teenage mothers • Proportion of HIV positives among 10–19 years age group. *MOVs for above:* MIS/ Rapid HH Survey, Rapid Survey MIS/ PRI reports, Sentinel surveillance reports	*Increase supportive attitude towards ARSH through:* • Orientation of State and District program managers • BCC communication activities and mass media campaigns *Increase capacity and skills for providing information and services through:* • Orientation of service providers • Improving MIS for data collection on ARSH *Increase provision of ARSH services (including maternal health, RTI/STI management, contraceptives, MTP and counseling services) through:* • Subcenter • PHC	Percentage knowing benefits of providing adolescent friendly health services *MOV:* Rapid assessment percentage of subcenters having communication material for adolescents *MOV:* Reports of supervisory visits. Percentage of planned group meetings held *MOV:* Subcenter/PHC report. Percentage of public providers trained in providing adolescent friendly services. *MOV:* Training reports • Number of newly married couples registered during the month • Proportion of teenage pregnant women attending ANCs • Proportion of teenage PW delivering in the institutions • Proportion of teenage girls availing MTP services • Proportion of adolescent seeking RTI services *MOV for above:* Subcenter/ PHC report

OVIs—Objectively verifiable indicators
MOV—Means of verification

During 64th World Health Assembly in 2011, a resolution on 'Youth and Health Risk' was adopted.

CONCLUSION

- Adolescent period is hazardous for adolescent health due to absence of proper guidance and counseling.
- Family has a crucial role in shaping adolescent behavior.
- Family has to ensure a safe, secure and supportive environment for the adolescents.
- Family members in the community to be informed and educated about the problems.
- A positive and encouraging attitude has to be developed among the family members and parents.
- School teachers should be trained on adolescent health.
- Community leaders also play a vital role on adolescent health care.

ADOLESCENT REPRODUCTIVE AND SEXUAL HEALTH

Sexuality is one of the most sensitive issues associated with adolescence. Low level of knowledge among young teenagers about family planning and healthy sexuality have serious social, economic and public health implications. Some of the public health challenges are teenage pregnancy, risk of maternal and infant mortality, STIs/RTIs including HIV/AIDS malnutrition and anemia worsens the situation further. Thus it is important to influence the health seeking behavior of the adolescent as their situation will be central in determining India's health, morbidity, mortality and the population growth scenario.

Adolescent reproductive and sexual health (ARSH) strategy has been approved as a part of Reproductive and Child Health (RCH) Phase II National Program Implementation Plan (NPIP). This strategy focuses on providing information and services on promoting safe sexual behavior including abstinence, delayed age at onset of sexual course, preventing unwanted and early pregnancies and preventing STIs including HIV/AIDS, in subcenters, Primary Health Centers, Community Health Centers and District Hospitals on fixed days and timings and also through outreach activities. A core package of services includes preventive, promotive, curative and counseling services.

World Health Organization (WHO) assisted Government of India in designing framework of adolescent health strategy for National Program Implementation Plan (NPIP) under RCH II. Government of India has positioned ARSH strategy as one of the key technical strategies in RCH II program under NRHM.

This strategy focuses on reorganizing the existing public health system in order to meet the needs of the adolescents. The ARSH strategy is a two pronged strategy.

Strategy one falls within the overall scale and coverage of the RCH II program. District Officer of Health and Family Welfare (DOHFW) will incorporate adolescent issues in all the RCH training programs and all RCH materials developed for communication and behavioral change. This will entail that interventions for addressing unmet need for contraception and pregnancy care, prevention of STIs including HIV/AIDS will have specific activities to reach out to adolescents.

Strategy two will be implemented in select districts (i.e. those districts where more than 60 percent girls marry before the age of eighteen, presuming the incidence of teenage pregnancy will be too high), where DOHFW will undertake special efforts to reorganize services at PHCs on dedicated days and timings for adolescents, depending upon the local capacities to deliver.

At District level, District RCH officer will be in-charge of ARSH service delivery.

In rural areas, private providers can be engaged in the provision of ARSH services.

The operational and logical framework for ARSH is shown in the **Tables 31.1 and 31.2** respectively.

Key Interventions

- *Orientation of service providers*: This is to make existing services adolescent friendly. A module has been developed for the purpose. RCH officer is the nodal person.
- *Environment building activities:* This consists of communication activities, for which material has to be developed in local language.
- *MIS:* This consists of monitoring the teenage pregnancy rate, institutional delivery, prevalence of STIs, etc.

BIBLIOGRAPHY

1. Ghai OP. Essential Pediatrics, 6th edn.
2. GOI. Reaching Adolescent Girls—Kishori Shakti Yojana and Other Initiatives. Dept of Women and Child Welfare, Ministry of HRD, New Delhi 2002.
3. Indian Public Health Journal. Mar. 2001; Sept. 2002.
4. Lal S. Mother's perception and ambitions about their daughters in rural areas. IJCM. 1992;12(1):22-8.
5. MOHFW—GOI. RCH Phase II. National Program Implementation Plan.
6. NIPCCD. Schemes for Adolescent Girls. Launched. News Letter No.12.
7. Selvarja. Indian Railways Medical Services. New Delhi.
8. UNFPA for UN System in India. Adolescent in India—A profile India 2000.
9. WHO—Core Programme Clusters. Adolescent Health and Development.
10. www.who.int/mediacentre/factsheet/fs345/en/index.html

CHAPTER 32

Alcoholism and Drug Addiction

DEFINITION

A drug is a substance, other than food, which when consumed, produces changes in the physical or mental functioning of the individual.

Drug use, is taking a drug for medical purpose like treating an illness or to relieve pain or tension or protecting the body against the disease.

Drug abuse is taking the drug for the reasons other than the medical reasons, in amount (quantity), strength, frequency and manner that damages the social, physical and mental functions and results in harm.

Drug addiction is the result of drug abuse, which produces both dependence and tolerance.

Drug dependence is described as a state, resulting from the interaction between a living organism and a drug, characterized by a response that always makes a compulsion to take the drug continuously or periodically, to experience its psychic effects and often to avoid the discomfort of its absence. Drug dependence can occur for more than one drug.

Drug dependence are of two kinds—Physical and Psychological.

Physical Dependence

This state occurs when the user's (abuser's) body becomes accustomed to the particular drug and he/she requires the drug, in increasing doses over a time, for normal functioning or to obtain the same results as earlier. This dependence is because of the development of 'tolerance' to the drug. (Tolerance means requiring more and more of a drug to get the same effects). Abrupt stopping of the drug results in a variety of adverse effects, known as 'Withdrawal symptoms', such as cramps, tremors, pain abdomen, sweating, depression, etc. His whole life is focused on drug procurement and use.

Psychological Dependence

This state occurs when a drug is so central to a person's thoughts, emotions and activities, that is extremely difficult to stop using it or even stop thinking about it. Psychological dependence is marked by an intense craving for the drug.

Addiction as a Disease

In the year 1956, addiction was declared as a disease by the American Medical Association. It is a disease which can be treated and arrested. The characteristic features of the disease are:

- *It is a primary disease:* It is not a symptom of a psychological disorder but a disease. It can cause mental, emotional and psychological problems. These problems cannot be treated unless addiction is treated first.
- *It is a permanent disease:* It cannot be cured but successfully can be arrested.
- *It is a progressive disease:* The disease invariably follows a course of serious deterioration over a period of time.
- *It is a terminal disease:* An addict may die due to any complication but the factor which induces the complication itself is the abuse of drug.

Types of Drug Abuse

Drug abuses are of the following types:

- *Too much*: Taking too much of the drug at a time or taking too frequently can result in fatality, e.g. sleeping pills.
- *Too long*: A drug is said to be abused if taken over a long period of time, resulting in serious problems, e.g. pethidine.
- *Wrong use*: A drug is said to be abused if taken for wrong reasons or without proper instructions.
- *Wrong combination*: A drug is said to be abused if taken in a wrong combination with other drug.
- *Wrong drug*: Use of a drug, like brown-sugar which has no legitimate use, itself is drug-abuse.

Reasons of Drug Abuse

These are easy availability, curiosity, emotional pleasure, social or group pressures. It is more common among teenagers and abuse of multiple drugs is also increasing. Other risk factors for drug abuse are unemployment, broken home, parental deprivation, migration, working in drug stores, genetic predisposition, etc.

Prevalence

Alcoholism and use of other psychoactive drugs is a global problem. Reliable prevalence rates are not available. About 15 to 20 million people smoke marijuana in US. About 40 percent of high school students have accepted marijuana as a part in their life. In India, about 25 to 40 percent of college students are addicted and it is on the increase.

IDENTIFICATION OF DRUG ABUSERS

- *Academic changes*:
  - Poor attendance at school or college
  - Decline in academic performance.
- *Physical changes:*
  - Slurring speech
  - Sweating at night
  - Loss of appetite
  - Reddening of eyes
  - Unsteady gait
  - Fresh injection sites
  - Temper tantrums
  - Puffiness under eyes.
- *Withdrawal symptoms:*
  - Tremors, cramps, gastrointestinal symptoms, pain abdomen, sweating, depression.
- *Other changes:*
  - Blood stains on clothes
  - Disappearance of articles from home (Addicts often sell articles to obtain money for drugs)
  - Odor on breath and clothes
  - Presence of needles, syringes, strange packets, etc. at home
  - Presence of solitude, especially spending long time in the toilet.

Dependence Producing Drugs

International classification of diseases (ICD)-10 recognizes the following psychoactive drugs, to be dependence producing.

- Alcohol
- Opioids
- Cannabinoids
- Sedatives or hypnotics
- Cocaine
- Stimulants
- Hallucinogens
- Tobacco
- Volatile solvents
- Others.

Alcohol

Depending upon the quantity consumed, alcohol is considered as a sedative, tranquillizer, hypnotic or anesthetic. Alcohol is the only drug whose self-induced intoxication is socially acceptable.

Alcohol is so rapidly absorbed from the stomach that it is detected in the blood within a couple of minutes and the maximum concentration is reached within about an hour of consumption. Presence of food in the stomach reduces its absorption by dilution.

Alcohol has a marked effect on the central nervous system. Its concentration differs in beer, rum, gin, brandy and whisky. It results in delirium, psychosis and paranoid schizophrenia.

The adverse effects are acute and chronic intoxication, toxic psychosis, cirrhosis of the liver, gastritis, pancreatitis, cardiomyopathy and peripheral neuropathy. Alcohol is also considered as a carcinogen resulting in cancer of esophagus, mouth, pharynx and larynx.

The social adverse effects are automobile and vehicular accidents, injuries, suicides, deaths due to violence, family disorganization, crime, etc.

Its effects during pregnancy are abortion, fetal alcohol syndrome (microcephaly, growth retardation, mental retardation, valvular disease).

Opioids

This consists of opiates and other narcotic hypnotics / analgesics. The source of opiates is opium (*Papaver somniferum*). The active alkaloid of opium is morphine. Morphine, pethidine, heroin, codeine, methadone are all narcotic analgesics. These drugs block pain receptors in brain and relieve pain and induce sleep.

These drugs result in psychic dependence very soon and very strongly.

Addiction to heroin is the worst type because it produces craving. The drug fentanyl is ten times as potent as heroin.

Cannabinoids

Cannabis is obtained from dried leaves, flower-tops and stem of hemp plants and is most widely used drug today allover. Hemp plants are *Cannabis sativa*, *C. indica* and *C. americana*.

The resinous exudates from the flowering tops of the female plant contains '*hashish*' or '*charas*'.

From the dried leaves and stem, '*bhang*' is prepared.

From the resinous mass of small leaves, '*ganja*' is prepared.

The term '*marijuana*' refers to any part of the plant which induces somatic and psychic changes in an individual.

Usually, the plant is cut, dried, chopped and incorporated into cigarettes and often in foods like sweets. When marijuana is inhaled, produces intoxication within minutes, lasting for about 2 to 4 hours. Oral consumption results in delayed onset of action, but lasts longer for many hours.

It results in relaxation, euphoria and a tendency to laugh and interference with perception of both time and space. It results in psychic dependence and death is rare.

Sedatives or Hypnotics

Commonly used sedatives are barbiturates, which are the derivatives of barbituric acid. Next common is diazepam. Barbiturates result in both physical and psychic dependence.

Cocaine

It is an alkaloid obtained from the leaves of coca plant, erythroxylon coca, formerly used as local anesthetic.

It stimulates central nervous system, produces a sense of excitement and hallucinations. It does not produce dependence. So, no withdrawal symptoms.

Pure cocaine (free base) is smoked, while the popular cocaine hydrochloride is snorked. It is being chewed in Bolivia and Peru in South America.

Stimulants

The commonly employed stimulants are amphetamines. They stimulate the central nervous system and result in mood elevation, sense of well-being, increased alertness, relieve fatigue and boost self-confidence and energy. Since they increase endurance, they are often called 'Superman' drugs. Thus, they result in psychic dependence. Commonly abused stimulants are dexedrine, benzedrine and methedrine.

Hallucinogens

These are the drugs which alter the normal structure of perception resulting in visual and auditory hallucinations, panic reaction and synesthesis. Hallucination is perception in the absence of the corresponding stimulus. Colors are heard; music becomes palpable; sound is tasted, smell is seen, sights are smelt etc. Thus, there is depersonalization.

The important hallucinogen is LSD (Lysergic acid diethylamide) It is obtained from ergot on rye grains. It is impregnated in piece of gelatin or blotting paper, kept under the tongue and chewed.

Lysergic acid diethylamide (LSD) is only a psychotogenic agent and does not result in physical dependence.

Tobacco

Tobacco has been used all over the world. Its use is legalized eventhough it is causing more deaths than all other psychoactive substances combined.

Tobacco contains the active principle nicotine which results in not only various types of cancers such as lung, larynx, esophagus, but also in other diseases like stroke, chronic bronchitis, myocardial infarction, aortic aneurysm, peptic-ulcer and low birthweight babies among pregnant mothers.

Passive smoking is as dangerous as active smoking. The habit of tobacco consumption is decreasing in developed countries and increasing in developing countries. People tend to misjudge the effects of tobacco because of long latent period.

The withdrawal symptoms are irritability, anxiety, headache, tremors and lethargy. Craving continues for several months.

Volatile Solvents

These are the liquids that release vapors, which are inhaled directly or poured on cloth and then sniffed. Examples of inhalants are petrol, diethyl ether, nitrous oxide, kerosene, typewriting correction fluid, cleaning fluid, paint thinner (varnish), etc.

Initially, there is euphoria and exhilaration followed, by confusion, disorientation and ataxia. Some inhalants like petrol and toluene can result in delusions and hallucination. Increasing doses can result in coma and death. Sniffing lead gasoline can result in lead encephalopathy.

Other Drugs

These include anabolic steroids, and caffeine.

Anabolic steroids: These are synthetic testosterone. They can be taken orally or parenterally. They improve the muscle tone

and physical strength and stamina. Usually, such drugs are abused by athletes.

Caffeine: This is another drug widely used globally in the form of tea, coffee, cocoa and cola drinks. Ingestion of caffeine over 500 mg a day can result in caffeinism characterized by anxiety, restlessness, insomnia, etc. Withdrawal of caffeine produces headache, nausea, irritability, lethargy, etc.

Health Hazards

Health hazards: These are physical, mental and social problems not only to himself/herself but also to the family and community. It progresses from bad to worse. The condition deteriorates seriously and may result in tragic event.
Reasons: Curiosity, social pressure (from family members), emotional pressure, group pressure, easy availability of drugs, etc.
Features: Poor attendance, decreased efficiency, slurring of speech, tremors, loss of appetite, loss of weight, sweating, unsteady gait, fresh injection sites, etc. Other changes are loss of materials from home, presence of syringes and needles, blood stains on clothes, preference of solitude, spending long time in toilets, etc.

Prevention and Control of Drug Abuse

These measures are implemented at different levels as follows:

Individual Level for the Addict

The different measures are:

- *Identification of drug addicts and medical care*: Medical care consists of their detoxication by using the drug disulfiram for the alcoholics. When the alcoholic is on this drug, consumption of alcohol gives rise to severe reaction characterized by nausea, vomiting, tremors, hypotension and diarrhea. The fear of recurrence of the reaction deters him from taking alcohol. Detoxication to be done in the hospital only. Still relapse rates are high.
- *Postdetoxication counseling and follow-up*: The addict is made aware of the long-term hazards of the drug. He is informed about his responsibility to safeguard his health by quitting the habit.
- This deaddiction procedure consists of the following steps:
  - Identification of drug addicts
  - Motivation for detoxication
  - Hospitalization, provide fear therapy, psychotherapy, counseling
  - Medical treatment
  - Change of the environment
  - Postdetoxication counseling to prevent relapse
  - Rehabilitation
- *Rehabilitation*: This is given if he has lost his job. He is given skilled training and placed in appropriate job. Rehabilitation is a difficult process because relapses are frequent. Vocational training and sheltered work opportunities are useful in rehabilitation of such addicts. It helps to prevent relapse.
- *Substitution*: In case of addiction to dangerous heroin, less potent 'methadone' is substituted. This enables to resume his place in the family and society, because methodone is legal and less dangerous.

Family Level

Parents are educated about the need to shower love and affection on their children and to be neither too strict nor too lenient with them. They should tell their children that they disapprove the drugs.

Community Level

Following measures are implemented:

- Educational approach:
  - Public are informed through campaigns on electronic media (television).
  - Educational programs are arranged for school children. School authorities with the help of police should make the school and surroundings a drug-free zone.
- Service approach:
  - Teen-centers to be established, which will attract the teenagers and they are made healthy and active by participating in sports, music, athletes, gymnasium, artistic activities, etc. and prevent them from drifting in to drug taking.
  - Self-help groups to be established, consisting of ex-addicts, who encourage those who want to give up the habit of taking drugs. They will be influenced and leave the habit in course of time and they lead a sober life.
- Legal approach:
  - Legislation may be directed at various levels such as manufacture, distribution, prescription, price, advertisements, consumption, etc. The related Public Health Act is 'Narcotic Drugs and Psychotrophtic Substances Act' 1985.

BIBLIOGRAPHY

1. Gupta MC, Mahajan BK. Textbook of Preventive and Social Medicine 3rd edn, 2003.
2. Neeraj Ahuja. A Short Textbook of Psychiatry. 4th edn, 1999.
3. WHO Expert Committee on Drug Dependence. Twenty-eight Report No 836, 1993.

SECTION 7

Health Administration and Organization

- Health for All
- Health Care
- National Rural Health Mission—2005–2012
- National Urban Health Mission
- Health Planning and Management
- National Health Planning
- National Health Policy
- National Voluntary Health Agencies/Organizations
- International Health Organizations
- Bilateral Agencies
- National Health Programs

CHAPTER 33

Health for All

MEANING

Health for All (HFA) simply means health services for all, i.e. basic, essential, utilitarian services to be provided to all, irrespective of caste, creed, community and ability to pay for it.

HISTORICAL PERSPECTIVE

This holistic concept was resolved by World Health Assembly during 1977 (30th May 1977). WHA decided to launch a social, global target 'Health for All by 2000 AD,' which was defined as, 'Attainment by all the people of the world, a level of health, which will enable or permit every individual to lead socially and economically a productive life' (useful life).

Socially a productive life means, one must be accepted, loved and respected by all the family members, friends, neighborers, colleagues, etc. and must be capable of participating actively in the social functions of the community.

Economically a productive life means, one must be capable of earning sufficiently enough to support himself and his family.

The year 2000 AD was only an arbitrary landmark. The assumption is that under the circumstance of availability of the nature of health services, then (during 1977), HFA was not achievable before 2000 AD and therefore with a commitment, the situation would improve.

IMPORTANCE

The social, global target was decided by WHA to launch because of the following reasons:

- Enjoying healthful life is the birth-right of every individual
- The health services were mainly curative oriented (not preventive and promotive oriented)
- The services were concentrated in the urban areas and to the rich (specially in the developing countries)
- The services were neglected to the rural people, who constitute the major portion of our population and the back-bone of our country
- The services were also neglected to the illiterate, the poor and to the urban-slums
- All these resulting in an imbalance of health status between the urban, literate, rich people and the rural, illiterate, poor people, which is a 'Social injustice' and is highly glaring. This health imbalance has to be neutralized. Otherwise it will deteriorate further, if timely corrective measures are not taken
- 'Reach the unreached' is the philosophy behind this target HFA by 2000 AD.

Health for All does not mean that:

- There will not be diseases and deaths by 2000 AD (infact there may be more diseases and new diseases)
- Everyone in the world would enjoy positive health
- Health services of specialists would be available to all
- There will be no need for the disease control and eradication programs
- There will be no requirement of health professionals in future.

Health for All does mean that:

- There should be even distribution of basic health services for all
- It should be within the reach of everyone (accessible)
- It should be accepted by all
- People should realize that they must participate in providing health services

- People should be able to lead socially and economically a productive life.

Milestones

- During 1977, World Health Assembly resolved (decided to launch) the social, global target 'HFA by 2000 AD.'
- During 1978 September, the International Health Conference was held at Alma-Ata, capital of Kazakhistan in USSR, where it was identified that the best approach (strategy) to achieve the social global target was 'Primary Health Care.' This was identified as the 'KEY' Strategy to achieve the social target and thus this strategy became a new 'revolutionary approach' in health care services.

  The conference defined Primary Health Care as, 'Essential Health Care made universally accessible to all individuals and acceptable to them, through their full participation and at a cost, the community and country can afford, at every stage of their development in the spirit of self reliance and self determination.
- In 1979, World Health Assembly, endorsed the declaration of Alma-Ata on Primary Health Care and encouraged all the member countries to formulate their own policies and strategies to implement primary health care in their own way, depending upon their resources.

  As one of the member countries, Government of India also opted and pledged to achieve this goal and became signatory to Alma-Ata declaration.
- In February 1980, Government of India, called for a National Health Conference at Delhi, under the Ministry of Health and Family Welfare to discuss strategies, policies and plans for the implementation of primary health care in the country. The responsibility was entrusted to the Planning Commission to proceed with that.
- In July 1980, the Planning Commission appointed an Expert Committee (Working group and study group) to suggest guidelines and suitable indicators to assess the health status of the country and its progress periodically (i.e. to evaluate the health services periodically).
- In 1981, the Working Group submitted its report of assessing the health status of the country, in terms of various indicators. This report became the basis of National Health Policy.
- In 1983, the National Health Policy was approved by the Government of India. For monitoring the progress of health status towards the goal of HFA by 2000 AD, WHO has listed the following four categories of Indicators:
  1. Health policy indicators.
  2. Health care delivery indicators.
  3. Socio-economic indicators.
  4. Health status indicators.

Health Policy Indicators

- Political commitment to HFA
- Resource allocation
- Degree of equity of distribution of health services

Table 33.1 Health status indicators

Sl.no.	Indicators	Rate during 1978	Target by 2000 AD	Current level
1.	Crude birth rate (CBR)	33/100 MYP	21/1000 MYP	20.97/1000 MYP (2011)
2.	Crude death rate (CDR)	14/1000 MYP	09/1000 MYP	7.48/1000 MYP (2011)
3.	Growth rate (CBR-CDR)	19/1000 MYP (=1.9%)	12/1000 MYP (1.2%)	13.49/1000 MYP (2011)
4.	Infant mortality rate (IMR)	125/1000 live births (LB)	< 60/1000 LB	47.57/1000 LB (2011)
5.	Maternal mortality rate (MMR)	4.5/1000 live births (LB)	<2/1000 LB	2.12/1000 LB (2011)
6.	Expectation of life at birth	52 years	64 years	63 years
7.	Net reproduction rate (NRR)	1.48	1	1.4
8.	Incidence of low birth weight	30 percent	<10 percent	30 percent
9.	Perinatal mortality rate (PNMR)	67/1000 LB	30/1000 LB	37/1000 LB (2006)
10.	Preschool child (1–5 yrs) mortality rate	24/1000 population of 1–5 yrs	10/1000 population of 1–5 yrs	17/1000 population of 1–5 yrs
11.	Couple protection rate (CPR)	23 percent	60 percent	40.4 percent (2011)
12.	Average family size	4.4	2	3.1 percent
13.	Antenatal mothers receiving care	40 percent	100 percent	82 percent
14.	Deliveries conducted by trained dais	30 percent	100 percent	50 percent
15.	Immunization coverage among infants	35 percent	100 percent	85 percent

- Community involvement
- Organized framework and managerial process.

Health Care Indicators

Availability of health services

- Doctor : Population ratio
- Nurse : Population ratio
- Doctor : Nurse ratio
- Health worker : Population ratio
- Pharmacist : Population ratio
- Lab technician : Population ratio
- Subcenter : Population ratio
- Health center : Population ratio

Socioeconomic Indicators

- Growth rate of population
- Per capita GNP
- Literacy level
- Family size
- Housing
- Food availability.

Health Status Indicators (Demographic Goals)

These are the indicators (indices) for which targets were fixed for 2000 AD, if achieved, means the status of HFA is achieved **(Table 33.1)**.

BIBLIOGRAPHY

1. CIA World Fact book.
2. GOI. MOHFW. Annual Report. 2009-10; Mar 2010.
3. WHO development of indicators for monitoring progress towards health for all by the year 2000. Geneva, 1981.
4. WHO evaluation of strategy for health for all by the year, 2000. Seventh Report on World Health Situation. Geneva, 1987.
5. WHO global strategy for health for all by the year 2000. Geneva, 1981.

CHAPTER 34

Health Care

Health has been declared as a fundamental human right. Since health is influenced by a number of factors, such as physical environment (like air, soil, water, etc.), food, housing, sanitation, lifestyle, etc. provision of health care also embraces multitude of services to be provided to individuals, families or communities by the agents of health services or professions, for the purpose of promoting and maintaining the health.

The term 'Medical care' refers chiefly to those personal services that are provided directly by physicians.

With the emergence of concept of positive health, as contained in the WHO definition of health, health care came to be conceived as an integrated care comprising, preventive, promotive, curative, rehabilitative/restorative services that bear a longitudinal association with an individual extending from 'womb to tomb' and continuing in the state of health as well as disease. It is thus clear that 'health care' includes 'medical care.'

Eventually health care is seen as a 'key' to socioeconomic development and progress of the country. Therefore, it is the responsibility of the Governments to provide the health care to all people/citizens, from womb to tomb, irrespective of caste, creed and capacity to pay for it.

Until the British rule, health care in India was ill-organized and it was based on Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH) system of medicine. After the advent of British rule and up to 1952, health care was predominantly curative oriented based on allopathy. It was available chiefly to urban people and the rich.

As per the recommendations of Bhore Committee (1946), provision of health care services was meant provision of comprehensive health care services in an integrated manner, in a package (as explained above). Comprehensive health care is not provided by the health department alone but in combination with the health related departments also such as agriculture, irrigation, fisheries, education, communication, etc.

THREE-TIER SYSTEM OF HEALTH CARE

The health care services in India are organized at three levels, each level supported by the higher level, to which the patient is referred **(Fig. 34.1)**.

Primary Level of Health Care

It is the first level of contact between the individual/family and the health system, where basic, essential, utilitarian services are provided. At this level, the health services are provided

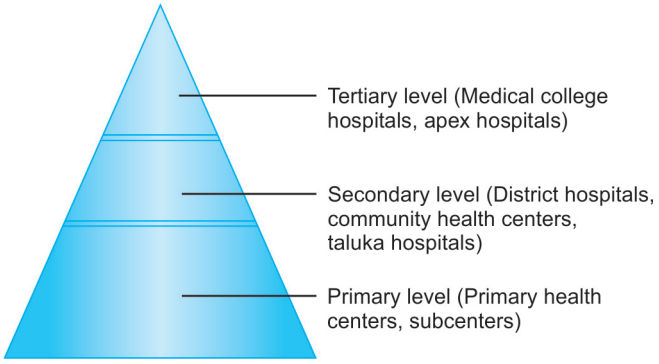


Fig. 34.1 Three-tier system of health care

even at the individual door level, i.e. at the 'grass-root' level. In India, this care is provided by primary health centers, and their subcenters, supplemented by the services of the village health guides, the anganwadi workers and the trained dais. These services are also called as 'Primary Health Care'.

Secondary Level of Health Care

At this level, services of the specialists are made available to the people, so as to deal with more complex problem. Thus, essentially curative services are provided as in Taluka Hospitals and Community Health Centers. These health institutions also serve as the first referral level/First Referral Units (FRU).

Tertiary Level of Health Care

At this level, services of specialists and super specialists are made available to the people. This type of care is provided in the regional/central/apex institutions, such as super speciality high-tech hospitals, District hospitals, Teaching hospitals, All India Institute of Medical Sciences, etc. These institutions not only provide high-tech diagnostic and highly specialized (superspeciality) care, but also planning and managerial skills. They conduct training programs also.

PRIMARY HEALTH CARE

This is a new revolutionary approach to health care, identified as the 'Key Strategy' of achieving the Global Social target 'Health for all by 2000 AD' in the International Health Conference, held at Alma-Ata (USSR) during the year 1978.

In the conference, Primary Health Care was defined as *an essential health care made universally accessible to individuals and acceptable to them, through their full participation and at a cost the community and country can afford.* It forms an integral part of both the country's health system, of which it is the nucleus and the overall social and economic development of the community.

The concept of primary health care has been accepted by all countries to achieve the goal HFA-2000 AD.

Attributes

- Essential health care : Means basic, essential, utilitarian services.
- Universally accessible : Means those services should be made reachable to all segments of the population.
- Acceptable : Means those services are provided in such a way that the people should accept them.
- Their full participation : Means provision of these services should start from the people of the community, so that the service becomes successful.
- Affordability : Means that the services must be economical and cost-effective so that Government can provide the services.
- Adaptability : Means the services provided should be flexible to suit the given situation (should be implemented).
- Availability : Refers to 'Round the clock' presence of the service.
- Appropriateness : Means the service should be relevant to the needs and demands of the people.
- Closeness : Refers to the proximity between the health provider and the consumer, in other words, the services are made available to the individual doors.
- Continuity : Refers to the service provided from 'Womb to tomb'.
- Comprehensiveness : Means the services should be preventive, promotive, curative and rehabilitative/restorative to the community.
- Coordinativeness : Means these basic services requires the cooperation of various health related departments.

Elements of Primary Health Care (i.e. Components)

- Education concerning prevailing health problems and methods of identifying, preventing and controlling them.
- Promotion of food supply and proper nutrition.
- An adequate supply of safe water and basic sanitation.
- Maternal and Child health care including family-planning.
- Immunization against the major infectious diseases.
- Prevention and control of locally endemic diseases.
- Appropriate treatment of common diseases and injuries.
- Provision of essential drugs.

Principles of Primary Health Care

Primary health care consists of four principles, namely equitable distribution, community participation, intersectoral coordination and appropriate technology **(Fig. 34.2)**.

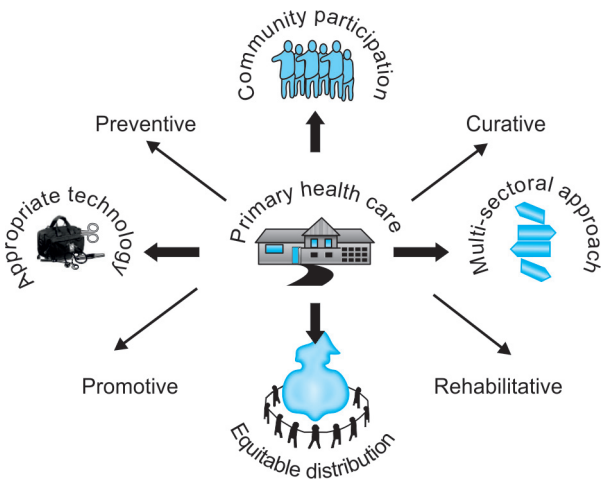


Fig. 34.2 Principles and components of primary health care

Equitable Distribution

This means that the basic health services which are provided under primary health care must be provided to all the people, irrespective of the cast, creed, community and ability to pay (rich or poor) for it and thus these services must be accessible to all. This principle is based on the fact that at present the health care services are concentrated in the towns and cities, (where 25 percent of population live and 75 percent of the budget is spent) to the rich and curative oriented. On the other hand, the needy and vulnerable groups of population like the poor rural and the urban slums (where 75% population live and 25% budget is spent) are neglected and who deserve the services most. This social injustice must be removed and the services must be equally distributed to all the people of the community. This is the 'Key' principle in Primary health care strategy.

Community Participation

This consists of active involvement of the people of the community in providing primary health care. This is based upon the fact that achieving universal coverage of primary health care is not possible without the involvement of the local community. Involvement of the community in planning, implementation and maintenance of health services is a very prominent feature. Community participation promotes social awareness and self-reliance of the community. It increases the community acceptance of the primary health care programs and reduces the distance between the providers and the consumers of health care.

Thus the health care should start with the people. It is by the people, of the people and for the people. This is called 'democratization' of the health service. Community participation is aimed at placing the health of the people in their hands. This is 'new dynamism' of health care. It contributes to their own development and in turn community's development.

One approach that has been successfully tried in India is training of front line health workers like anganwadi workers, traditional birth attendants (dais) and village health guides. They are selected locally, trained locally and provide service locally (to the area they belong) free of cost. They get honorarium. They provide the care in ways that are acceptable to the community by overcoming the cultural and other barriers. Thus these frontline workers constitute the essential features of primary health care in India and community participation has thus become a new revolutionary approach in country. This corresponds to 'Barefoot doctors' scheme of China. No health program will be successful without the participation of the public.

Advantages of community participation

- It is a cost effective method of providing health services.
- People begin to view health more objectively. So they are more likely to accept the care.
- There will be greater commitment of the people resulting in the success of health care services.
- Health awareness becomes an integral part of village life.
- Health workers get greater support for their activities.
- People become more soft reliant in taking care of their health.
- Health care services become more relevant to the health needs of the people.
- There is less dependence on the Government.
- Quality of the health care improves.

Intersectoral Co-ordination

It is also realized that primary health care to the community cannot be provided by health sector alone. It requires the co-ordination of other health related sectors also such as education, communication, fisheries, animal husbandry, food and agricultural department, animal husbandry, social-welfare, public-works, voluntary organizations, etc. **(Fig. 34.3)**. Co-ordination of all these sectors is essential. This requires a strong political action. The co-ordination committees will make policies and implement in a planned way, so as to avoid duplication of the activities. The committee also reviews the activities periodically.

Appropriate Technology

This means that the technology of the health care service provided must be 'appropriate', i.e. it must be simple, scientifically sound, practically adaptable, culturally acceptable, economically cheaper and operationally convenient **(Fig. 34.4)**. Appropriate technologies that have been developed and introduced in the country are Oral rehydration therapy, immunization programs, nutritional supplementation, DOTS, distribution of disposable delivery kits for domiciliary midwifery services, distribution of IFA tablets, biogas plants for cooking, heating

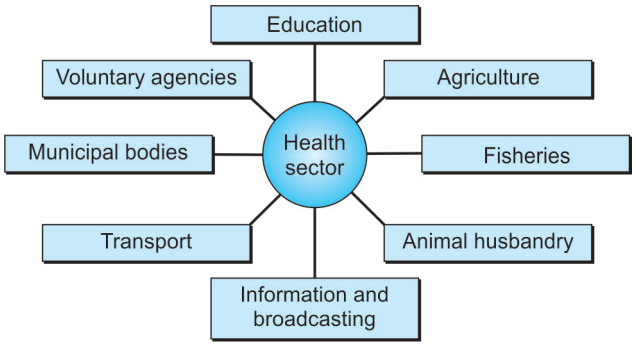


Fig. 34.3 Intersectoral co-ordination of primary health care

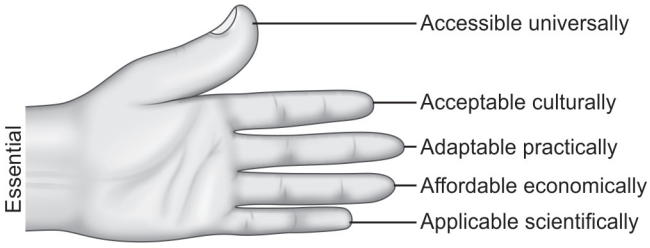


Fig. 34.4 Attributes of primary health care

and lighting, smokeless chulhas for cooking, family welfare services, etc.

Organizational Framework of Health Care Systems

Depending upon the health technology applied and the source of funds for operation, the health care system in India is represented by five major sectors or agencies.

1. *Public health sector*
   - A. Primary Health Care
     - a. Primary health centers
     - b. Subcenters
   - B. Hospitals
     - a. Community Health Centers/Taluka Hospitals
     - b. District hospitals
     - c. Teaching hospitals
     - d. Specialist hospitals (Apex hospitals)
   - C. Other agencies
     - a. Employees' State Insurance (ESI) Hospitals
     - b. Central Government Health Scheme
     - c. Railway hospitals
     - d. Defence hospitals
2. *Private sector*
   - a. Private hospitals, polyclinics, nursing homes
   - b. General practitioners' clinics or dispensaries
3. *Indigenous systems of medicine*
   - a. Ayurveda
   - b. Siddha
   - c. Unani
   - d. Tibbi
   - e. Homeopathy
   - f. Yoga
   - g. Unqualified and unregistered practitioners.
4. Voluntary health agencies
5. National health programs

PUBLIC HEALTH SECTORS

Primary Health Care

This was identified as the 'strategy' to achieve the WHO's global, social target 'Health For All by 2000 AD', in the International Health Conference, held at Alma-Ata, during 1978.

Hitherto, under basic health services, the concept was to provide the service at the individual doors. But under primary health care, it was felt to start the health service from the community and place their health in their own hands, i.e. by community participation. Meanwhile during 1977, Government of India had launched a 'Rural Health Scheme', based on the principle of placing peoples' health in peoples' hands, as per the recommendations of Shrivastav Committee in 1975, as a three-tier system of health care delivery—village level, subcenter level, primary health center level.

Village Level (Grass-root Level)

This is the first level of contact between the health system and the individual/family of the community. At this level, the primary health care is provided not by the medical personnel but by the non-medical personnel such as Village health guide, Dai (Traditional birth attendant) and Anganwadi worker, who constitute the link and bridge the gap between the health sector and the community. They are working under the following schemes respectively:

- Village health guide scheme
- Training of local dais
- ICDS scheme

These schemes are launched with the intention of securing peoples' participation in taking care of their own health.

Village health guide scheme (VHG-Scheme): This was launched on 2nd October 1977 (Gandhi Jayanthi Day) in order to secure community participation in providing the health care. This was originally called as 'Community Health Workers Scheme.' Later the terminology was changed over to VHG scheme during 1981 and was made centrally sponsored scheme under Family Welfare program.

This scheme is in operation in all the States, except five states, where alternative system of rural health schemes are in progress, as follows:

- Jammu and Kashmir (Rehbar-e-Sehat)
- Arunachal Pradesh (Medics)
- Tamil Nadu (Mini health center)
- Kerala (Strengthening of PHCs)
- Karnataka.

In May 1986, Government of India issued a circular stating that male health guides should be replaced by a female health guide, because she is more accessible and acceptable by the community.

A Village Health Guide is a one who has an aptitude for social service. She is a non-governmental, voluntary worker for health. One VHG is selected for each village or 1000 rural population.

Selection of the VHG is done by the Village Health Committee, consisting of 4 members, 3 men being nominated by Gramapanchayath and 1 woman, of scheduled caste, in the presence of Medical Officer and Block representatives, on the following guidelines:

- She must be a permanent, local resident of that village, (That means she is selected from the village where she is going to work)
- She must be literate, as to read, write and maintain records
- She must be acceptable to all sections of society
- She must be willing to do community health work for 2 to 3 hours a day.

After selection, she is given training in the Primary Health Center by the Medical Officer, for 3 months on the basic aspects of health such as personal hygiene, sanitation, health education, first-aid, ORT, family welfare, etc. with the stipend of ₹ 200 per month.

After training she is awarded a certificate and given a manual describing her responsibilities and a kit with simple medicines like paracetamol tabs, tincture iodine, plaster roll, cotton, bandage cloth and multivitamins worth of ₹ 600 per anum. She then goes back to her village and guides the people on health (hence called village health guide) by providing health education, creating awareness on family welfare services, immunization, sanitation, personal hygiene, use of ORT, etc. Rest of the time she engages in her own pursuits. She is paid an honorarium of ₹ 600 every year.

She works in liaison with other health functionaries. She is not answerable to the MO of PHC but answerable to village health committee.

As the training involves expenditure, Government will not train another person at least for 3 years, unless it is a big village with a population of more than 2000.

As on today, nearly 4 lakhs of VHGs have been working in the country. The national target is to provide 1 VHG for each village or 1000 rural population.

Training of local dais (Traditional birth attendants): This is another component of Rural Health Scheme undertaken by Govt. of India, launched in 1978, following the introduction of VHG scheme, for encouraging the community participation of health care delivery.

Traditional birth attendants (TBAs) are the only people who are available in the villages to conduct the deliveries. Their identification and training goes a longway in reducing MMR and neonatal tetanus (NNMR/IMR). Because of their illiteracy, ignorance and uncleanliness, the deliveries conducted by them often results in maternal and neonatal deaths. After training, the traditional birth attendant is called trained birth attendant.

Importance of training TBAs

- Age old-practice of conducting delivery by dais is prevalent.
- Their skills are accepted by the people.
- Not only rural people but also some of urban areas also take their help.
- Female health worker may not be available all the time to conduct all the deliveries in her area.
- About 90 percent of the deliveries are normal and do not require the services of specialists.
- Dais can be trained locally in PHCs.
- Their training would improve the quality of MCH services.
- This helps in community participation.

The local dais are identified and imparted training at the Primary Health Center by the Lady Medical Officer, for 1 month with a stipend of ₹ 300/-.

She is given training on anatomy of the reproductive system, physiology of pregnancy and labor, observation of danger signals, conducting delivery by observing five cleans and knowledge on Family planning. Five cleans are—clean hands, clean surface, clean blade, clean ligature and clean cord stump.

During these 30 days, she will have training at PHC for 2 days in a week and remaining 4 days of the week, except Sundays, she will accompany the health worker female (HWF) to the villages, preferably in the dai's area. During her training, she is required to conduct at least 2 deliveries under the guidance and supervision of HWF or ANM or HA (health assistant) Female.

After the training, she is given a certificate and a maternity kit (midwifery kit). The kit consists of sterile gauze, cotton, clean blade, sterile thread, bowl, soap, antiseptic lotion, plastic sheet, tincture iodine and enema-can. The contents are replaced after conducting delivery. She is entitled to receive an amount of ₹ 10/- per delivery, provided the case is registered in subcenter or PHC and also for each newborn registered by her, she will receive ₹ 3. However, she is free to charge her fee for conducting delivery.

These dais are also expected to motivate the couples for adapting small family norm.

The national target is to train one local dai in each village. So far, about 5.5 lakhs of dais have been trained.

Anganwadi worker (AWW): Angan means 'courtyard'. Anganwadi worker is a local lady, studied upto 10th standard, selected as a worker/teacher, for 1000 population, to provide basic health services (primary health care) mainly to mothers (Antenatal, postnatal, and other mothers of reproductive age, all belonging to SC/ST and to socioeconomic status Cl. V.) and to children below 6 years of age group, in an integrated manner under one roof. She is the 'Key' person to deliver the services under ICDS-Scheme. The 'nucleus' or 'the focal point' of ICDS being the anganwadi center.

She caters the services to a population of 1000, covering about 170 children between 0 and 6 years, 30 expectant mothers, 15 lactating mothers and about 200 women in the age group of 15 to 44 years. She is assisted by a helper. In tribal areas 1 AWW covers 700 population.

AWW is selected from the community, she is expected to serve. She is trained for 4 months in various aspects of health, nutrition and child development. After the training, she works as a part-time worker and is paid an honourarium of about ₹ 500/- per month.

Her services include:

- Preparing and serving supplementary food for the beneficiaries
- Growth monitoring of the children
- Health and nutrition education to the mothers
- Non-formal education of the children, (between 3 and 6 years of age) in the form of toys, play, game, songs, etc.
- Referral services
- Liaison with other community development functionaries
- Maintains the records
- Submits the reports to Project Officer of ICDS monthly. AWW is supervised by Mukhya Sevika.

There are about 100 AWWs in each ICDS-project. One such project for one community development block of about 1 lakh population. As on date, about 5500 such blocks/projects are functioning in the country. There is one supervisor, Mukhya Sevika, for every 20 to 25 AWWs.

Subcenter Level

A subcenter is an infrastructure of Primary Health Center (PHC) thus constituting the peripheral outpost of health care delivery system in the rural areas. There are about 4 to 6 subcenters under each PHC, each subcenter serves a population of about 5000 in plain areas and about 3000 population in the hilly, tribal and backward areas. About 1.5 lakh subcenters are functioning in the country as of date.

Each subcenter is manned by one male and one female health worker. The center has two portions—a clinic portion and a residential portion. In the residential portion, only the HWF resides and the HWM resides outside. The clinic portion is meant for providing mainly MCH and Family Welfare services such as care of expectant mothers, including routine investigations like Hb percent and urine examinations, conducting deliveries, IUD fittings and immunizations.

The health worker female (HWF) is supervised by health assistant female (HAF). One HAF supervises 6 HWFs. The subcenters are established to come closer to the population to deliver the health care services. The subcenter differs from the Primary Health Center in that there is no Medical officer and no inpatient or outpatient facilities. Antenatal clinic is conducted once in a week.

Primary Health Center Level

A primary health center (PHC) is a peripheral, rural hospital, where comprehensive health care services, such as preventive, promotive, curative, rehabilitative and referral services are provided to the rural people. Each PHC serves a population of about 30,000 population in the plain areas and about 20,000 population in hilly and tribal areas, distributed over about 30 villages, spread over 24 km^2 area with a radial distance of 2.75 km. Each PHC has an infrastructure of 4 to 6 subcenters. There are about 25,000 PHCs functioning in the country as on March 2005, constituting peripheral end organs of Health care delivery system.

Evolution: The need for setting PHCs was suggested by the 'Health Survey and Development Committee (Bhore Committee) in 1946, to provide comprehensive health care to serve the rural population.

725 PHCs were established during 1952–53 following the meeting of the Central Council of Health, at the rate of one PHC for one community development block covering a population of about 1 lakh, distributed over about 100 villages.

Meanwhile, there was a criticism that these PHCs were not providing adequate health care services, because of poor staff and wider coverage of population.

During 1962, the Health Survey and Development Committee, headed by Dr AL Mudaliar emphasized the need for strengthening the PHCs rather than setting up more new ones and the population coverage should be scaled down to 40,000 per PHC.

During 1965, the Mukherjee Committee recommended the appointment of exclusive staff for carrying out the family planning activities.

During 1966, the same committee recommended that the Unipurpose health workers, who were carrying out only one type of health service for about 10,000 population per worker, should be entrusted with more of responsibilities for about 5,000 population per worker and be called as multipurpose workers. This recommendation led to the appointment of Health Worker Male (HWM) and Health Worker Female (HWF).

By the end of Fifth Five Year Plan, (1975–80), about 5500 PHCs were functioning in the country.

During 1983, the National Health Plan proposed re-organization of PHCs on the basis of one PHC for every 30,000 rural population in the plains and one PHC for every 20,000 population in the hilly, tribal and backward areas.

As on date, about 22,669 PHCs, 4.5 lakhs subcenters 4510 Community Health Centers have been functioning in the country constituting health infrastructure at grass-root level.

Building: The PHC is a pucca concrete building having a consultation room for the Medical Officer, a waiting hall for patients, a MCH and FW service room, a dispensary, a minor operation theater, a laboratory, a store room, an office room (records room) and a ward of 6 (4 maternity and 2 general) beds.

Some PHCs have an annexure building, for Family Welfare services such as organization of tubectomy camps.

There may be quarters for the staff members.

Under Reorientation of Medical Education (ROME) program, 3 PHCs are attached to each medical college and in those PHCs, dormitories are constructed for the residence of House-Surgeons.

Staff pattern of PHC: The present staff pattern for each PHC is as follows:

Medical officer (MO)*	–	1
Pharmacist	–	1
Staff nurse	–	1
Health worker female (ANM)	–	1
Block extension educator	–	1
Health assistant male	–	1
Health assistant female	–	1
Upper division clerk	–	1
Lower division clerk	–	1
Laboratory technician	–	1
Ophthalmic assistant	–	1
Driver	–	1
Class IV staff (peon/sweeper)	–	4
Total	**–**	**16**

**Note*: There is a second medical officer (or Lady medical officer) post in some PHCs.

The staff-list shows that there are different categories of persons with varied literacy level, designation and income.

All of them work in collaboration to provide comprehensive (preventive, promotive, curative, restorative/rehabilitative) health care services to the rural population. Hence the staff of PHC together are called as 'Health team.'

Functions of the Primary Health Center

The functions of PHC covers all the 8 essential elements of primary health care. They are:

- Medical care
- MCH services including family planning
- Improvement of environmental sanitation with special emphasis on safe water supply
- Prevention and control of locally endemic diseases (Immunization)
- Collection and reporting of vital statistics
- Health education
- Implementation of relevant National Health Programs
- Basic laboratory services
- Referral services
- Training programs for health workers, health assistants, local dais, etc.

INDIAN PUBLIC HEALTH STANDARDS FOR PRIMARY HEALTH CENTERS

In order to provide optimal level of quality health care, sensitive to the needs in the rural areas, a set of standards are being recommended for Primary Health Centers, Sub Centers and Community Health Centers, called Indian Public Health Standards (IPHS) by the Bureau of Indian Standards (BIS), under National Rural Health Mission (NRHM). These standards would help monitor and improve the functioning of PHCs.

Keeping in view the available resources for the functional requirement for PHCs with minimum standards such as building, manpower, instruments, equipments, drugs and other facilities, IPHS have been prepared with the following objectives.

Objectives

- To provide comprehensive health care (i.e. preventive, promotive, curative services)
- To achieve and maintain an acceptable standard of quality of care
- To make the services more responsive and sensitive to the needs of the community.

Minimum Requirements (Assured Services) at the Primary Health Center for Meeting the IPHS

- Medical Care
  - 6 hours of OPD services daily
  - 24 hours emergency services
  - Referral services
  - Inpatient services

- Maternal and Child Health Care including family planning
  - Efficient antenatal care:
    - Early registration ideally before 12th week of pregnancy
    - Two doses of tetanus toxoid
    - One pack of IFA tablets
    - Basic laboratory investigations
    - Referral of high risk cases
  - Intranatal care:
    - 24 hours delivery services both normal and assisted.
    - Promotion of institutional deliveries.
    - Management of pregnancy induced hypertension (PIH) i.e. Pre-eclampsia.
  - Postnatal care:
    - Minimum of two postnatal visits within 48 hours of delivery.
    - Essential new born care.
    - Initiation of early breastfeeding.
    - Provision of facilities under Janani Suraksha Yojana.
  - New born care:
    - Facilities for neonatal resuscitation
    - Management of neonatal hypothermia/jaundice.
  - Care of the child:
    - Care during routine illness
    - Emergency care including Integrated Management of Neonatal and Childhood Illness (IMNCI).
    - Immunization services
    - Vitamin a prophylaxis.
  - Family Planning:
    - Provision of contraceptive devices
    - Permanent methods
- MTP services
  - Using Manual Vacuum Aspiration (MVA) technique.
- Management of Reproductive Treat Infections/STIs.
- Nutrition services (coordinated with ICDS).
- School health services.
- Adolescent health care.
- Promotion of Safe Drinking Water and Basic Sanitation.
- Prevention and control of locally endemic diseases.
- Disease Surveillance and Control of Epidemics.
- Collection and reporting of vital events.
- Information, Education and Communication activities.
- Implementation of relevant National Health Programs including Integrated Disease Surveillance Project (IDSP).
- Referral services by providing transport facilities for emergency cases.
- Training program for the following groups
  - Health workers, Traditional Birth Attendants.
  - Paramedics in the treatment of minor ailments
  - ASHAs.
  - Doctors through Continuing Medical Education (CME) programs.
  - ANMs and LHVs.
  - AYUSH doctors.
- Basic Laboratory Services
  - Routine urine, stools and blood tests.
  - Sputum for AFB.
  - Gram's stain for diagnosis of RTIs/STDs.
  - Rapid tests for the diagnosis of typhoid, malaria, syphilis and pregnancy.
  - Tests for fecal contamination of water and chlorine level in water.
- Monitoring and Supervision of FHWs and ASHAs.
- Functional linkage with sub center by supervisory visits.
- Mainstreaming of AYUSH system/facilities.
- Rehabilitation of handicapped persons.

Essential Infrastructure

1. *PHC building:* The suggested layout of a PHC and operation theater is given in the **Figures 34.5 and 34.6**.
2. *Equipment and furnitures:* These must be adequate and functional.

Manpower

Table 34.1 shows the recommended manpower for primary health center.

Table 34.1 Manpower for primary health center

Staff	Existing	Recommended
Medical officer	1	3 (at least 1 female)
AYUSH practitioner	Nil	1
Account manager	Nil	1
Pharmacist	1	2
Nurse—midwife (staff)	1	5
Health workers (F)	1	1
Health educator	1	1
Health assistant (males and female)	2	2
Clerks	2	2
Lab technician	1	2
Driver	1	Optional/vehicles may be outsourced
Class IV	4	4
Total	**15**	**24/25**

Note: Additional manpower may be hired as per provision under NRHM/RCH II program.

Drugs

- All the drugs required for the national health programs and emergency management should be available in adequate quantities.
- Stock should be maintained.
- Drugs required for AYUSH practitioner should also be available.

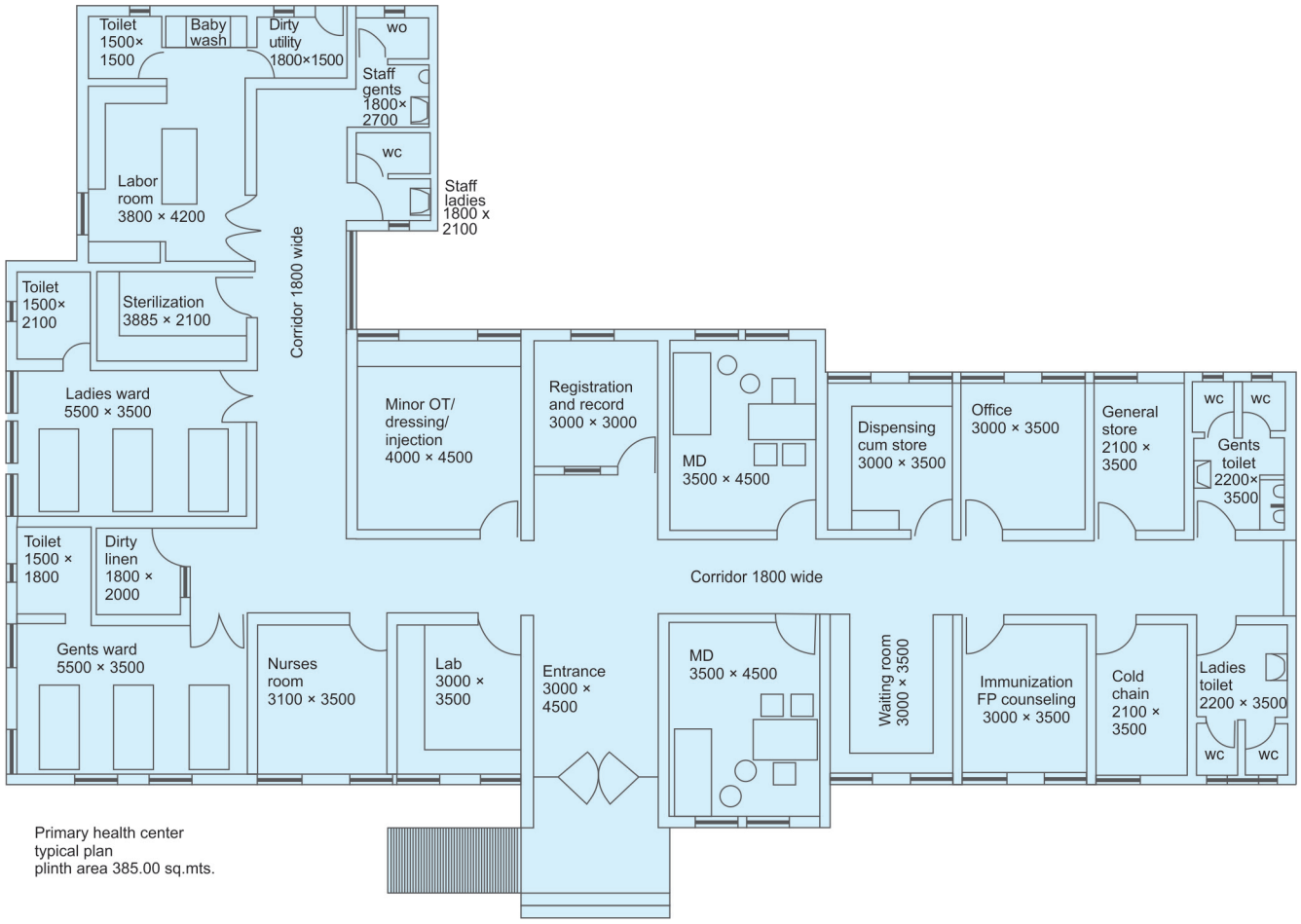


Fig. 34.5 Layout of primary health center

Note: This drawing is only for reference, the design shall be prepared as per the location and shape of the site, levels of the site and climatic condition.

Transport Facilities

- The PHC should have an ambulance for transportation of emergency patients.
- Referral transport may be outsourced.
- The vehicle can also be used for supervisory and outreach activities.

Laundry and Dietary Facilities for Indoor Patients

Waste Management of Primary Health Center

This should be carried out as per the Act. The proposal for disinfection of liquid bio-medical waste at PHCs in Karnataka, is shown in **Figure 34.7**.

Quality Assurance

- Periodic training of all the categories of staff.
- Standard treatment protocol to be followed.

Monitoring

This is done to ensure the quality of services.

Accountability

Every PHC should have a Rogi Kalyan Samiti/Management Committee to monitor the functions of the PHC.

Job Responsibilities of the Members of the Health Team

Medical Officer of Primary Health Center

Medical officer (MO) is the captain of the health team. He is the chief drawing officer for the finance. He attends to the

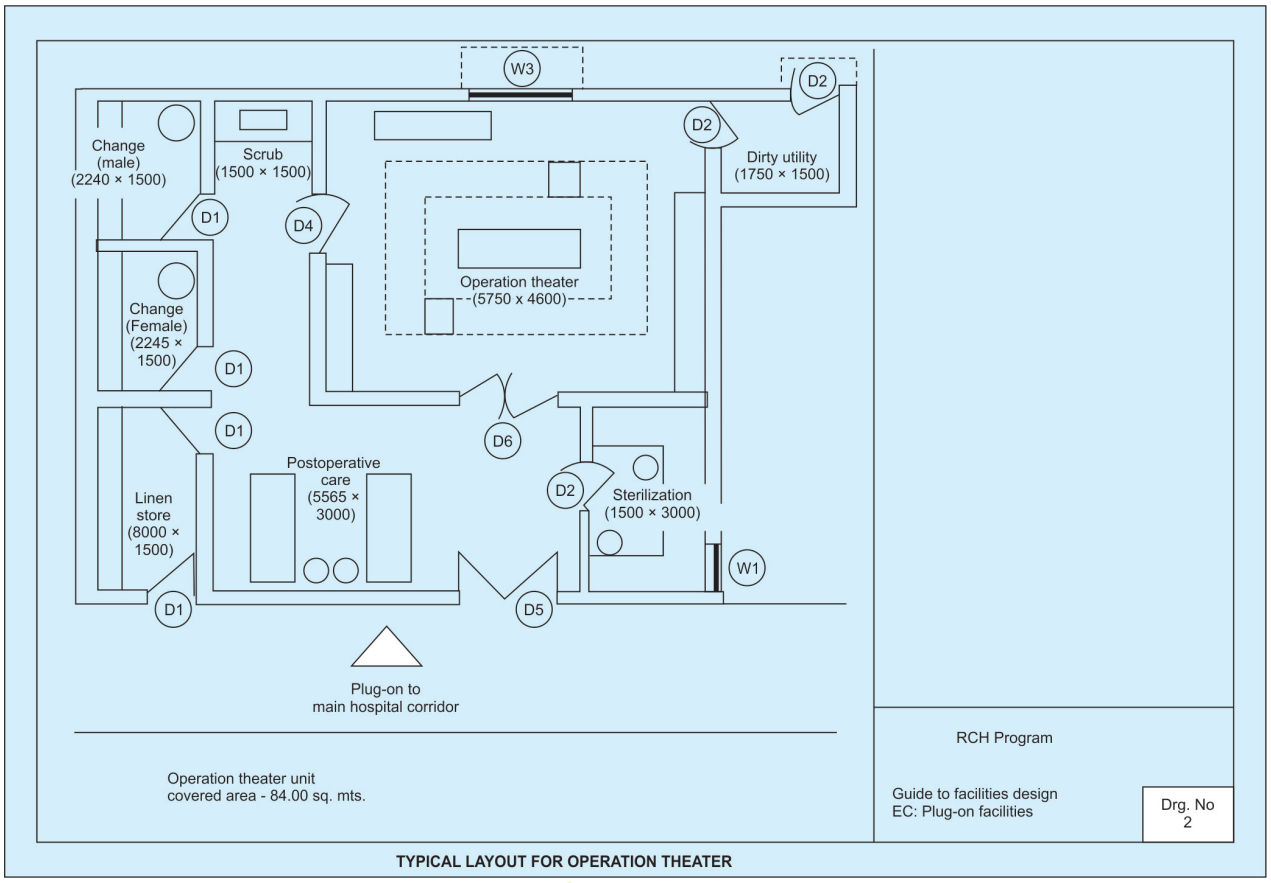


Fig. 34.6 Layout of operation theater (optional)

Note: The layout shown integrates the OT with the existing facility following the principles of functional consistency. Care has been taken to ensure that the dirty utility remains accessible from outside the building.

outpatients during morning hours and visits each subcenter, by rotation, on fixed days, in the afternoon to supervise the field work. He has limited inpatient services. He refers the cases, beyond his capacity, to the nearest CHC or district hospital or teaching hospital.

He conducts monthly meeting with all the members of the health team and the staff members of all the subcenters of that PHC to review the progress of their activities and solves the administrative problems if any.

He is the chief of the health team and works as a trainer, planner, promoter, director, supervisor, co-ordinator as well as an evaluator.

The Second Medical Officer takes the burden off the shoulders of the first MO and enables him to improve the quality of the service, by performing identical duties.

HEALTH WORKER FEMALE

She is an auxillary nurse midwife (ANM) now designated as 'multipurpose worker' (MPW). She is the 'front-line' staff and the 'key' person to deliver MCH services in the rural areas. She is posted to subcenter to cover a population of about 5000 in plain areas and about 3000 in hilly, tribal areas, distributed over 4–5 villages. Subcenter constitutes the 'nucleus' for the delivery of MCH-services in the rural areas.

Health worker female (HWF) performs the following activities.

Record Keeping

Health worker female (HWF) maintains the following registers.

- Antenatal register—in which she registers the names of all the pregnant mothers, of her area, from 12th week of amenorrhea onwards and enters the details of the antenatal care provided.
- Postnatal register—in which she registers the names of all postnatal mothers and the details of the postnatal check-up.
- Under Five Children's register—in which she registers the names of all under five children of her area and enters the details of the services provided, mainly immunization.

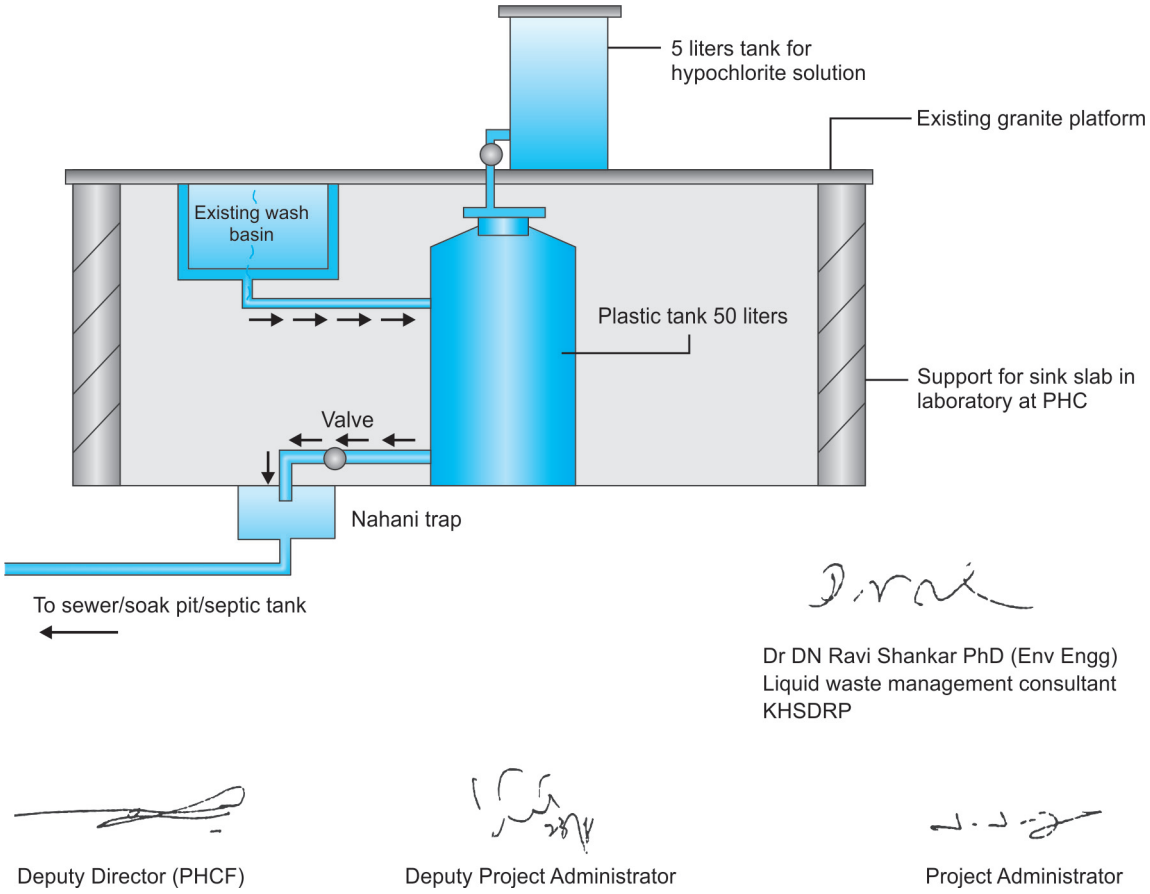


Fig. 34.7 Proposal for disinfection of 'liquid biomedical waste' at primary health centers in Karnataka

- Clinic attendance register.
- Eligible couple register—in which she registers the names of all married women, who are in the reproductive age group.
- Home-visiting register.
- Birth and Death registers
- Family planning register—in which she registers about distribution of oral pills, condoms, tubectomies, vasectomies and IUD fittings.

Antenatal Care

Health worker female (HWF) provides antenatal care both at home as well as at the subcenter/clinic.

Care at Home

Health worker female (HWF) visits the expectant mother's house at least 4 to 5 times (and more often if the mother is at risk) and gives advice on nutrition, exercise, rest, personal hygiene, cleanliness and sensitizes on family planning and breastfeeding of the child.

She also identifies the cases requiring help for medical termination of pregnancy and refers them to the nearest approved institution.

Care at the Clinic

Health worker female (HWF) conducts antenatal clinic once in a week, when the MO visits subcenter. She assists him and the health assistant female in conducting the clinic.

She does routine examination of the urine and Hb percent. She assists MO in recording the Blood pressure. She also gives health education individually and in groups. She also treats minor ailments if any during the remaining days of the week.

Intranatal Care

- Health worker female (HWF) conducts 50 percent of total deliveries in her area.

- She supervises the deliveries conducted by dais and wherever called in.
- She recognizes the 'danger signals' during labor and refers all such cases to the nearby hospitals.

Postnatal Care

She will pay at least 3 to 5 visits after the delivery. She gives advice on early ambulation, nutrition, breastfeeding, personal hygiene and also motivates the mother for family planning.

Family Planning Services

- She distributes conventional contraceptives and oral pills to the newly married couples.
- She identifies eligible couples and motivates the women for IUD insertion.
- She identifies target couples and motivates for sterilization.
- She provides follow-up services to family planning adopters.

Care of Infants

- She identifies infants of her area and assesses their growth and development, by plotting the weight in 'Road to Health' card.
- She arranges for primary immunization.

Births and Deaths

She records births and deaths occurring in her area and submits to the local birth and death registrar and also to her supervisor.

Notification

She notifies the notifiable diseases/outbreaks, whenever she comes across to the MO.

Training

- She gives training to Dais about observation of 5-cleans, while conducting deliveries.
- She also gives training to village health guides.

Health Education

She gives health education to all the expectant and lactating mothers, family planning acceptors and others coming to subcenter.

Health Care

She provides treatment for all minor ailments, distributes ORS packets to the children with diarrhea and provides first-aid in cases of emergencies. She refers the cases beyond her competence to nearby hospital.

Miscellaneous

- She maintains cleanliness of the subcenter.
- She attends monthly meetings at PHC and submits her reports.
- She involves dais and village health guides of her area in promoting family welfare work.
- She participates in pulse polio immunization.
- She assists MO and Health Assistant Female in their work.
- She coordinates her activities with Anganwadi workers, Mahilamandals and such others.
- She will set up women depot holders for distribution of conventional contraceptives.

HEALTH WORKER MALE

Health worker male (HWM) also works in subcenter area, but does not reside in the subcenter building. He stays outside. He does not carry out MCH-services but carries out the following activities.

Record Keeping

- Health worker male (HWM) maintains the records of the village survey of his area.
- He prepares and maintains family records.
- He maintains the records of communicable diseases and
- He maintains the records of family planning services and immunization.

Role in the Control of Communicable Diseases

Malaria

He detects cases of malaria by active surveillance (He takes thick and thin blood smears from cases of fever, administers presumptive treatment, sends the smears for laboratory examination and in case proves positive, comes and gives radical treatment).

Leprosy

- He identifies the cases of leprosy in his area and refers them to MO for confirmation and treatment. He motivates the defaulters to take the treatment correctly and completely.
- He educates the family members of the leprosy case to show sympathy on him/her and that it is curable.

Tuberculosis

- He identifies the cases of pulmonary tuberculosis by collecting sputum smears from those having cough with fever for more than 21 days and sends those slides for laboratory examination.
- He also acts as a DOTS-agent in providing the treatment for TB patients.
- He motivates the TB cases to take the treatment regularly.

Other Communicable Diseases

- He identifies the cases of fever with rashes, diarrheas, jaundice, tetanus, whooping cough, diphtheria, fever with convulsions, eye infections, etc. and notifies to his supervisor health assistant male and also to MO of PHC.
- He also takes part in acute flaccid paralysis (AFP) surveillance.
- He distributes ORS packets to all cases of diarrheas and dysenteries.

Improvement of Environmental Sanitation

- He disinfects the sources of water, specially wells with bleaching powder periodically and during outbreaks daily.
- He educates the people about hazards of open air defecation and motivates them to use sanitary latrines.
- He educates the community on keeping the premises clean in and around the houses and also about the methods of disposal of solid and liquid wastes.

Immunization

- He administers DPT, OPV, MV and BCG vaccine to all infants in his area.
- He participates actively in pulse polio immunization Program.

Family Welfare Services

- He educates the couples on Family planning.
- He distributes condoms to eligible couples.
- He motivates the target couples for sterilization.
- He provides follow-up of services to male family planning acceptors.
- He establishes male depot holders in his area for family planning services.

Miscellaneous Activities

- Health worker male (HWM) attends monthly meetings in the PHC and submits his reports to MO for evaluation.
- He assists MO and health assistant male in organizing sterilization camps, immunization camps, etc.
- He identifies cases of PEM among underfives and motivates to Anganwadi centers.
- He carries out health education activities to the community.

HEALTH ASSISTANT FEMALE

- One health assistant female (HAF) supervises and guides four health workers female in their activities.
- She visits each of the four subcenters by rotation on fixed days.
- She carries out supervisory house visiting to supervise immunization of mothers and children.
- She guides the female health worker in conducting antenatal and family planning clinics.
- She utilizes the services of Mahila mandals and local leaders in organizing immunization and family welfare programs.
- She identifies cases requiring MTP and refers them to the approved institutions.
- She arranges group meetings with local leaders, involves them in carrying out health education activities of various health programs.
- She assists the MO of PHC in the organization of tubectomy camps, immunization camps, etc.
- She indents and provides materials to health workers.
- She attends monthly meetings and submits her reports to MO for evaluation.
- She attends to cases referred by health workers and refers cases beyond her competency to MO.

HEALTH ASSISTANT MALE

- One health assistant male (HAM) supervises and guides four health workers male in carrying out all their activities including maintenance of their records.
- He carries out supervisory house visiting.
- He will be alert to the outbreak of the diseases and takes possible remedial measures.
- He notifies to the MO of PHC about the outbreak.
- He ensures that all cases of TB, Leprosy, Malaria take regular and complete treatment.
- He supervises the chlorination of water sources including wells.
- He helps the community in the construction of soakage pits, sanitary latrines, biogas plants, compost pits, etc.
- Conducts immunization session for school children.

- Motivates couple for adapting family welfare methods and ensures their follow-up.
- Identifies cases of malnutrition among underfives and motivates them to Anganwadi centers.
- Ensures vitamin A syrup and IFA tabs to the children.
- Identifies cases of blindness and refers them to PHC for further needful action.
- Collects and compiles the data of births and deaths and submits to the birth and deaths registrar.
- Gives health education to the community at large.

Community Health Center

It is a 30 bedded hospital created by upgradation of an erstwhile PHC. One out of four PHCs is upgraded. Each community health center (CHC) covers a population of about 1 lakh, distributed over about 100 villages. These are established to provide the services of specialists in surgery, medicine, obstetrics and gynecology and pediatrics alongwith the facilities of laboratory, X-ray and blood bank.

Thus, a CHC acts as the first level referral center/First Referral Unit (FRU).

For strengthening the preventive and promotive services, a special post of 'Community health officer' has been created. The community health officer is selected from the senior health assistants of PHC with minimum of 7 years experience in rural health programs.

Staff Pattern of Community Health Center

Medical officers	- 4 (Surgeon, physician, pediatrician and obstetrician)
Nurse and midwives	- 7
Dresser	- 1
Pharmacist	- 1
Lab Technician	- 1
Radiographer	- 1
Ward boys	- 2
Dhobi	- 1
Sweepers	- 3
Mali	- 1
Chowkidar	- 1
Aya	- 1
Peon	- 1
Total	**- 25**

Services Provided

- Inpatient and outpatient services
- Services of specialists
- Emergency care
- Specialized diagnostic services.

INDIAN PUBLIC HEALTH STANDARDS FOR COMMUNITY HEALTH CENTERS

Community Health Centers (CHC), which constitute the First Referral Unit (FRU) and function as Secondary level of health care, were designed to provide referral as well as specialist health care to the rural population, will be 30 bedded hospital.

In order to provide optimal expert care and quality service, Indian Public Health Standards (IPHS) are being prescribed by the Bureau of Indian Standards. These standards also provide a yardstick to measure the services being provided there.

Objectives

- To provide optimal expert care to the rural community.
- To achieve and maintain an acceptable standard of quality of care.
- To make the services more responsive and sensitive to the needs of the community.

Service Delivery in Community Health Centers

Each CHC should provide the following assured services.

- Care of routine and emergency cases in surgery.
- Care of routine and emergency cases in medicine.
- 24 hour delivery services—both normal and assisted.
- Emergency and essential obstetric care including caesarean section.
- Family planning services including laproscopic services.
- Safe abortion services.
- Newborn care.
- Routine and emergency care of sick children.
- Delivery of all National Health Program services.
- Other services like
  - Blood storage services
  - Essential laboratory services
  - Referral (transport) services
    - Functional ambulance round the clock
    - Preference for Ex-Army personnel
    - Charges for transportation, ₹ 5/- km
    - Driver on contract basis
    - Driver gets ₹ 4.50/- km covering the cost towards petrol, salary and minor repairs.
    - He should deposit 50 paise per km in casualty Medical Officer's office, kept towards major repair.
    - Driver owns the ambulance after five years.

Minimum Requirements for the Delivery of Above-mentioned Services

- Persons who have completed the professional development course
- Public health program manager
- Anesthetists.

Equipment

- Standard surgical sets
- IUD insertion kit
- Equipment for anesthesia
- Equipment for neonatal resuscitation
- Materials kit for blood transfusion
- Equipment for operation theater
- Equipment for labor room
- Equipment for radiology
- Facilities for blood bank.

Drugs

All Allopathic, Ayurvedic, Unani, Siddha and Homeopathic (AYUSH) drugs to be provided.

Manpower

The recommended strength of manpower are as given in **Table 34.2**.

Support Manpower

Staff nurses 19, public health nurse 1, auxillary nurse midwife 1, pharmacist 3, pharmacist (AYUSH) 1, laboratory technician 3, radiographer 2, ophthalmic assistant 1, dresser (certified St. Johns ambulance) 2, ward boys 5, sweeper 5, chowkidar 5, dhobi 1, mali 1, aya 5, peon 2, OPD attendant 1, registration clerk 2, statistical assistant (data entry operator) 2, accountant 1 and OT technician 1, total = 64.

Investigative Facilities

ECG machine, lab facilities including necessary reagents and facilities for collecting and transport of samples should be available.

Physical Infrastructure

The CHC should have 30 indoor beds with one operation theater, labour room, X-ray facility and laboratory facility.

Table 34.2 Recommended strength of manpower for community health center

Personnel	Strength	Justification
Block Health Officer (a senior specialist)		Overall administration/ management of CHC. Coordination of National Health Programs. Management of ASHAs (Accredited Social Health Activist). Arrangement of training programs.
General surgeon	1	
Physician	1	
Obstetrician and gynecologist	1	
Pediatrician	1	
Anesthetist	1	May be on contractual appointment or Having of services from private hospital.
Public Health Manager (MD in Community Medicine)	1	
Ophthalmologist	1	One for every five CHCs
Dental surgeon (BDS)	1	
General Duty Medical Officers (MBBS graduates)	6	Including at least two female doctors
Specialist of AYUSH	1	
General Duty Medical Officers of AYUSH	1	
Total	15/16	

The building should have the following areas:

Entrance zone, OPD clinics for various specialties, waiting room, pharmacy, emergency room/casualty, minor OT, injection cum dressing room, male and female wards, toilets, ancillary room, operation theater, labor room, public utilities for men and women, laundry facilities, civil engineering services for electricity, telephone and water supplies, administrative office room with computers and store room.

Hospitals

Hospitals differs from health centers in that the services are mainly curative oriented, not having defined catchment area and the health team consists of only curative staff such as doctors, nurses, compounders, etc.

So the debate is that the hospitals should not remain as 'an ivory tower of diseases' in the community but should take an active participation in providing comprehensive health care services to the community.

The different types of hospitals are Community health centers, District hospitals, Teaching hospitals and Apex hospitals.

District Health Officer (DHO) is the chief and overall in charge of all hospitals of the districts including primary health centers. He is responsible for the control of all endemic diseases in his district and implementation of the relevant national health programs.

Other Agencies

Employees State Insurance Hospitals

The employees state insurance (ESI) hospitals are exclusively for the benefit of industrial workers and their parents. The benefits of the ESI-scheme, under the ESI-Act covers employees whose wages do not exceed ₹ 7500 per month. ESI Scheme is an unique piece of social legislation in India.

Central Government Health Scheme

This was previously known as Contributory Health Service Scheme. This covers the employees and pensioners of Central Government and their families. The Members of the Parliament (MPs) also constitute the beneficiaries.

Central government health scheme (CGHS) was first started in New Delhi, in 1954, to provide comprehensive health care to the employees of Central Government. The Central Govt. employees contribute a small premium and in turn get the following benefits, outpatient and inpatient treatment, emergency and ambulance services, maternal and child health services including immunization and family planning, dentures and spectacles at subsidized rates.

The scope has been extended to cover 16 cities in India other than Delhi and also to other sectors of the population such as employees of the autonomous organizations, widows receiving family pension, Ex-Governors and retired judges.

Today, nearly 5 million beneficiaries are included under this scheme. In Delhi, there is also an Yoga center for them.

Railway Hospitals

These are exclusively for the employees of the railways. Health check-up of these employees is provided at the time of entry into service and thereafter at yearly intervals. Services of specialists are also available in these hospitals. Lady medical officers, health visitors and midwives provide MCH services, family planning and school health services.

Private Sector

Private agencies like nursing homes, polyclinics, private hospitals, General practitioners, etc. also contribute in providing health care services to the people. General practitioners constitute nearly 70 percent of medical profession.

All these private agencies mainly provide curative services and to those who can pay. The services are not organized.

INDIGENOUS SYSTEM OF MEDICINE

This constitutes Ayurveda, Yoga, Unani, Siddi, Homeopathy (AYUSH), etc. The practitioners of such medicine are mainly found in rural areas. Most of them are local residents. They mingle with the people socially and culturally. Govt. of India is studying to avail the services of these medicines for effective and total health coverage.

- Voluntary Health Agencies
- National Health Programs

] Described elsewhere

BIBLIOGRAPHY

1. GOI. MOHFW. Indian Public Health Standards (Revised) for Primary and Community Health Centers 2007.
2. Govt. of India. Annual Report 1986-87. Ministry of Health and Family Welfare, New Delhi 1987.
3. Govt. of India. Center Calling 1977. Ministry of Health and Family Welfare, New Delhi 1977.
4. Govt. of India. Modules for Continuing Education of Health Assistant (male and female) and Health Workers (male and female), New Delhi 1990.
5. NRHM News Leter Vol. 6(3);2011.
6. WHO Notes for the Practicing Midwife. SEARO. Regional Health Paper No 5, 1985.
7. WHO Primary Health Care. Report of the International Conference on Primary Health Care. Alma Ata, USSR 6-12, Health For All Series No 1; Geneva 1978.

CHAPTER 35

National Rural Health Mission—2005-2012

Health of the citizens is fundamental to the economic and social development of any country. The cause of low state of health in India are many including lack of sanitation, poor standard of living, poor nutritional status, lack of safe water supply and lack of appropriate health care. These are serious impediments to the progress of our country.

Recognizing the importance of health in the process of the development of the country, and improving the quality of life of our citizens, Government of India has resolved to launch National Rural Health Mission (NRHM) to carry out necessary architectural correction in the basic health care delivery system, as a strategic framework to implement National Health Policy, 2002.

OBJECTIVES

National Rural Health Mission (NRHM) seeks to provide effective efficient and affordable health care, mainly with reference to nutrition, sanitation, hygiene, safe drinking water and also to mainstream the Indian systems of medicine [Ayurveda, yoga, unani, siddha, and homeopathy (AYUSH)] to facilitate health care, mainly to those residing in the rural areas, especially the disadvantaged group including, women and children with special focus on 18 states which have weak public health indicators and/or weak infrastructure. The NRHM was launched by honorable Prime Minister of India, Dr Manmohan Singh on 12th April 2005, with the emblem **(Fig. 35.1)**, with a budget out lay of Rs. 6500 crores for 2005-06 to realize the dream of 'Health For All and All For Health'. The mission is for the period from 2005 to 2012 and now extended from 01.04.2012 to 31.03.2017.

Fig. 35.1 National Rural Health Mission

The plan of action includes:

- Increasing public expenditure on health
- Reducing regional imbalance in health infrastructure
- Pooling resources
- Integration of organizational structures
- Optimization of health manpower
- Decentralization and district management of health programs
- Community participation and ownership of assets
- Induction of management and financial personnel into district health system
- Operationalizing community health centers into functional hospitals meeting Indian Public Health Standards (IPHS) in each Block of the country.

The National Rural Health Mission subsumes key national programs, namely

- Reproductive and Child Health II project (RCH II)
- National Disease Control Programs (NDCP)
- Integrated Disease Surveillance Project (IDSP)
- Mainstreaming of AYUSH.

National rural health mission seeks to provide effective health care to rural population throughout the country with special initial focus on 18 states which have poor public health indicators and/or weak infrastructure.

These 18 states are Uttar Pradesh, Uttaranchal, Madhya Pradesh, Chattisgarh, Bihar, Jharkand, Orissa, Rajasthan, Himachal Pradesh, Jammu and Kashmir, Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Mizoram, Sikkim and Tripura.

STATE OF PUBLIC HEALTH IN INDIA

- Public health expenditure has declined from 1.3 percent of GDP in 1990 to 0.9 percent of GDP in 1999 (GDP = Gross Domestic Product. It is the market value of all final goods and services produced within a country in a given period of time)
- The contribution of Union Government to public health expenditure is 15 percent while state contribution is 85 percent
- National health programs have limited synergization at operational levels
- Lack of community ownership of public health programs impacts level of efficiency, accountability and effectiveness
- Lack of integration of sanitation, hygiene, nutrition and drinking water issues
- There are striking regional inequalities
- Population stabilization is still a challenge
- Curative services favor the rich
- Only 10 percent Indians have some form of health insurance
- Hospitalized Indians spend on an average 58 percent of their total annual expenditure
- Over 40 percent of hospitalized Indians borrow heavily to cover expenses
- Over 25 percent of hospitalized Indians fall below poverty line because of hospital expenses.

NATIONAL RURAL HEALTH MISSION—A VISION

- To provide effective health care services to rural population, especially to mothers and children with initial focus on 18 states
- To raise the public health expenditure from 0.9 percent of GDP in 1999 to 2.3 percent of GDP
- To undertake architectural correction in health care delivery system
- To provide services through the appointment of Accredited Social Health Activist (ASHA) in each village
- To strengthen the rural hospitals to meet public health standards
- To integrate national health programs
- To mainstream AYUSH
- To decentralize village and district level health planning and management
- To define time bound goals
- To seek access of rural people (especially poor mothers and children) to equitable, affordable, accountable and effective primary health care
- To provide improved health care services under Janani Suraksha Yojana (JSY) for the Below Poverty Line families.

GOALS

- Reduction of Infant Mortality Rate (IMR) and Maternal Mortality Ratio (MMR)
- Universal access to public health services such as women's health, child health, safe drinking water, sanitation and hygiene, immunization and nutrition
- Prevention and control of communicable and non-communicable diseases including locally endemic diseases
- Access to integrated comprehensive primary health care
- Population stabilization, gender and demographic balance
- Revitalize local health traditions and mainstream AYUSH
- Promotion of healthy life-styles.

STRATEGIES

Core Strategies

- To enhance the capacity of Panchayati Raj Institutions (PRIs) to manage public health services
- To promote access of improved health care at household level through female Accredited Social Health Activist (ASHA)
- To make health plan for each village through Village Health Committee of the Panchayat
- To strengthen subcenter by more multipurpose workers
- To strengthen existing PHCs and CHCs
- To provide one Community Health Center of 30 to 50 bed strength per lakh population
- To prepare and implement an Intersectoral District Health Plan, prepared by District Health Mission
- To integrate Vertical Health Programs and Family Welfare Programs
- To provide technical support to Health Missions at National, State and District levels for public health management

- To formulate transparent policies for deployment and career development of Human Resources for health
- To promote healthy life-styles such as reduction in consumption of tobacco, alcohol, etc.

Supplementary Strategies

- To regulate private sector, including the rural practitioners, to ensure availability of quality service to the people at reasonable cost
- To promote public-private partnership to achieve public health goals
- To mainstream AYUSH
- To Reorient Medical Education (ROME) to support rural health issues
- To introduce effective risk pooling mechanisms and social insurance to provide health security of the poor.

PLAN OF ACTION

Accredited Social Health Activist

Accredited Social Health Activist (ASHA) is primarily a woman resident of the village, preferably in the age of 25-45 years, married/widow/divorced; educated upto minimum of 8th standard. She is being selected by the Village Health and Sanitation Committee, at the rate of one per 1000 population and is accountable to village Panchayat.

She acts as an interface/link worker between the community (family level) and the public health system (Female Health Worker), by providing primary health care, on the following health issues:

- She motivates the pregnant mother of her area to get at least three antenatal visits
- She escorts for institutional delivery
- She ensures postnatal check-ups in case of home deliveries
- She promotes the couples to adopt suitable contraceptive (temporary or permanent) method and to have a small family norm
- She promotes adolescent reproductive and sexual health (ARSH) among adolescent girls
- She advices the mothers on correct breastfeeding practices and immunization of the child
- She creates awareness among the people about the importance of cleanliness in and around the houses, drinking safe water, using sanitary latrines, personal hygiene, etc.
- She also acts as a DOTS agent under RNTCP
- She will inform about the births and deaths to the sub-center or Primary Health Center.
- She provides treatment for minor ailments and first aid for minor injuries.
- She acts as a depot holder for essential provisions like ORS packs, IFA tablets, disposable delivery kits, oral pills, condoms, etc.
- She works with village health committee to develop comprehensive village health plan

Thus, ASHA provides basic nutritional, immunization, family planning and educational services

Accredited Social Health Activist (ASHA) is not entitled to any pay. She is a honourary volunteer receiving performance based compensation for escorting services under Janani Suraksha Yojana (JSY), for promoting universal immunization and also TA/DA for attending training. She is accountable to Gram Panchayat. She is trained by Anganwadi Worker and Female Health Worker of the area and attends monthly meeting.

Currently, ASHA is envisaged in 18 focus states. After the orientation training, ASHA is positioned with kits containing both AYUSH and Allopathic formulations.

Strengthening Subcenters

- Increase in fund to ₹ 10,000 per anum
- Supply of both allopathic and AYUSH drugs
- Increasing the number of subcenters and multipurpose workers
- Upgrading of subcenters including buildings.

Strengthening Primary Health Centers

For improving the quality of services through:

- Adequate and regular supply of drugs
- Provision of 24 hours service in 50 percent PHCs
- Observation of standard treatment guidelines.

Strengthening Community Health Centers (30-50 beds)

- Operationalizing the CHCs, (First Referral Units) as 24 hour FRUs
- Setting of new Indian Public Health Standards to improve the quality of services
- Promotion of Stakeholder Committees (Rogi Kalyan Samitis) for hospital management
- Creation of new Community Health Centers to meet the population norm.

District Health Plan

- This would be an amalgamation of field responses through village health plans, state and National priorities for Health, Water supply, Sanitation and Nutrition

- These related departments would integrate into District Health Mission, headed by District Health Officer for monitoring
- District becomes the core unit of planning, budgeting and implementation
- 'Funneling' of funds for integration of programs
- All national programs merge into District Health Mission.

Implementation of Total Sanitation Campaign

Implementation of Total Sanitation Campaign (TSC) includes IEC activities, rural sanitary marts, promotion of individual household toilets and school sanitation program.

Strengthening Disease Control Programs

- All national programs shall be integrated under the mission
- Covering both communicable and non-communicable disease
- Strengthening Integrated Disease Surveillance Project at village level
- Provision of mobile medical unit at District level for improved outreach activities.

Public-Private Partnership

- Mission should have representation of private sector because 75 percent of health services are being currently provided by the private sector
- To develop guidelines for Public-Private Partnership (PPP) in health sector
- NGOs should be included as members of various Task Groups.

New Health Financing Mechanisms

- By organization of various Task Groups
- By standardization of services
- By monitoring these services
- By reimbursement of costs for services to CHCs from District Health Fund
- By creation of District Health Fund Management
- By encouraging Community Based Health Insurance Schemes, as part of the mission.

Reorientation of Medical Education

Administrative Set-up of NRHM

- Village Health and Sanitation samiti—at village level
- Rogi Kalyan Samiti—for community management of hospitals
- District Health Mission—at district level
- State Health Mission—at state level
- National Mission—at national level
- Task groups—for selected tasks (Time-bound).

TARGETS OF THE NRHM (BY THE YEAR 2012)

- Reduction of Infant Mortality Rate (IMR) to 30/1000 livebirths
- Reduction of Maternal Mortality Rate (MMR) to 01/1000 livebirths
- Reduction of Total Fertility Rate (TFR) to 2.1
- *Reduction of malaria mortality rate:* 50 percent up to 2010, additional 10 percent by 2012
- *Reduction of kala-azar mortality rate:* 100 percent by 2010 and sustaining elimination until 2012
- *Reduction of filaria/microfilaria rate:* 70 percent by 2010, 80 percent by 2012 and elimination by the year 2015
- *Reduction of Japanese encephalitis mortality rate:* 50 percent by 2010 and sustaining at that level until 2012
- *Cataract operation:* Increasing to 46 lakhs per year until 2012
- Reduction of Leprosy prevalence rate from 1.8/10,000 in 2005 to less than 1/10,000 thereafter
- *Tuberculosis DOTS services:* Maintain 85 percent cure rate through entire mission period
- Upgrading Community Health Centers to Indian public health standards
- Increase utilization of First Referral Units from less than 20 percent to 75 percent
- Engaging 2,50,000 female ASHAs in 18 states.

JSY and JSSY Schemes

Described under National Health Program RCH II.

PROGRESS UNDER NRHM (AS ON DECEMBER 2011)

- 8.52 lakh ASHA workers are selected
- 6.90 lakh ASHAs are trained and positioned with kits
- Janani Suraksha Yojana (JSY) scheme is operatinoalized in all the states, benefiting 19.43 lakh mothers during 2011-12
- Janani Shishu Suraksha Yojana (JSSY) scheme is launched in June 2011, extending the benefits for unhealthy new borns

- 69.25 lakh monthly Health and Nutrition Days have been organized at Anganwadi centres in various states during 2010-11
- Integrated Management of Neonatal and Childhood Illness (IMNCI) started in 499 districts
- Accelerated immunization program been taken up
- Intense monitoring of poliomyelitis progress
- Japanese encephalitis vaccination completed in 11 district in four states
- Neonatal tetanus declared eliminated from 7 states in the country
- 4.9 lakh Village Health and Sanitation Committees have been constituted
- A total of 30,818 Rogi Kalyan Samitis have been set up in various health centers and hospitals and have been registered
- 1.47 lakh subcenters are provided with united funds of ₹10,000 each
- Out of 4535 Community Health Centers, 2499 have been selected for upgradation to Indian Public Health Standards
- 1797 Mobile Medical Units are operating
- Mainstreaming of AYUSH has been taken up
- 11205 doctors, 1572 specialists, 53552 ANMs, 26734 Staff Nurses, 18272 paramedics have been appointed
- During the financial year 2009-10, out of ₹14,050 crores allocated for the Ministry, an amount of ₹11,613.39 crores was released as a part of NRHM.

AUTO-DISABLE SYRINGES

It has been observed recently that the glass syringes used in immunization are often unsafe. Therefore, the glass syringes and needles are replaced by auto disable syringes (ADS).

This AD syringe will have a fixed needle. It is presterilized in proper pack. They are available in two sizes, of 0.1 ml and 0.5 ml for immunization purposes. In addition to this, 5 ml disposable syringes and needles will be supplied for reconstitution of BCG and measles vaccine separately.

Advantages of AD Syringes

- It is designed to prevent the reuse of nonsterile syringes
- The fixed needle design reduces the dead space in the syringe that wastes vaccine and eliminates the chances of air bubble entry into the syringe due to loose fitting of the needle
- They are made, dose specific (0.1 ml and 0.5 ml) and hence withdrawing the plunger to the full length ensures correct dose. No adjustment is required
- Since they are presterilized, it saves time of sterilization.

Instructions

- Since the plunger can go back and forward only once, air should not be drawn in, to inject it into the vial before drawing vaccine. Moreover, injecting air into the vial will lock the syringe
- Select the correct syringe for the vaccine to be administered
- Don't use the syringe, if the package is damaged, opened or expired
- After opening the package and the needle cover, do not insert the needle in the inverted vial, beyond the level of the vaccine, because it may draw air bubble. Do not draw air into the syringe
- In case air enters the syringe accidentally, follow these steps to remove the air bubbles:
  - Remove the syringe, hold upright, tap the barrel so that bubbles will come towards the tip of syringe
  - Pull the plunger back, so that air will enter in and comes in contact with the air bubble in the syringe
  - Then carefully push the plunger to the dose mark (0.5 or 0.1ml) thus expelling air bubble.

Disposal of AD Syringes

- Remove the needle from AD syringe immediately after using it by using Hub cutter, which cuts the plastic hub of syringe and not the metal part of the needle
- The needles are collected in white translucent container
- The broken syringes and vaccine vials are collected in red container
- The red and white bags are then sent to Biomedical Waste Treatment Facilities (BWTF)
- If BWTF does not exist, the collected materials are autoclaved. If not, the waste is boiled in water for at least 10 minutes or treated with disinfectant
- From the autoclaved/disinfected waste, the needles and broken vials are disposed by burying in a pit and the syringes and the unbroken vials are disposed by sending them for recycling
- The containers are washed properly for reuse.

BIBLIOGRAPHY

1. GOI. MOHFW. National Rural Health Mission 2005-2012. Mission Document.
2. Indian Public Health Association. National Rural Health Mission. Ind Jr. of Pub Health. Special Issue 2005;49(3).
3. National Rural Health Mission. Immunization is Priceless for a healthy young India. News Letter 2006;1(3).
4. New Letter. NRHM, Ministry of Health and Family Welfare, New Delhi 2006.
5. NRHM Bulletin. Vol. 7(1) Nov-Dec 2011.
6. NRHM Bulletin Vol. 6(3) Jan-Feb 2011.
7. NRHM Bulletin Vol. 7(4) July-Aug 2012.

CHAPTER 36

National Urban Health Mission

National Urban Health Mission (NUHM) has been taken up during the 11th five year plan (2008–2012) to meet the health needs of the urban poor, particularly the slum dwellers, through primary health care services by investing high caliber health professionals, appropriate technology through public private partnership and health insurance.

This covers all cities with a population of more than 1,00,000. It covers slum dwellers, other marginalized urban dwellers like rickshaw pullers, street vendors, railway and bus station coolies, homeless people, street children, construction site workers, who may be in slums or sites.

(NRHM covers rural areas and restricts to reproductive and child health services).

RATIONALE

1. Urban population is estimated to increase from 35.7 crores in 2011 to 43.2 crores in 2021.
2. Rapid increase in the urban population can lead to increase in the number of slums.
3. Slum population is growing at the rate of 7 percent annually.
4. Poor health status of the urban slums.
5. Inadequacy of the health care delivery to the slum population.
6. Unfriendly treatment at governmental hospitals.
7. Slum people are at greater health hazards because of the following reasons:
   - Overcrowding
   - Poor living conditions
   - Poor sanitary conditions
   - Lack of safe water supply
   - Environmental pollution (air, water and soil)
   - Outbreak of communicable diseases
   - Increased incidence of STIs, RTIs, HIV/AIDS.

GOAL

It is to improve the health status of the poor by:

- Facilitating equitable access to quality health care
- Revising public health system
- Building public private partnership
- Community based risk pooling and insurance mechanism
- Active involvement of the urban local bodies.

STRATEGIES

1. Strengthening urban primary health structure:
   a. By creating new urban health centers, each covering a slum population of 20,000 to 30,000.
   b. Provision of evening OPD.
   c. Provision of comprehensive health care (preventive, promotive and curative care).
   d. Provision of need based equipment, drugs and human resources.
   e. Provision of Rogi Kalyan Samiti.
   f. Provision of outreach health sessions in the slums.
   g. Using GIS map, for easy access of patients.
2. Strengthening community participation, improving health awareness and capacity building, through partnership with nongovernment providers.
3. Establishment of Mahila Arogya Samiti (MAS).

4. Appointment of Urban Social Health Activist (USHA).
5. Capacity building of stake holders.
6. Prioritizing the most vulnerable amongst the poor like destitute, beggars, street children, construction workers, coolies, rickshaw pullers, sex workers, street vendors and such others.
7. Ensuring quality health care services by defining Indian Public Health Standards suitably modified for urban areas, defining parameters for accreditation of nongovernment providers, developing capacity of both public and private providers, encouraging the acceptance and enforcement of local public health Acts and encouraging development of standard treatment protocols.

TARGETS UNDER NATIONAL URBAN HEALTH MISSION

- IMR—30/1000 live births by 2012.
- MMR—01/1000 live births by 2012.
- TFR—2.1 by 2012 (Total fertility rate)
- Malaria—50 percent reduction in mortality by 2015.
- Kala azar—100 percent reduction in mortality by 2010 and sustaining elimination by 2015.
- Filariasis—>80 percent coverage of population by Mass Drug Administration (MDA) with DiEthyl Carbamazepine (DEC).
  70 percent reduction by 2010, 80 percent by 2012 and elimination by 2015.
- Dengue fever—50 percent reduction in mortality by 2010 and sustaining at that level.
- Chickungunya—Control of outbreaks and morbidity.
- Tuberculosis—85 percent cure rate through DOTS.
- Leprosy—Reduction in the prevalence rate to less than 1 per 10,000 population.

Coverage and Duration of National Urban Health Mission

Duration: Period of Eleventh Five Year Plan (2008–2012).

Coverage: Entire urban poor population of 430 cities.

Phase I: All cities with population of more than 1 lakh.

Phase II: All towns with population of less than 1 lakh.

Definition of Slum

Any compact habitation of at least 300 people or about 60 to 70 households of poorly built, congested tenements, in unhygienic environments, usually without adequate infrastructure and lacking in proper sanitary and drinking water facilities in these towns irrespective of the fact as to whether such slums have been notified or not as 'Slum' by State/Local government and Union Territory (UT) administration under any Act, recognized or not, are legal or not, is be covered under NUHM.

INSTITUTIONAL FRAMEWORK UNDER NATIONAL URBAN HEALTH MISSION

At the National and State level, National Rural Health Mission (NRHM) is utilized for NUHM activities. At each city level, separate City NUHM Health Society is framed, which monitors Mahila Arogya Samiti (MAS), USHA (Urban Social Health Activist) and other activities of NUHM **(Fig. 36.1)**.

Urban Social Health Activist (USHA)

She is a resident woman of the same slum, studied at least upto 8th standard, preferably in the age group of 25–45 years, married/widowed/divorced, chosen by Urban Local Body (ULB) counselors.

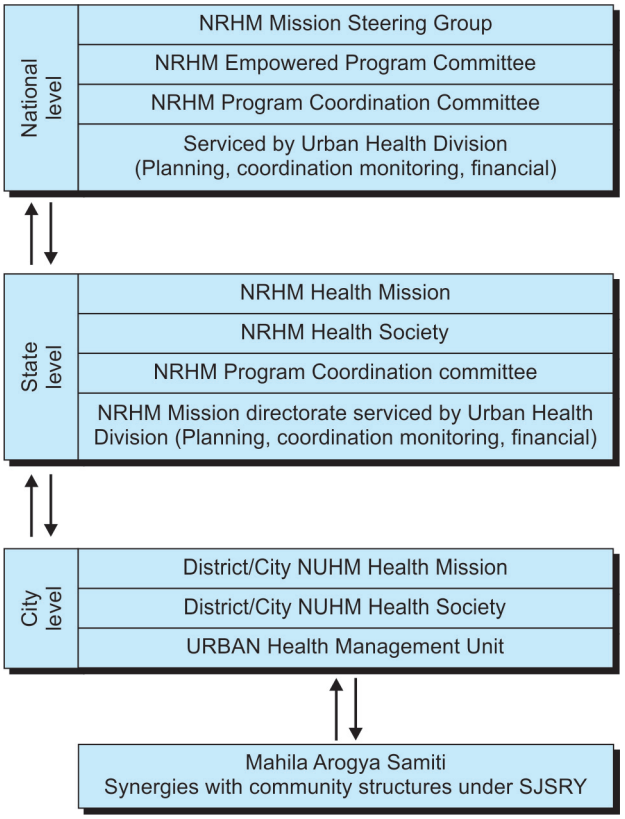


Fig. 36.1 Institutional framework under NUHM

Functions of USHA

- To promote good health practices in her area
- To facilitate awareness on RCH services
- To motivate all types of family planning methods
- To register all pregnant mothers and to motivate them for antenatal care
- To act as a Depot holder for essential provisions like ORS packets, IFA tablets, chloroquine tablets, oral pills, condoms, etc.
- To support ANM/MAS (Mahila Arogya Samiti) in conducting monthly outreach session regularly
- To form and promote Mahila Arogya Samiti
- To escort the patients requiring health services
- To encourage the community participation in health activities
- To maintain the records of vital events in her area
- To treat minor ailments with the drug kit provided.

Activities of USHA are monitored by ANMs of Primary Urban Health Center (PUHC) and Urban Local Body (ULB) counselors.

Functions of Mahila Arogya Samiti

- To focus on preventive and promotive care
- To act as peer education group
- To facilitate access to identified facilities
- Community monitoring and referral
- Risk pooling fund and health insurance.

Functions of Auxillary Nurse Midwife of Primary Urban Health Center

- To provide preventive and promotive health care services at the household level
- To monitor the activities of USHA
- To arrange outreach medical camps.

COMMUNITY RISK POOLING

This consists of women from Mahila Arogya Samiti. One time seed money (₹25 per household) will be given by the Government at the initial time and again annual performance grant (₹25 per household) is given. From this pool, money is utilized for other purposes, as shown in **Figure 36.2**.

Uses of this Pooling

The fund is utilized for unforeseen health expenditure of the member or family, other activities like group meetings, mobilization for health camps etc.

URBAN HEALTH INSURANCE MODEL

This includes all the urban population (slum and nonslum). All members are issued photo identity card (Family health suraksha card). Premium—annual amount is fixed per person and subsidized premium is offered for the poor.

Benefits

- It includes hospitalization, in patient services for more than 24 hours.
- It includes consultation, investigation and room charges and medicines and surgical/medical procedures.
- Maternal and childhood conditions and illnesses.
- Monetary coverage is up to a maximum of ₹50,000/year/enrolled household.
- Amount is directly paid to the empanelled.

Public and private health care provider **(Fig. 36.3)**.

PRIMARY URBAN HEALTH CENTER

This is located preferably near the slum to be served which will be accessed by slum dwellers. It covers approximately 50,000 population, including 25 to 30 thousand slum population. It mainly provides curative health care. Annual fund of ₹1 per head is provided to each PUHC.

Staff Pattern of Primary Urban Health Center

Medical officer	– 1
Pharmacist/Lab. technician	– 2
Program health manager	– 1
Multi-skilled nurse	– 2
ANMs	– 4
Account keeper	– 1
Support staff	– 3

Functions of Primary Urban Health Center

- Medical care—OPD services. 4 hours in the morning and 2 hours in the evening
- RCH—II services
- National Health Progam
- Collection and reporting of vital events
- IDSP (Integrated disease surveillance project)
- Referral services
- Basic laboratory services
- Counseling services

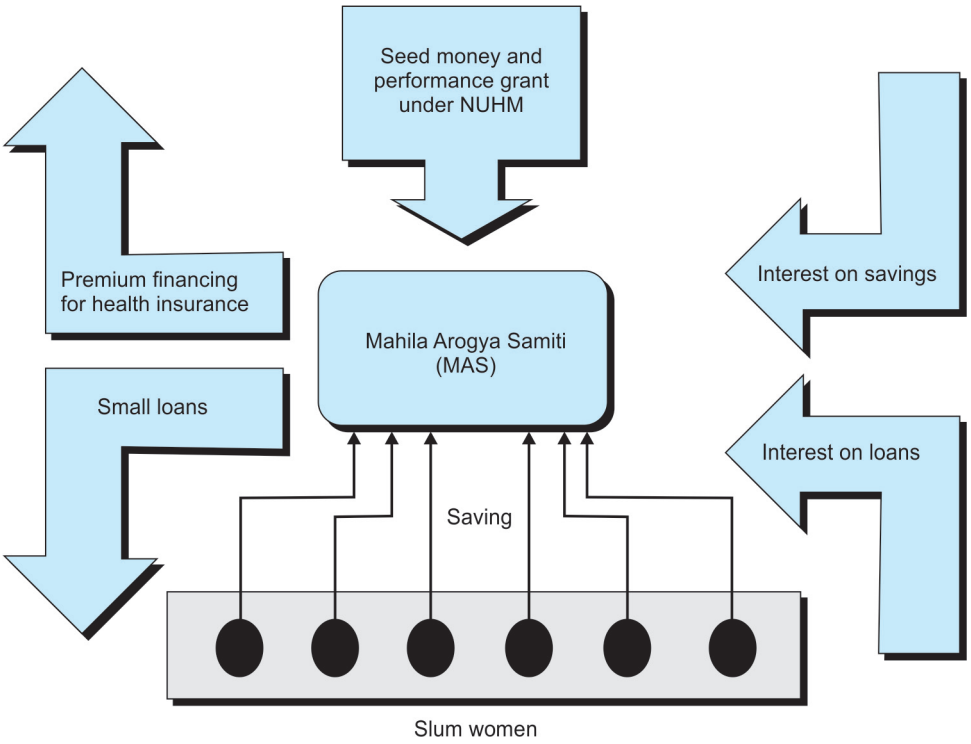


Fig. 36.2 Community risk pooling under NUHM

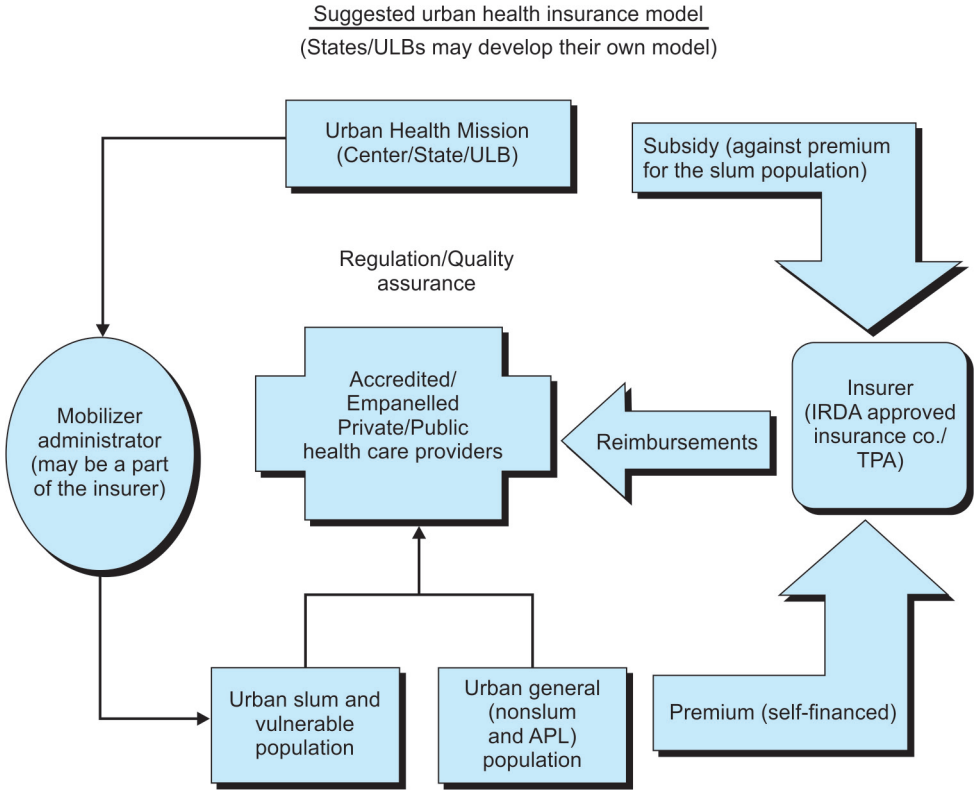


Fig. 36.3 Public and private healthcare provider

- Services for noncommunicable diseases
- Social mobilization and community level activities.

Referral Units

Existing hospitals including urban local body maternity homes, state Government hospitals and medical colleges will be accredited as referral points for health care services.

INTRASECTORAL COORDINATION

- Housing and slum development society to establish new PUHCs
- Colocation of RNTCP, ICTC, AYUSH, IDSP, NVBDCP etc. at UHCs
- Convergence of all National Health Programs
- Convergence with Swarn Jayanthi Shahri Rozgar Yojana (SJSRY)
- Convergence with ICDs and education department
- Convergence with Jawaharlal Nehur National Urban Renewal Mission (JNNURM).

MONITORING AND EVALUATION

State/District/City Urban Health Mission will regularly monitor the progress and provide feedback.
Monitoring will be done in three stages:

- Community based monitoring
- Health management information system (HMIS) for reporting and feedback
- External evaluations.

BIBLIOGRAPHY

1. http://www.urban.health.resource.centre.in/module.
2. Planning Commission, GOI; Tenth Plan Document, 2002-07, Vol.II.
3. www.mohfw.nic.in

CHAPTER 37

Health Planning and Management

PLANNING

Planning is a process of identifying a course of action systematically in an organized manner to achieve the objectives by utilizing the available resources skillfully in a cost-effective way. Health planning is a blue print of the course of action in various steps in a sequential order. It is a cyclical process. Evaluation is done at the end and feedback in the cycle. If necessary, the methodologies of course of action in the steps are then modified to improve the efficiency, i.e. operational research.

Thus, planning consists of formulation of action plan, execution (implementation), monitoring, evaluation and modifications if necessary. The points to be taken into consideration in health planning are the resources, the interventions and the budget.

Formulation of Action Plan

This consists of the following measures:

- Assessment of health situation by collection, compilation, tabulation, analysis and interpretation of the data about demographic profile of the population, socioeconomic status, availability of health facilities, topographical condition, cultural beliefs and attitudes. This helps to know the felt needs and demands of the community and also the available resources.
- Fixing up of the priorities, depending upon the magnitude of the health problem, the felt needs and their acceptability.
- Establishment of goals and objectives. The ultimate goal is to improve the health status of the community. For that, there must be objectives to be established. If objectives are not established, there is a possibility of activities becoming haphazard. In other words, objectives act as a guide for the actions. Selection of the strategies will help in achieving the aim and objectives.

For example, under Revised National Tuberculosis Control Programme, Aim (Goal) is to control tuberculosis in the country.

Objectives are detection of at least 70 percent of the estimated cases and achievement of at least 85 percent cure rate among the detected cases.

Strategy is Directly Observed Treatment Short Course (DOTS) Chemotherapy.

Another example, under National Poliomyelitis Eradication Program, the aim (goal) is to eradicate the disease poliomyelitis. The objective is to achieve and maintain zero incidence of poliomyelitis for three continuous calendar years and the strategies are sustain and maintain high level of routine immunization, pulse polio immunization, acute flaccid paralysis surveillance and mop up immunization.

Next step is assessment of resources such as manpower (health personnel), materials (like equipment, drugs, vaccines, etc.), money (funds), the skill, the knowledge and the techniques required for implementing the health program. If there is a gap between the required resources and the available resources, it has to be bridged.

Then a tentative time table of the course of action, i.e. 'time frame' of the program, is designed to carry out the action plan. The action plan should be practicable, feasible, adaptable and acceptable to the beneficiaries. It should be prepared in such a way that each stage of the activity should define not only the time required but also the cost factor with the guidelines.

The time schedule is represented graphically as 'Gantt Chart', named after Frenchman Henry Laurence Gantt. It is a work breakdown structure, in which the starting and completion dates of all activities of a project are illustrated **(Fig. 37.1)**.

The X-axis represents the time required for the completion of the activity and the Y-axis represents the nature of the activity undertaken. Different activities undertaken at different time and the different dates of completion can be represented simultaneously as horizontal bars parallel or in series with them. This helps the organizer to keep a track on various activities.

Suppose, a health camp has to be organized say on 25th April 2010, the work schedule (preparation) to be started much before that, as follows.

Components of work schedule of the health camp, represented on Y-axis.

a. Contacting the concerned NGOs for cooperation.
b. Fix the location (e.g. school, get permission from the school authorities).
c. Publicity campaign taken up in that area.
d. Arrange the supply of materials.
e. Registration of beneficiaries.
f. Finalizing the activities.
g. Fix the individual responsibilities.
h. Start providing the service.

Execution (Implementation)

The identified personnel are trained to carry out the action plan with the necessary leadership of the team. Different responsibilities are fixed to the different personnel depending upon their knowledge and skills. With an effective organization, the action plan is executed (implemented).

Sometimes, there will be shortcomings like delay in supplies, lack of fund, inadequate staff, communication gap, etc. They are identified and tried to overcome **(Fig. 37.2)**.

Monitoring

This consists of day-to-day follow-up of the activities to ensure whether the activities are being carried out as per schedule or not. This helps to identify the deviations (like administrative problems) if any and to take corrective actions. The program can then be reoriented and implemented in a better way.

Evaluation

This means the assessment of the performance of the activities carried out in terms of the degree of achievement of the objectives and also in terms of cost-effectiveness.

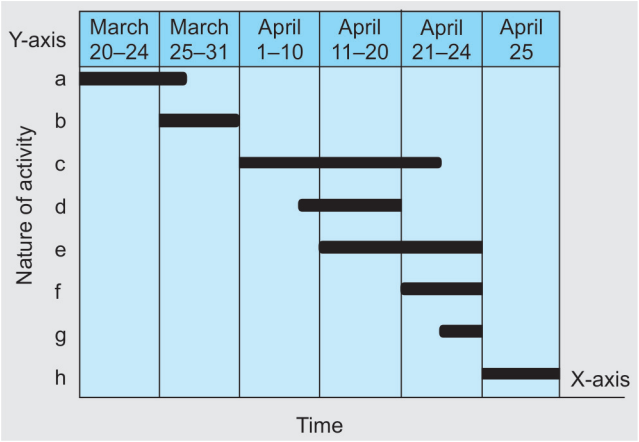


Fig. 37.1 Gantt chart

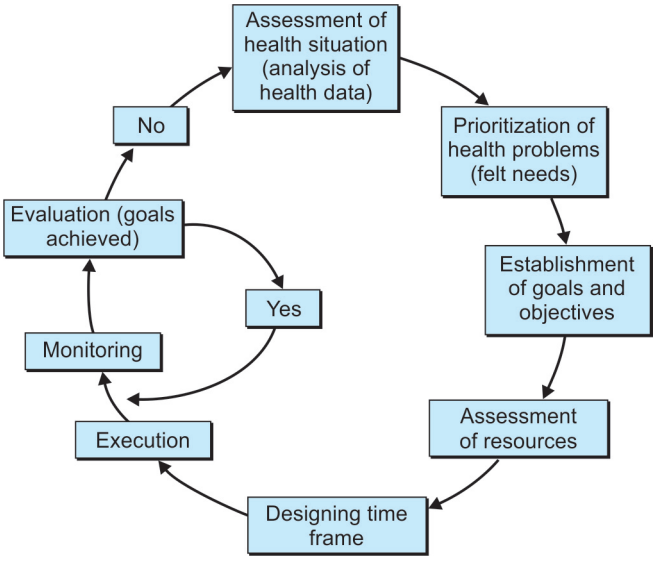


Fig. 37.2 Planning cycle

Operational Research

This consists of improving the methodology of the action plan to achieve better results by replanning.

MANAGEMENT (NETWORK ANALYSIS)

It is a process of carrying out the project work of the health care service, involving all the resources to achieve the defined objectives, efficiently and economically by a network analysis, i.e. by preparing a schedule diagrammatically, in a logical

sequence from the commencement to the completion of the work representing the different components of the project work and the period required for each of the components. This helps in identifying the critical points in the chain of activities so that the monitoring of the activities can be done and also the total duration required for the completion of the work can also be done. Thus, network analysis is a quantitative technique in health management, as in organization of ICDS – project, Pulse Polio Immunization Program, Health Training Programs, etc.

Objectives

- To minimize the total project time
- To minimize the total cost of the project
- To minimize the conflicts, delays and interruptions
- To utilize the resources optimally.

Methods

There are two methods of network analysis namely Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM).

Program Evaluation and Review Technique

This method is adopted when a project work consists of a large number of processes which should be brought together into an integrated plan. This involves the numbering of series of process (events) in a serial order and the time required for completion of each event. This helps to prepare a schedule to identify the crucial problems and also to know the total duration required for the completion of the work, as shown below.

Sl. No.	Activity of the project work	Duration (in weeks)
1.	Preparation of the plan	1
2.	Approval of the plan	2
3.	Preparation of the list of beneficiaries	4
4.	Arrangement of human resources	6
5.	Training of the manpower	3
6.	Education of the community	2
7.	Indent for the equipment	1
8.	Transport arrangement	2
9.	Starting the service	1

Critical Path Method

In this method of network analysis, the schedule is prepared in the form of a flow diagram, in which the events are shown as circles, the duration of activity as lines and the direction as arrows. Length of the arrow has no significance.

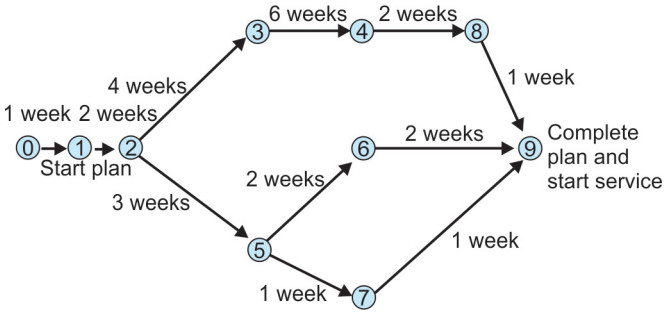


Fig. 37.3 Flow diagram of critical path

Fulkerson's rule should be followed. According to this rule, the number of events should be in the order of happening. Each activity will have a preceding and a succeeding event. Head event (succeeding event) should be numbered to higher number than the tail event. There should be one starting point and one end point **(Fig. 37.3)**.

It is to be noted that some activities are dependent and some are independent. For example, preparing a blue print of a building plan is a must before construction is taken up. Earthwork and foundation work is a must before other works are done. It is called dependent or sequential activities, which need to be completed before next activity is taken up. The independent activities such as electrical, sanitary and wooden works, etc., can be taken simultaneously parallely. These independent activities are also called parallel activities (e.g. serial number 3 and 5; 6 and 7). However, completion of all paths is necessary to achieve the completion of the project work.

Critical path is the longest time required for the completion of the project. In the above diagram, the path 1, 2, 3, 4, 8 and 9 requiring 16 weeks is the critical path. All other paths other than critical path are called noncritical path. These are respectively 1, 2, 5, 6 and 9 requiring 10 weeks and 1, 2, 5, 7 and 9 requiring 8 weeks. Critical path is given top priority and scrutinized till the end during execution of the project. If any activity is delayed in critical path, the whole activity of the project work gets delayed.

Differences between PERT and CPM

	Program evaluation and review technique (PERT)	Critical path method (CPM)
1.	Design is based on event	Design is based on activity
2.	Time requirement is estimated	Time requirement is taken from previous experience
3.	Main objective is to take shortest time	There is mixture of time and cost
4.	Activity time is not subjective	Activity time is subjective
5.	Slack time* cannot be identified	Slack time can be identified

*Slack time is the difference between the minimum time required and the maximum time taken up for the activity.

COST BENEFIT ANALYSIS

This was the first thought by Jules Dupuit, a French Engineer during 1848. In health field, CV Jetanovic Grab and Umera used this analysis to compare benefits of sanitary measures and vaccination in control of typhoid.

Cost benefit analysis is defined as, "A formal discipline used to weigh the total expected costs against the total expected benefits of one or more actions in order to choose the best or most profitable option".

Cost benefit analysis quantifies the positive factors (benefits) and the negative factors (costs). The difference between the two factors indicates whether the planned action is advisable or not. Action having benefit/cost ratio >1 is selected.

Principles

1. There must be a common unit of measurement, e.g. money.
2. The valuations of the policy makers should represent the valuations of the beneficiaries.
3. The analysis of the project should involve 'With action versus Without action' comparison.
4. Double counting of benefits or costs must be avoided.
5. Long-term benefits should be considered.

Example: Is it cost benefit to keep a conventional refrigerator to maintain cold-chain in subcenter?

Costs

Cost of refrigerator = minus ₹ 50 per week.
Cost of electric power = minus ₹ 10 per week.

Benefits

Traveling charge for female Health worker from sub-center to PHC	Plus ₹ 30 per week
Absence of her work in sub-center due to travel	Plus ₹ 40 per week
Benefit	₹ 10 per week

Therefore, the benefit is ₹ 520 per year, per subcenter. So, it is a cost benefit action to keep a refrigerator in sub-center rather than FHW coming to PHC to collect vaccine every time.

Lead time: It is the time between starting of activity (utilization of resources) to starting of benefits.

Opportunity cost: It is the loss to the community because of inadequate or failure to use the available resources.

Merits

- It helps in budgeting in health system.
- It helps in long-term investment planning.

Demerits

- Since it is often difficult to express all the benefits in terms of monetary units, decision maker's bias can happen.
- Decision maker may miss the indirect benefits/costs.
- The lead time may be often long.

COST-EFFECTIVE ANALYSIS

It is an analysis in which the cost of the program is compared with the outcome (effectiveness), not in terms of monetary units but in terms of reduction of morbidity, mortality, etc. This is compared with other alternatives to identify the most efficient one.

Example:

- Hospital treatment of TB patients V/s DOTS (DOTS is cost-effective).
- Provision of safe water supply V/s treatment of water borne diseases (Purification of water is cost-effective).

Merits

- It helps in evaluating the activities of the health program.
- It helps in identifying the weak points in implementing the program.

Demerits

- It is often difficult to measure all benefits in terms of effectiveness.
- The identification of benefits may be subjective (e.g. time of a patient).

MANAGER

A manager in health care services is the one, who manages the activities of an organization efficiently in various capacities, as a captain and achieves the objectives.

Management of activities as:

1. *Planner:* Manager will plan the health care project work in such a way as to achieve the objectives.
2. *Promoter:* He promotes the concerned persons of the health team in carrying out their activities efficiently.

3. *Organizer:* He organizes the work with good resources such as manpower, money and materials like equipment, transport supplies, etc.
4. *Director:* He directs the entire team members properly by describing their nature of work and places the right person for the right job to work efficiently.
5. *Coordinator:* He coordinates all the members, as to carryout the activities smoothly without any hurdles.
6. *Controller:* He controls the entire health team through proper direction.
7. *Monitor:* He prepares the budget, monitors the activities and the investment and will assess the financial performance.
8. *Evaluator:* He will evaluate the activities periodically by going through the records and reports.
9. *Innovator:* He comes out with new ideas for efficient functioning of the organization.

A good example for a manger is the Medical Officer of Primary Health Center.

BIBLIOGRAPHY

1. Gupta MC, Mahajan BK. Textbook of Preventive and Social Medicine, 3rd edn, 2003.
2. Park K. Park's Textbook of Preventive and Social Medicine, 18th edn, 2005.
3. WHO Application of Modern Management Methods and Techniques for the improved delivery of Health Services. SEA/PHA/120; New Delhi 1973.
4. WHO Tech Rep Ser No 350, 1967.

CHAPTER 38

National Health Planning

Health planning is an integral part of country's development. The guidelines for national health planning were provided periodically by the expert committees, appointed by the Planning Commission, Government of India.

The Planning Commission was set up by Government of India during the year 1950, which was entrusted with the responsibility of giving the guidelines for the country's socioeconomic development. The Commission comprises of a chairman, a deputy chairman and several members, assisted by several technical divisions, program advisors and general secretariat. Since 1950, many five year plans have been produced.

The objectives of these plans are:

- Eradication of poverty by increasing the National income of the country.
- Eradication of unemployment through creation of new job opportunities.
- Provision of basic amenities like education, housing, family planning, public health, water supply, sanitation, etc.

The reports of some of the important expert health committees are briefed as follows:

BHORE COMMITTEE REPORT, 1946

Government of India, during the preindependence era, in 1943, constituted a 'Health Survey and Development Committee' under the chairmanship of Sir Joseph Bhore to survey the then existing health situation and health care system in the country and to give recommendations for further development. The committee submitted its report during 1946, popularly known as 'Bhore Committee Report.'

The committee mooted the idea of introducing primary health centers as focal points for providing a package of comprehensive health care, comprising preventive, promotive and curative services.

The committee proposed short-term and long-term measures for meeting the health care needs of the people. As a short-term measure the committee recommended one Primary Health Center catering a population of 40,000, supported by infrastructure of three subcenters. Each PHC should have a health team comprising 2 medical officers, 4 public health nurses, 1 nurse, 4 midwives, 1 clerk, 1 pharmacist, 2 health assistants, 2 sanitary inspectors, 15 class IV employees.

As a long-term measure, the committee recommended 1 PHC with 75 beds, catering 10,000-20,000 population and also creation of secondary level hospitals with 650 beds and tertiary level hospitals (District hospitals) with 2500 beds, for provision of specialized services.

The committee also recommended three months training in preventive and Social Medicine during medical education to prepare Social Physicians.

Thus, Bhore Committee provided guidelines for national health planning in India.

MUDALIAR COMMITTEE REPORT, 1962

After Independence, Government of India constituted 'Health Survey and Planning Committee', under the chairmanship of Sir AL Mudaliar, in the year 1959, popularly known as Mudaliar Committee, to evaluate the measures undertaken by Bhore Committee and to give recommendations for future

development in the country and also to review the first and second five-year health plan projects.

The Committee submitted the report in 1961, in which it expressed dissatisfaction over the quality of health care provided by Primary Health Centers and advised strengthening of existing PHCs before opening new PHCs. It also advised strengthening of taluka and District. Hospitals, so that they can function effectively as referral centers. It also advised improvement in the quality of health care provided by PHCs. Thus, the recommendations of Mudaliar Committee formed the basis for establishing PHCs in the 3rd and the 4th Five Year Plan periods.

CHADAH COMMITTEE REPORT, 1963

Another Expert Committee was appointed by the Government of India, under the Chairmanship of Dr MS Chadah, who was the Director General of Health Services (DGHS).

The Committee recommended that 'Surveillance' activities under National Malaria Eradication Program should be carried out by the Health Workers of PHCs at the rate of 1 per 10,000 population. They must also carry out the additional duties such as collection of vital statistics and family planning and that they must be supervised by Health Assistants. Since the health workers carryout additional duties, they must be called as 'multipurpose' workers.

MUKERJI COMMITTEE REPORT, 1965

Very soon it was realized that the basic health workers could not function effectively as multipurpose workers. Neither malaria surveillance activities nor family planning activities were carried out effectively. So, a committee was appointed under the chairmanship of Sri Mukerji, the then secretary of Health to the Government of India, to review the strategy for the Family Planning Program. The committee recommended separate staff as Family Planning Assistants to carryout family planning duties only, so that the health workers can carry out malaria surveillance activities effectively. The recommendations were accepted by Government of India.

MUKERJI COMMITTEE REPORT, 1966

In the next year, the same committee recommended creation of a network of Rural Family Planning Centers (RFPC) attached to each PHC to integrate the maternal and Health Services and Family Planning. It also recommended the establishment of Urban Family Planning Centers for 50,000 population in the urban areas, along with necessary staff.

JUNGALWALA COMMITTEE REPORT, 1967

This committee was appointed by the Government of India, under the Chairmanship of Dr Jungalwala, the then Director of National Institute of Health Administration and Education, to integrate the health services. So, this committee is also known as 'Committee on Integration of Health Services'.

The committee examined the service conditions of various cadres in health services and made various recommendations for the integration of health services. They were unified cader, common seniority, recognition of extra qualifications, equal pay for equal work, special pay for special work, elimination of private practice by Government doctors and provision of good conditions.

KARTAR SINGH COMMITTEE REPORT, 1973

This committee was appointed under the Chairmanship of Kartar Singh, who was the then Additional Secretary to the Ministry of Health and Family Planning, Government of India, in 1972.

The objectives are:

- To suggest structure for integrated services at peripheral and supervisory levels.
- To assess the feasibility of having multipurpose workers in the field.
- To recommend the training requirements for the personnels.

The committee observed that in PHCs, there were different caders of health workers under different National Programs as vaccinators (NSEP), surveillance workers (NMEP), Basic Health Worker for (NFPCP), Health education assistants (N Trachoma CP), Leprosy workers (NLCP), etc. Each worker covering a population of 10 to 20 thousand. It is not feasible in India for one worker to cater this population size in rural areas.

The committee submitted the report in 1973. The recommendations are:

- Replacement of the term Auxillary Nurse Midwife (ANM) by Female Multipurpose Workers (MPW-F).
- The nomenclature of BHW, MSW, vaccinators, etc. to be merged into one cader, i.e. Health worker-male and female (BHW = Basic Health Worker; MSW = Medico Social Worker).
- The supervisors of male and female Health workers to be designated as Male and Female Health Assistants.
- There should be one Primary Health Center for a population of 50,000 including 16 subcenters.

- Each subcenter to be staffed by one male and one female health worker, catering to the population of 3000 to 3500.
- There should be one male supervisor for every four male health workers and one female supervisor for every four female health workers.
- The Medical Officer of PHC will be in overall charge of all the health workers and supervisors.

These recommendations were accepted by Government of India to be implemented in a phased manner during Fifth Five Year Plan.

SRIVASTAV COMMITTEE REPORT

During 1974, the Government of India set up a committee on 'Medical Education and Support Manpower', under the chairmanship of Dr JB Srivastav, Director General of Health Services to study the medical education and health care delivery system in India and to formulate recommendations to devise a suitable curriculum for medical education and health care delivery system. The committee submitted the report in 1975 April.

The committee recommended creation of paraprofessional health workers from within the community itself (like teachers, postmasters, gram sevaks, etc.) to provide simple preventive, promotive and curative services to the community. (This recommendation resulted in the introduction of Rural Health Scheme/community health workers scheme on October 2, 1977).

The committee also recommended establishment of two caders, namely multipurpose health workers and health assistants between community health workers and medical officers at PHC.

The committee also recommended the establishment of Medical and Health Education Commission for implementing the reforms on the lines of University Grants Commission.

During 1977-78, steps were undertaken to involve medical colleges in providing total health care of the selected PHCs and also Reorientation of Medical Education (ROME) to the medical students and health workers.

NATIONAL DEVELOPMENTAL PLANS

The Government of India set up a Planning Commission, consisting of a Chairman, a Deputy Chairman and 5 members, in 1950, to assess the resources of the country (manpower, material and money/capital) and to draft plans for the socioeconomic development of the country. Since health development constitutes an integral part of socioeconomic development of the country, National developmental plans were formulated by the Planning Commission on Five Year basis including health development plans, formulating Five Year Plans.

The main objectives of the health programs during the Five Year Plans are:

- Control or eradication of communicable diseases
- Stabilization of population
- Strengthening of the basic health services
- Development of health manpower resources.

The main achievement in health sector in the Five Year Plans are as follows:

First Five-Year-Plan (1951-1956)

- PHCs were established as per the recommendations of Bhore Committee
- The Central Council of Health was constituted (1952)
- The following National Health Programs were launched
  - National Malaria Control Program (1953)
  - National Family Planning Program (1953)
  - National Leprosy Control Program (1954)
  - National Water Supply and Sanitation Program (1954)
  - National Filaria Control Program (1955)
- Prevention of Food Adulteration Act was passed in 1954 by Parliament
- Contributory Health Service Scheme was introduced in 1954.

Second Five-Year-Plan (1956-1961)

- The National Health Programs implemented during the first plan were continued.
- The NMCP was switched over to National Malaria Eradication Program.
- The following institutions were established
  - Central Health Education Bureau (1956)
  - Indian Medical Council (1956)
  - National Tuberculosis Institute, Bangalore (1959).

Third Five-Year-Plan (1961-1966)

- Following National Health Programs were launched
  - National Smallpox Eradication Program (1962)
  - National Goitre Control Program (1962)
  - National/District Tuberculosis Control Program (1962)
  - School Health Program (1962)
  - National Trachoma Control Program (1963)
  - Applied Nutrition Program (1963)
- Following Institutions were established.
  - Central Bureau of Health Intelligence (1961)
  - Central Family Planning Institute (1962)
  - National Institute of Communicable Diseases (1963)
  - National Institute of Health Administration and Education (1964).

Fourth Five-Year-Plan (1969-1974)

- Chittaranjan Mobile Hospitals were started (1970)
- National All India Hospital Postpartum Program was launched (1970)
- Medical Termination of Pregnancy Act (MTP-Act) was passed (1971)
- Multipurpose Health Worker Scheme (1973)
- National Program of Minimum Needs (1973) were launched.

Fifth Five-Year-Plan (1974-1979)

- The program launched in the previous plan were stressed.
- The following activities were introduced.
  - Rural Health Scheme (1977)
  - Integrated Child Development Services Scheme (1975)
  - Community Health Worker Scheme (1977)
  - NMEP strategy was replaced by Modified Plan of Operation of Malaria Control (1977)
  - 20-points program (1975)
  - National Program for Prevention of Blindness (1976)
  - National Program for Control of Blindness (1976)
  - Population Policy (1976)
  - Reorientation of Medical Education (ROME) Scheme (1977)
  - Expanded Program of Immunization (1978)
  - Child Marriage Restraint Act (1978) was passed
  - Smallpox was eradicated (1977).

Sixth Five-Year-Plan (1980-1985)

- Government of India became signatory to the Declaration of Alma-Ata on Primary Health Care to achieve the Social target Health For All-by 2000 AD in 1981 and accordingly revised the Minimum Needs Program to reinforce the health care infrastructure.
- National Health Policy was approved (1983).
- International Drinking Water and Sanitation Decade was launched (1981)
- Leprosy Control Program was switched over to National Leprosy Eradication Program (1983)
- National Guineaworm Eradication Program was launched (1983).

Seventh Five-Year-Plan (1985-1990)

- Expanded Program of Immunization was converted into Universal Immunization Program (1985)
- Following health programs were launched
  - National Diabetes Control Program (1987)
  - National AIDS Control Program (1987)
  - New 20-point Program (1987)
  - National Acute Respiratory Infection Control Program (1990).

Eighth Five-Year-Plan (1992-1997)

- Child Survival and Safe Motherhood Program was launched (1992)
- CSSM-Program was later converted into Reproductive and Child Health (RCH) Program (1994)
- Rational Drug Policy was revised (1995)
- NTB Control Program was revised and called as Revised National Tuberculosis Control Program (RNTCP) (1997)
- Act was passed on Infant Feeding and Infant Foods (1992)
- Rights to persons with disabilities were conferred (1995).

Ninth Five-Year-Plan (1997-2002)

- Pulse Polio Immunization Program was intensified and called Intensive Pulse Polio Immunization Program (1999)
- Government of India announced National Population Policy 2000 National Health Policy 2002 and National AIDS Prevention and Control Policy 2002
- Guinea worm disease was eradicated
- Tenth Five-Year-Plan was launched (2003).

Tenth Five-Year-Plan (2002-2007)

During this period, efforts are directed to improve the health status of the people by improving the access to and enhance the quality of primary health care and to improve the efficiency of existing health care infrastructure at primary, secondary and tertiary care settings.

The targets for the Tenth Five-Year-Plan and beyond are as follows:

- Reduction of poverty ratio by 5 percent points by 2007 and by 15 percent points by 2012
- All children in school by 2003 and all children to complete 5 years of schooling by 2007
- Reduction in gender gaps in literacy and wage rates by at least 50 percent by 2007
- Reduction in the decadal rate of population growth between 2001 and 2011 to 16.2 percent
- Increase in literacy rate to 75 percent within the plan period
- Reduction of Infant Morbidity Rate to 45 per 1000 livebirths by 2007 and to 28 by 2012

- Reduction of Maternal Mortality Ratio to 2 per 1000 livebirths by 2007 and to 1 by 2012
- All villages to have potable drinking water within this plan period.

Achievements during the past 55 years of planned period.

	First plan (1951-1956)	Tenth plan (2002-2007)
1. Primary health centers	725	2,29,367
2. Subcenters	–	1,38,368
3. Community health centers	–	3,076
4. Total hospital beds	1,25,000	9,08,168 (2001)
5. Medical colleges	42	222
6. Annual admissions in medical colleges	3,500	19,000
7. Dental colleges	7	142
8. Allopathic doctors	65,000	5,75,000 (2001)
9. Nurses	18,500	8,39,862
10. ANMs	12,780	5,02,503
11. Health visitors	578	40,536
12. Health worker (Female)	–	1,37,407 (2001)
13. Health worker (Male)	–	71,053
14. Village Health Guides	–	3,23,000 (2002)

ORGANIZATION OF INDIAN HEALTH ADMINISTRATION

Health administration consists of four levels, descending from the centers to the periphery – as Central level, State level, District level and Village level.

Central Level

There are three 'organs' of health system at the Central level:
1. Union Ministry of Health and Family Welfare
2. Directorate General of Health Services
3. Central Council of Health and Family Welfare.

Union Ministry of Health and Family Welfare

This comprises of three departments – namely Department of Health, Department of Family Welfare and Department of 'AYUSH'. 'AYUSH' is a multi-disciplinary department including *Ayurveda*, *Yoga*-naturopathy, *Unani*, *Siddha* and Homeopathy.

There are three heads—political, executive and technical.

Political head: The Minister of Health is the political head of the health administration. This Cabinet Minister is assisted by a Minister of State and a Deputy Health Minister. Thus, all the three are political appointed.

Executive head: These are the Secretaries to the Government of India, one each to the Department of Health and to the Department of Family Welfare, assisted by Joint secretaries, Deputy secretaries and a large administrative staff.

Technical head: This is the Director General of Health Services (DGHS). He is assisted by Additional DGHS, a team of deputies, a Drug controller and a large team of administrative staff.

Functions of union ministry of health: These are formalized under Union list and Concurrent list.

Union list: The functions in this list are:
- International health regulations
- Administration of higher, central research institutes
- Census and publication of statistical data
- Immigration and emigration
- Regulation of manufacture and sale of drugs and biologicals
- Regulation of labor and safety in mines and oil fields
- Regulation of professional bodies
- Co-ordination with other States and other ministries.

Concurrent list: This consists of joint responsibilities between the Center and the State Governments. This includes the following functions:
- Prevention of inter-state extension of communicable diseases
- Prevention of food adulteration
- Control of drugs and poisons
- Vital statistics and registration
- Social security and social insurance (Labor welfare)
- Economic and Social Planning
- Ports other than major
- Family planning and population control.

Directorate General of Health Services

The Director General of Health Services is the technical head, assisted by a team of members.

The functions of this 'Organ' are:
- Appraisal of all health matters in the country
- International health regulations : All international airports and seaports are under direct control
- Control of drug standards, under the Drugs Act 1940
- Maintenance of Medical Store depots
- Administration of all National Institutes
- Administration of Medical Colleges – Lady Hardinge, Maulana Azad and Medical Colleges at Puducherry and Goa

- Encourages Medical Research through Indian Council of Medical Research (ICMR)
- Implementation Central Government Health Scheme
- Implementation of all National Health Programs
- Running Central Health Education Bureau, which carries out all health education activities
- Running Central Bureau of Health Intelligence, which publishes information on health statistics
- Runs National Medical Library – which is the biggest medical library in Asia. It offers reference services to other libraries in the country through satellite link-ups.

Central Council of Health and Family Welfare (CCHFW)

This 'Organ' was set up on August 9, 1952, to help promote a working relationship between the Center and the States in implementation of all health programs and provide a forum for co-operation. CCHFW is composed of Union Health Minister as Chairman, Health Ministers of all States and Union territories as members. It meets once a year and decides what needs to be done in the areas of Family planning, health, medical education and research.

The functions of the council are:

- Promoting co-operation and co-ordination between the health organizations at the central and state levels
- Formulating broad policy and program outlines for the provision of medical relief and health care and also for training of health personnel
- Proposing suitable legislations in public health matters
- Recommending a framework for appropriate distribution of grants-in-aid to states for health purposes
- Reviews the health work done in the past one year.

State Level

The political head of health administration at the state level is the Minister of Health and Family Welfare.

The executive head is the Secretary, Department of Health and Family Welfare, assisted by Joint Secretary, Deputy Secretaries and administrative staff.

The technical heads are the Director of Health and Family Welfare Services and the Director of Medical Education and Research, assisted by Deputy Director, Additional Director and administrative staff.

Functions

- Patient care through a network of hospitals, dispensaries, community health centers, taluka hospitals and primary health centers
- Family welfare and population control
- Implementation of health programs
- Health planning, policy formulation and budgeting in the state
- Running of medical, dental, nursing and pharmacy colleges in the state to develop health manpower
- Improving Information, Education and Communication activities
- Laboratory services support
- *Provincial stores:* Logistics and supplies
- Food standards and prevention of food adulteration
- Health administration of minor ports
- Medical and allied research.

District Level

The District Health and Family Welfare Officer (DHO) is the technical head and is responsible for providing health services in the entire district. DHO is assisted by an Additional DHO, RCH officer, Education Officer and administrative staff.

The administration is different for urban and rural areas.

For Urban Areas

The health services are the responsibility of the Mayor (political head) for the corporations (with population above 2 lakhs), the Municipal Commissioner (executive head) for the cities with municipal boards (for population from 10,000 to 2 lakhs) and the Municipal Health Officer is the technical head.

The Municipal Health Officer is assisted by Registrar of Births and Deaths, sanitary inspectors and administrative staff. The health services include treatment, registration of births and deaths, disposal of the dead, elimination of stray dogs, water supply, maintenance and control of eating establishments (like hotels, canteens, etc.), diaries, and slaughter houses, school health services and the control of epidemics.

For Rural Areas

The rural areas of the district have been organized into Blocks, known as Community Development Blocks, each Block is an unit of rural planning and development, comprising approximately about 100 villages, covering a population of about 1,00,000, each block in-charge of Block Development Officer.

Panchayati Raj

The Panchayati Raj is a three tier structure of rural, local, self-government in India, consisting of three institutions namely Gram Panchayat, the executive body at the village level, Panchayat Samiti, at the block level and Zilla Panchayat/ Parishad at the district levels.

The health organization at the district level includes:

- District Health and Family Welfare Officer (DHO) and his assistants
- District hospital and District stores
- Network of primary health centers, community health centers and subcenters.

The main functions of District Health Organization are:

- Primary health care
- Secondary/Referral health care
- Family welfare
- Implementation of National Programs
- Control of epidemics.

Village Level

Gram Sabha is the assembly of all adults of the village and elects members for Gram Panchayat, which is an executive body for planning and development of the village.

The health organization at the taluka level comprises of Taluka hospitals and Community Health Centers.

The health organization at the village level comprises of a network of primary health centers (consisting of Medical Officer and his team) and subcenters (consisting of Health Worker Male and Female).

At the 'grass-root' level, the health services are provided by nonmedical personnel such as Village Health Guide, *Anganwadi* worker and the trained Traditional Birth Attendant, i.e. primary health care workers.

RURAL DEVELOPMENT

Community Development Program

It is a process designed to improve the social and economic condition of the community uniting with those of governmental authorities. This program was launched on 2nd October 1952, as a program 'of the people, for the people and by the people', to exterminate the three ills of poverty, illiteracy and disease.

Under this program, the rural India has been organized into Community Development Blocks, each block comprising of 100 villages, covering a population of about 1 lakh (80,00–1,20,000 population), headed by Block Development Officer (BDO).

This program envisages improvement of agriculture, communication, education, health, housing, sanitation and rural industries.

During the first ten years, Government of India supported the program financially in three stages, each of five years. It provided ₹12 lakhs during the first stage and ₹5 lakhs during the second stage. Later, State Government took up the responsibility. Inspite of 6 decades of the functioning of the program, results are far from satisfactory.

Integrated Rural Development Program

Another program was launched as a supplementary to community development program in April 1978 to eliminate poverty and to improves the quality of life of rural people, called Integrated Rural Development Program (IRDP). Under this program, the beneficiaries are agricultural laborers, small cultivators, village artisans and craftsmen. They are provided with bank loans and subsidies by the government. This program is being implemented through District Rural Development Agency (DRDA).

Village Level Worker (Gram Sevak)

He is the key person to transform the economic and social life of the rural people. He is in charge of about ten villages and attends to about five to six thousand people. He lives very close to them, understands their 'felt-needs' and arouses interest in them for their village development, serving as a link between the community people and government agencies.

BIBLIOGRAPHY

1. Govt of India—A Reference Annual. Director Publication Divison, Ministry of Information and Broadcasting; New Delhi 1987.
2. Govt of India. Draft Fifth Five Year Plan 1974-79. Vol I & II. Planning Commission, New Delhi 1974.
3. Govt of India. Health Information of India 2000-01. Ministry of Health and Family Welfare; New Delhi 2003.
4. Govt of India. Report of Expert Committee. Ministry of Health and Family Welfare. New Delhi 1987.

CHAPTER 39

National Health Policy

National health policy (NHP) is a statement, enunciated by Government of India, as a 'blue-print' for further action, about the manner in which the tasks related to health and allied subjects, to be performed. It aims at the elimination of poverty, illiteracy, ill-health, ignorance and inequality.

India is one of the few countries in the world to have come out with a national policy on health. In view of the commitment made by the Government of India to achieve the global, social target HFA by 2000 AD, the expert committee (appointed by the Planning Commission) submitted the report in 1981, about assessing the health status of the country, in terms of various indicators, which became the basis of National Health Policy.

NHP was finalized by the Ministry of Health and Family Welfare in 1982, with the goal of HFA by 2000 AD and NHP was approved in August 1983. The main objective of the policy was to achieve HFA by 2000 AD, i.e. to achieve a level of health that will enable every individual to lead socially and economically a productive life, through the universal provision of comprehensive primary health care services.

NHP consists of 20 paras (strategies). Para no. 12 consists of the following problems requiring urgent action.

PRIORITY AREAS OF THE POLICY

- *Small family norm*: To be achieved by voluntary efforts and moving towards the goal of population stabilization. For this separate policy was enuntiated as National Population Policy (NPP).
- *Maternal and child health*: A vicious relationship exists between high birth rates and high infant mortality, contributing to the desire for more children. Therefore, highest priority is to be accorded to programs for the improvement of maternal and child health, with a special focus on the less privileged sections of the society. Efforts are directed to train the traditional birth attendants to ensure that all deliveries are conducted by trained persons.
- *Immunization program*: This is aimed at cent-percent coverage of targetted population with vaccine preventable diseases.
- *Improvement of nutritional status*: This is to ensure adequate nutrition for all segments of the population by directing the efforts at improving the purchasing power of the poorer sections of the society (through schemes like employment guarantee scheme), measures aimed at improving the eating habits, cooking practices, promotion of breastfeeding to infants and eradication of various taboos detrimental to health.
- *Water supply and sanitation*: The provision of safe drinking water and sanitary disposal of human and animal wastes, both in urban and rural areas, must constitute an integrated package. This should be accompanied by intensive health education for the improvement of personal hygiene and community health at large.
- *Environmental protection*: This is to ensure against the haphazard exploitation of resources causing ecological disturbances leading to health hazards. So policies must be established for industrial development and urbanization programs. Environmental appraisal procedures must be developed and strictly applied in according clearance to the various industrial and developmental projects.
- *School health program*: Organized school health services to be established.

- *Occupational health service*: There is an urgent need for launching well considered schemes to prevent and treat diseases and injuries arising from occupational hazards, not only in the various industries but also from agricultural fields.
- *Prevention of food adulteration and maintenance of quality of drugs*: Effective legislation to be enacted to check and prevent adulteration and contamination of foods at various stages of their production, processing, storage, transport, distribution, etc. Similarly measures should be taken to ensure against the manufacture and sale of spurious and sub-standard drugs.

Other Strategies of NHP, 1983

- Prohibition of private practice by Government Doctors, in a phased manner.
- Exploitation of the services of the practitioners of AYUSH system of medicine such as Ayurveda, Yoga (Naturopathy), Unani, Siddha and Tibbi and Homeopathy.
- Inculcation of healthful living habits by the people by nation-wide health education programs.
- Inclusion of nutrition promotion and population control techniques in school curricula.
- Universal adult literacy education.
- Nationwide health information system for timely warning of emergencies, planning of health strategies and determining the manpower requirements.
- Promotion of herbal gardening and health industry to increase the production of drugs, biomedicals, vaccines and essential medical equipment.
- Initiation of statewise health insurance schemes for raising additional funds for health.
- Promotion of basic and applied research.
- Establishment of intersectoral coordination.
- Training of all categories of medical personnel.

Targets

The targets set under NHP-1983 are the same health status indicators, set under HFA by 2000 AD.

NATIONAL HEALTH POLICY, 2002

Because of certain comments and criticism, the policy was revised by Ministry of Health and Family Welfare, in the year 2002 as 'New National Health Policy–2002.'

Relevance

NHP 1983, was perceived to achieve HFA by 2000 AD through universal provision of primary health care services, not visualizing enormous resources necessitated to achieve the goal.

Contrastingly NHP 2002 is projected as a realistic document based on a conceptional and operational framework that is consistent with the socioeconomic realities prevailing in India.

Objectives

Objective is to achieve an acceptable standard of good health among the people of the country, by increasing the access to the health services by decentralizing the public health system by establishing the new health infrastructures, by emphasizing primary level of health care, by promoting rational use of drugs, by increasing primary health investment and by enhancing private-sector participation.

Goals

Goals of NHP–2002, to be achieved by 2005-2015 are:

- Eradication of poliomyelitis and yaws – 2005
- Elimination of leprosy – 2005
- Elimination of kala-azar – 2010
- Elimination of lymphatic filariasis – 2015
- Achieve zero level growth of HIV/AIDS – 2007
- Reduce mortality by 50 percent on account of TB, malaria and other water-borne and vector-borne diseases by – 2010
- Reduce prevalence of blindness to, 0.5 percent – 2010
- Reduce IMR to 30/1000 LB and MMR to 1/1000 LB (i.e. 100/Lakh LB) – 2010
- Increase utilization of public health facilities from current level of < 20 to > 75 percent – 2010
- Establish an integrated system of surveillance, health statistics and health accounting by – 2005

MILLENNIUM DEVELOPMENT GOALS

During September 2000, representative members of 189 countries met in New York. It was Millennium Summit. The summit was to achieve the following goals (Millennium Development Goals–MDG) by 2015:

- To eradicate poverty and hunger
- To achieve universal primary education
- To promote gender equality and empower women
- To reduce child mortality (IMR to 27 and U5MR to 32)
- To improve maternal health
- To combat HIV/AIDS, malaria and other communicable diseases

- To ensure environmental sustainability with an access to safe drinking water
- To develop a global partnership for development.

India committed in September 2000 to this vision MDGs that has human development at its core to sustain social and economic progress. Eight goals, eighteen targets and forty eight indicators **(Table 39.1)** have been accepted as framework for measuring development progress.

The goals to be achieved not later than 2015. Meeting targets related to income, poverty and education will not be possible until there is improvement in health of the communities.

The areas of focus to improve the health are the communicable diseases, noncommunicable diseases, nutrition and maternal and child health.

NATIONAL HOUSING POLICY

This was adopted by the Parliament in August 1992. The objective is to reduce the number of families without houses. The strategies are:

- Provision of developed land and finances to enable them to construct houses

Table 39.1 Millennium development goals (MDGs)—targets and indicators

MDG	Goals and targets		Indicators
Goal 1	*Eradicate extreme poverty and hunger*	1.	Proportion of population below $1 a day
Target 1	Have, between 1990 and 2015, the proportion of people whose income is less than $1 a day	2.	Poverty gap ratio (incidence × depth of poverty)
		3.	Share of poorest quintile in national consumption
Target 2	Have, between 1990 and 2015, the proportion of people who suffer from hunger	4.	Prevalence of underweight children (under 5 years of age)
		5.	Proportion of population below minimum level of dietary energy consumption
Goal 2	*Achieve universal primary education*	6.	Net enrolment ratio in primary education
Target 3	Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	7.	Proportion of pupils starting grade 1 who reach grade 5
		8.	Literacy rate of 15 to 24 years old
Goal 3	*Promote gender equality and empower women*	9.	Ratio of girls to boys in primary, secondary and tertiary education
Target 4	Eliminate gender disparity in primary and secondary education preferably by 2005 and in all levels of education no later than 2015.	10.	Ratio of literate females to males among 15 to 24 years old
		11.	Share of women in wage employment in the non-agricultural sector
		12.	Proportion of seats held by women in national parliament
Goal 4	*Reduce child mortality*	13.	Under-five mortality rate
Target 5	Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	14.	Infant mortality rate
		15.	Proportion of one-year-old children immunized against measles
Goal 5	*Improve maternal health*	16.	Maternal mortality ratio
Target 6	Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	17.	Proportion of births attended by skilled health personnel
Goal 6	*Combat HIV/AIDS, malaria and other diseases*	18.	HIV prevalence among 15 to 24 years old pregnant women
Target 7	Have halted by 2015 and begun to reverse the spread of HIV/AIDS	19.	Condom use rate of the contraceptive prevalence rate
		20.	Ratio of school attendance of orphans to school attendance of non-orphans aged 10-14
Target 8	Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	21.	Prevalence and death rates associated with malaria
		22.	Proportion of population in malaria-risk areas using effective malaria prevention and treatment measures
		23.	Prevalence and death rates associated with tuberculosis
		24.	Proportion of tuberculosis cases detected and cured under directly observed treatment short course (DOTS)

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MDG	Goals and targets		Indicators
Goal 7	*Ensure environmental susceptibility*	25.	Proportion of land area covered by forest
Target 9	Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources	26.	Ratio of area protected to maintain biological diversity to surface area
		27.	Energy use per unit of GDP
		28.	Carbon dioxide emissions (per capita) and consumption of ozone-depleting chlorofluorocarbons
Target 10	Have, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	29.	Proportion of population using solid fuels (proposed as an additional MDG indicator: not yet adopted)
		30.	Proportion of population with sustainable access to an improved water source, urban and rural
		31.	Proportion of population with access to improved sanitation
Target 11	Have achieved, by 2020, a significant improvement in the lives of at least 100 million slum dwellers	32.	Proportion of households with access to secure tenure
Goal 8	*Develop a global partnership for development*		Some of the indicators listed below will be monitored separately for the
Target 12	Develop further an open, rule-based, predictable, non-discriminatory trading and financial system (includes a commitment to good governance, development, and poverty reduction—both nationality and internationality)		*Official development assistance*
		33.	Net ODA total and to least developed countries, as a percentage of OECD/DAC donors' gross income
		34.	Proportion of bilateral, sector-allocable ODA of OECD/DAC donors for basic social services (basic education, primary health care, nutrition, safe water, and sanitation)
		35.	Proportion of bilateral ODA of OECD/DAC donors that is untied
		36.	ODA received in landlocked countries as proportion of their GNI
		37.	ODA received in small island developing states as proportion of their GNI
Target 13	Address the special needs of the least developed countries (includes tariff and quota free access for exports, enhanced program of debt relief for HIPC and cancellation of official bilateral, debt, and more generous ODA for countries committed to poverty reduction)		*Market access*
		38.	Proportion of total developed country imports (excluding arms) from developing countries and least developed countries admitted free of duties
		39.	Average tariffs imposed by developed countries on agricultural products and clothing from developing countries
Target 14	Address the special needs of landlocked countries Program of Action for the Sustainable Development of Small Island Developing States and 22nd General Assembly provisions)	40.	Agricultural support estimate for OECD countries as a percentage and small island developing states (through the of their GDP)
		41.	Proportion of ODA provided to help build trade capacity
Target 15	Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term		*Debt sustainability*
		42.	Total number of countries that have reached their HIPC decision points and completion points (cumulative)
		43.	Debt relief committed under HIPC initiative, US$
		44.	Debt service as a percentage of exports of goods and services
Target 16	In co-operation with developing countries, develop and implement strategies for decent and productive work for youth	45.	Unemployment rate of 15 to 24 years old, male and female and total
		46.	Proportion of population with access to affordable, essential drugs on a sustainable basis
Target 17	In co-operation with pharmaceutical companies, provide access to affordable, essential drugs in developing countries	47.	Telephone lines and cellular subscribers per 100 population
		48.	(a) Personal computers in use and (b) Internet users, each per 100 population
Target 18	In co-operation with the private sector, make available the benefits of new technologies, especially information and communications.		

- Promotion of using the energy saving building materials and cost-effective technologies
- Upgradation of all unserviceable houses
- Provision of minimum basic services (like water supply, drains, sanitary latrines, smokeless *chulhas*, etc.) to the houses that do not have them.

NATIONAL NUTRITION POLICY

National Nutrition Policy (NNP) was adopted by the Government of India during 1993, because of rampant malnutrition in the country, resulting not only increased mortality among vulnerable groups of population but also reducing the working capacity and productivity of the adults affecting the socioeconomic development of the country.

The NNP laid emphasis on provision of basic nutritional services to the population in general and to the vulnerable sections in particular.

Strategies

There are two strategies—direct (Short term) and indirect (Long term).

Direct (Short-term) Strategies

- Expansion of ICDS network all over the country to cover uncovered blocks.
- Extension of supplementary nutrition for the expectant mothers from first trimester to 1 year after birth.
- Bring adolescent girls under the ambit of ICDS and give them iron and folic acid tablets, provide them training in home based skills and education on nutrition.
- Extend and intensify vitamin A prophylaxis, fortification of salt with iron and folic acid and sale of iodized salt.

Indirect (Long-term) Strategies

- *Food production and availability:*
  - Increase the food production, so as to ensure a per capita availability of 215 kg/year by 2000 AD.
  - Enforce land ceiling laws and carry out tenurial reforms.
  - Strict implementation of Prevention of Food Adulteration Act.
  - Provision of special rations to the landless laborers during the lean season.
- *Income generation and transfer:*
  - Increase the employment opportunities for women and grant them wages equal to those given to men.
  - Periodically revise the Minimum Wages Act and strictly enforce it.
- *Behavior change through communication and education:*
  - Incorporate basic knowledge about health and nutrition in school curricula.
  - Intensify IEC activities.
- Motivation of the people to utilize services like family welfare, immunization and antenatal and postnatal care.
- Monitoring of the nutrition programs by periodical assessment of nutritional status of the children, adolescents, pregnant and nursing women.
- Carrying out research activities on food and nutrition (such as food supply, consumption habits, etc.).

Administration

NNP to be implemented by the Department of Women and Child Development under the Ministry of Human Resources and Development, working in co-ordination with other health related departments.

At the Center, is the National Nutrition Council (NNC) with Prime Minister as the President. Members include Union Ministers, few State Ministers, representatives of NGOs and Female Health Workers. NNC makes policies.

At the State level, is the State Nutrition Council under the chairmanship of Chief Minister.

NATIONAL POPULATION POLICY–2000: AN OVERVIEW

In 1952, India became the first country in the world to launch National Family Planning Program, with a view to stabilize the population. The decline in the mortality rates after 1952, was not matched with the decline in the fertility rates.

In 1976, India formed its first-National Population Policy (NPP). It called for an increase in the legal minimum age of marriage from 15 to 18 for females and from 18 to 21 for males. However, the policy was modified in 1977 and reiterated the importance of small family norm without compulsion and changed the program title to 'National Family Welfare Program.'

In 1983, National Health Policy was evolved by Government of India to attain the social target HFA-by 2000 AD with a long-term demographic goal of achieving Net Reproduction Rate of 1 by the year 2000 (which is not achieved) and also emphasized the need for a separate population policy in the year 1991.

In 1993, an Expert Committee was constituted under the chairmanship of MS Swaminathan to prepare National Population Policy.

In 1994, the NPP was submitted, but it was not approved due to political reasons.

Prenatal Diagnostic Techniques (Regulation and Prevention of Misuse) Act 1994: In order to prevent to misuse

of modern prenatal diagnostic techniques particularly for selective abortion of female fetuses, this Act was passed by Parliament in 1994. The Act seeks to permit prenatal diagnostic techniques on a woman only in certain specified circumstances and in registered institutions. Penalties have been prescribed for violation of the law. The Act has come into force w.e.f. January 1996.

In 1995, Government of India adopted a report, 'India's Family Welfare Program: Towards a Reproductive and Child Health Approach. The outcome of this was the scrapping of all targets for contraceptives and sterilizations, which were laid down in National Family Welfare Program.

In 1997, the National RCH Program was launched. It was client based, target free approach. There was decentralization of family welfare services making accessible to all and the involvement of NGOs.

In 1998, another draft on NPP was formulated.

In 1998, this revised NPP was placed before the cabinet.

In 2000, (on February 15, 2000) the New National Population Policy–2000 was approved by the Government of India.

The New NPP-2000 is enunciated for attaining population stability by target-free approach in administering family welfare services. The policy recognizes the fact that following measures are necessary for achieving population stabilization:

- Universal primary and secondary education.
- Provision of basic sanitary facilities like protected water supply, sanitary latrines, good housing, etc.
- Empowerment of women for improved health and nutrition and enhancement of opportunities for their employment.
- Expansion of transport and communication networks.
- Decentralization of the planning and implementation.
- Increasing participation of men and NGOs in family welfare activities.
- NPP-2000 has set a time bound hierarchy of the following objectives, referred to as immediate, intermediate and ultimate:
  - *Immediate or short-term objective:* It is to provide basic RCH services to the people and to satisfy the unmet needs of the couples for contraceptive services.
  - *Intermediate or medium-term objective:* It is to bring the total fertility rate (TFR) to replacement level (NRR = 1) by the year 2010.
  - *Ultimate or long-term objective:* It is to achieve a stable population by the year 2045, at a level consistent with requirements for social development, economic growth and environmental protection of the country.

Goals

The goals set by NPP are the targets to be achieved by the year 2010. The goals are set under the following broad headings:

- Reproductive health targets
- Child health targets
- General health targets.

Reproductive Health Targets

- Active universal access in respect of fertility regulation services
- Promotion of small family norm to achieve NRR = 1
- Making family welfare program a people centered, program
- Promotion of delayed marriages for girls, not earlier than 18 years and preferably after 20 years of age
- Achieve 80 percent institutional deliveries and 100 percent deliveries by trained personnel
- Reduction of maternal mortality rate to less than 1 per 1000 livebirths.

Child Health Targets

- Universal immunization of children against vaccine preventable diseases.
- Compulsory and free primary and secondary education and reduction of school dropouts to less than 20 percent for both boys and girls.
- Reduction of infant mortality rate to less than 30 per 1000 livebirths.

General Health Targets

- Contain the spread of HIV/AIDS and promote greater integration between the management of reproductive tract infections (RTIs) and sexually transmitted infections (STIs) and the National AIDS Control Organization.
- Address the unmet needs for basic RCH-services, supplies and infrastructure.
- Integration of Indian Systems of Medicine in the provision of RCH-services.
- Achieve 100 percent registration of births, deaths, marriages and pregnancies.
- Prevention and control of communicable diseases.

If NPP-2000 is correctly and fully implemented, it is anticipated that in the year 2010, the population will be 1107 million instead of 1162 millions, as projected by the Technical Group of Population Projections.

NATIONAL POLICY FOR CHILDREN

This was approved by the parliament on August 22, 1974. The policy declares that, 'It shall be the policy of the State to provide adequate services to children, both before and after birth and through the period of growth, to ensure their full physical, mental and social development. The state shall progressively increase the scope of such services so that within a reasonable time, all children in the country enjoy optimum conditions for their balanced growth.'

According to the Declaration, children constitute the nation's important asset and their development is the integral part of national development and therefore declares that nation is responsible for their nurture and solicitude.

Article 24, prohibits child labor. Article 39 stressed that their tender age should not be abused. Article 45, stressed upon the State to provide free and compulsory education for all children until they reach 14 years of age.

The policy also spells out various measures to be adopted and priorities to be assigned to children's programs concentrating on child health, child nutrition and welfare of the handicapped and destitute children.

Following the enunciation of National Policy for Children, a number of programs were introduced by the Government of India such as ICDS—scheme, supplementary nutrition, nutrition education, constitution of the 'National Children's Fund,' (under the Charitable Endowments Act, 1980), institution of National Awards for Child Welfare, Welfare of the handicapped, CSSM-Program, etc.

In 1990, the Government of India agreed on at the World Summit for Children, which includes 4 sets of rights of children namely, right to survival, right to protection, right to development and right to participation.

NATIONAL POLICY FOR OLDER PERSONS

Described under chapter Preventive Geriatrics.

BIBLIOGRAPHY

1. Government of India. Health Policy (Draft). Ministry of Health and Family Welfare, New Delhi, 1999.
2. Government of India. National Plan of Action on Nutrition. Food and Nutrition Board. Department of Women and Children. Ministry of HRD, New Delhi, 1995.
3. Government of India. National Population Policy. Ministry of Health and Family Welfare, New Delhi.
4. ICMR Bulletin. Closing gaps to achieve Millennium Development Goals. New Delhi. 2004;4:11-2.

CHAPTER 40

National Voluntary Health Agencies/Organizations

A voluntary or Non-Governmental Organization (NGO) is a non-political, non-profit based, independent organization, having an autonomous body, consisting of a group of members, which holds meeting periodically, collects funds from private sources, philanthropists, Government, etc. and spends money for one of the following intentions and is named accordingly.

- Promotion of a religion (in which case it is called Religious or Missionary Organization)
- Social relief and welfare (a welfare organization)
- Protection of interests of the members of a profession (a professional body IMA)
- Provision of health services to the people (a Voluntary Health Agency).

While the Voluntary Health Agency (VHA) are mainly concerned with the provision of health care services to the people, the other organizations (NGOs) also carry out health services spasmodically in addition to their main ones. For example, missionary bodies have set up charitable hospitals, orphanages and old-age homes.

Indian Medical Association (IMA), Rotary club, Lions club, etc. periodically conduct school health check-ups, health camps, immunization camps, cataract camps, etc. They also organize relief camps during the period of disasters. Many Social Welfare Organizations carry out rehabilitation of deaf, the blind, and the physically handicapped.

VOLUNTARY HEALTH AGENCIES

Their main aim is to provide health care services to the community at large. They share the burden of health care of the people with the Government and the Private practitioners.

The voluntary health agencies (VHAs) raise their finances through membership fee and the sale of greeting cards, seals, flags, etc. Additionally they collect funds from Government and donations from philanthropists.

Advantages

(Over Government Organizations)

- Compared to Government Organizations, VHA (NGOs) are better accepted.
- Community participation is better in the programs undertaken by VHAs.
- The programs are flexible and not rigid.
- They are not handicapped by bureaucratism and red tapism.
- They work at fast pace and at low operative costs.
- They provide an opportunity to those individuals, who are interested in social work.

Limitations of Voluntary Health Agencies

- Their programs are often related to non-critical health problems.
- Their services are not always targeted to those who are in greatest need of them nor are they conducted in the areas that need them most.
- Their programs often do not run according to modern principles and techniques of management.

The only country having enormous VHAs is the United States of America. There are more than 20,000 voluntary agencies functioning. The voluntary health agencies have

been compared to 'motor trucks' which can penetrate the by-ways and the official agencies to 'Railway trunk lines', which must run on the tracks established by law.

Functions of Voluntary Health Agencies

- They supplement the work of Government agencies, by providing resources such as manpower, materials and money.
- They explore ways and means of doing new things including research activities (pioneering).
- They carry out extensive IEC activities (education)
- They carry out demonstrations and experimental projects
- They guide and criticize the work of Government agencies (guarding)
- They mobilize public opinion for the benefit of the community.

VOLUNTARY HEALTH ASSOCIATION OF INDIA

Voluntary Health Association of India (VHAI) is a non-profit, registered society formed in the year 1970. It is a federation of 27 State Voluntary Health Associations, linking together more than 4500 health care institutions and grass-root level community health programs spread across the country.

VHAI's primary objective is to 'make health a reality for the people of India' by promoting community health, social justice and human rights related to the provision and distribution of health services in India.

VHAI tries to achieve these goals through campaigns, policy research, advocacy, need-based training, media and parliamentary interventions, publications and audio-visuals, dissemination of information and running of health and development projects in some difficult areas.

VHAI works for people centered policies and their effective implementation. It sensitizes the general public on important health and development issues for evolving a sustainable health movement in the country with due emphasis on its rich health and cultured heritage.

VOLUNTARY HEALTH AGENCIES IN INDIA

Indian Red Cross Society

Explained under International Health Organizations.

Tuberculosis Association of India

This was organized during the year 1939 with New Delhi as headquarters, having state branches in all the states.

Activities:

- Every year, it raises funds by conducting a TB seal sale campaign.
- Tuberculosis Association of India (TAI) conducts training of doctors and health workers in the control of TB.
- It publishes periodicals related to TB.
- It conducts annual conferences, encouraging research on TB.
- It runs TB sanatoria (hospitals) at New Delhi, Kasauli, Mehrauli and Dharampur.

Family Planning Association of India

Family Planning Association of India (FPAI) was established in 1949 with headquarters at Mumbai. It has branches all over the country.

Activities:

- FPAI runs clinics providing family welfare services, including MTP and sterilization.
- It conducts mobile camps in rural areas.
- It conducts training program for doctors, para-medical workers, volunteers and opinion builders in the area of family planning. It has two Regional Training Centers at Hyderabad and Gwalior.
- FPAI imparts education about population control, family life, safe sex and prevention of STDs.
- It organizes seminars, workshops and conferences.
- It publishes quarterly journal related to family welfare.
- Its Parivar Pragati Pariyojana undertakes community development activities.
- It gives financial assistance to other NGOs undertaking family welfare activities.

Hind Kusht Nivaran Sangh

This was founded in 1950, with New Delhi as the headquarters.

Activities:

- Hind Kusht Nivaran Sangh (HKNS) provides financial assistance to leprosy homes and clinics.
- It provides health education through publications and posters.
- It provides training to medical workers and physio-therapists.
- It encourages research and field investigations in leprosy.
- It holds periodic leprosy conferences.
- It brings out a quarterly journal called 'Leprosy in India'.

Voluntary Health Association of India

Voluntary Health Association of India (VHAI) is a federation of the organizations in the field of health and community development.

Activities:

- It develops and distributes health educational material.
- It brings out newsletters and journals devoted to health and community development.
- It sets up stalls in the exhibitions in different parts of the country.
- It imparts training to different categories of health personnel.
- Its speciality is training of the health trainers.

VHAI is the first organization to popularize the concept of 'Well Baby Clinics' and India.

Indian Council for Child Welfare

Indian Council for Child Welfare (ICCW) was established in 1952. It is affiliated to International Union for Child Welfare. It has a network of state councils and district councils all over the country.

Its services are mainly concentrated over the development of India's children, physically, mentally, socially, morally and spiritually in a healthy and normal manner and in conditions of freedom and dignity.

Bharat Sevak Samaj

This was formed in 1952. The main objective of this is to help people to achieve health by their own actions and efforts. It has a network of branches in all the states and districts. Improvement of sanitation in the villages is one of the important activities of Bharat Sevak Samaj (BSS).

Central Social Welfare Board

This is an autonomous body, under the control of Ministry of Education. This was set up by Government of India, in August 1953.

Activities:

- It surveys the needs and requirements of voluntary welfare organizations in the country
- It promotes the formation of social welfare organizations
- It provides financial aid to deserving welfare organizations
- It initiated 'Family and Child Welfare Services' in 1968, in rural areas for the welfare of women and children through various activities such as mother craft, social education, literacy classes, distribution of milk, organization of play centers for children, etc.
- It started a scheme of 'Industrial cooperatives', under which the women of the lower middle class in urban areas, were employed and given salary, thus raising their economic status.

Kasturba Memorial Fund

This was created in commemoration of Smt Kasturba Gandhi, after her death in 1944. It has a fund of nearly one crore rupees.

The main activity is to improve the rural women through gram-sevikas.

The money of the trust is actively utilized in various welfare projects in the country.

All India Women's Conference

This is the only VHA organized for the welfare of the women in the country. It was established in 1926 and has branches all over the country. It is running MCH clinics, adult education center to improve specially female literacy, milk centers and family planning clinics.

All India Blind Relief Society

This was established in 1946. It is functioning for the relief of the blind. It conducts ophthalmic camps. It works in co-ordination with other institutions and organization for the blind.

BIBLIOGRAPHY

1. Govt of India. Voluntary Health Organizations. Central Health Education Bureau. New Delhi 1961.
2. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.

CHAPTER 41

International Health Organizations

With the shrinking of the world into a global village, the jet travel and human interactions has increased the transmission of diseases from one country to another country. Hence, international co-operation in health and disease is desirable.

Several attempts were made in the past for achieving an universal agreement on health issues. These attempts ultimately culminated in the establishment of World Health Organization (WHO) and other International Health Agencies. Bilateral Government agencies and several Non-Government Organizations also play a significant role in international health.

Realizing that the diseases do not respect the geographic boundaries, following the pandemicity of cholera and plague, Europeans were the first to conceive a plan of stopping the importation of plague by detaining the ships, crews, travelers and cargoes for 40 days, a procedure called 'Quarantine,' during 14th century. During this period the disease would manifest itself or die out. Thus, quarantine practice became popular to prevent the international spread of not only cholera but also plague. But 40 days detention affected international trade and travel. This prompted the convening of many international sanitary conferences.

FIRST INTERNATIONAL SANITARY CONFERENCE (1851)

This was convened in Paris. Many European countries attended the conference. The objective was to introduce uniformity into quantine measures, because quarantine measures varied from country-to-country. But the conference was ended in failure, because it was ratified by only three countries. So this code never came into force. Ten more conferences were held between 1851 and 1902 to reach an agreement. All proved futile. They failed to achieve agreement on an uniform quarantine procedure, partly because of the gaps in the knowledge of the natural history of the quarantinable diseases and partly because of the political differences. However, there was a feeling of arriving at an international plan of action to control communicable diseases.

PAN AMERICAN SANITARY BUREAU (1902)

Pan American Sanitary Bureau (PASB) was the World's first international health agency established in 1902, to co-ordinate quarantine procedures among the American states. The Pan American Sanitary Code evolved by PASB in 1924, is still in force. In 1947, the PASB was reorganized and was renamed as Pan American Sanitary Organization (PASO). Later in 1949, it was agreed that PASO would serve as WHO regional office for Americas. In 1958, it was renamed as Pan American Health Organization (PAHO), with its headquarters in Washington DC.

PAHO member states include all the 35 countries of America. A major effort of PAHO was the launch of polio eradication in 1985. In September 1994, America was officially declared polio-free.

OFFICE INTERNATIONAL d'HYGIÈNE PUBLIQUE (1907)

Following the establishment of PASB, France also felt the need to have a permanent health agency (permanent international health bureau–Office International d'Hygiène Publique (OIHP) – popularly called 'Paris office,' to disseminate

information about communicable diseases and to evolve uniform quarantine procedures. The agreement for the establishment of OIHP was signed in Rome in 1907. It was started purely as European organization, grew steadily, covering 60 countries including British India. Thus, OIHP attained an International character.

OIHP did remarkable work in disseminating the knowledge of communicable diseases and their control and also contributed to other areas of international health. OIHP continued to serve for 40 years as an International Health Organization. Eventually in 1950, it was wound up with WHO.

HEALTH ORGANIZATION OF THE LEAGUE OF NATIONS (1923)

The League of Nations was established after the First World War (1914–1918) to ensure peace and stability in the world. However, it was unable to prevent the Second World War and was thus a political failure. It established a Health Organization in 1923 and carried out a commendable work in the field of health, hygiene, nutrition, rural housing, training of health workers, etc. in addition to quarantine and control of communicable diseases. It established Eastern Bureau at Singapore. Its efforts to amalgamate OIHP and PASB did not succeed. It started to publish Weekly Epidemiological Records. In 1939, the League of Nations was dissolved. But its activities including the publication of Weekly Epidemiological Records continued for 16 years, i.e. till the start of Second World War. Its function was ultimately taken over by WHO.

UNITED NATIONS RELIEF AND REHABILITATION ADMINISTRATION

This was an outcome of Second World War. The Health Organization of League of Nations was isolated in Geneva, during the Second World War period (1939–1945) and the Paris Office (OIHP) had fallen in German hands. Then United Nations Relief and Rehabilitation Administration (UNRRA) was set-up during 1943 with the purpose of organizing recovery from the effects of Second World War, specially epidemics. There was a need to tide over the situation. The inspiration came from President Roosevelt himself and so UNRRA was established in 1943. The objectives were to control the epidemics and to offer health and rehabilitative services to displaced persons. It existed hardly for 3 years and did commendable work including control of malaria in Greece and Italy, eradicating malaria in Sardinia and preventing the spread of typhus.

WORLD HEALTH ORGANIZATION

Birth

After the Second World War, United Nations Organization (UNO) was established in 1945 to maintain world peace and security. The member countries proposed the establishment of an International Health Organization in the conference held at San Francisco during 1945. An International health conference was held in New York in 1946 to draft the constitution of the proposed organization. The constitution was ratified on 7th April 1948 and on the same day World Health Organization officially came into existence. Hence, 7th April of every year is celebrated as the World Health Day, with a special message. A new theme is suggested every year to focus the attention of the world on current specific, health issues of international significance and generate a favorable climate for their management and control. Thus, WHO is a specialized agency of United Nations. It is a non-political health agency.

Constitution

The headquarters of WHO is situated at Geneva. The constitution was drafted by Dr Rene Sand of Brussels, a pioneer of Social Medicine and Dr Brock Chisholme, a Canadian psychiatrist who became the first. Director General of WHO. The constitution is a master piece in medical literature. It has its own constitution, own governing bodies, own membership and own budget. WHO is an autonomous body.

Objectives

The main objective of WHO is, 'Attainment of highest level of health by all the people of the world.'

The preamble of the constitution is as follows:

- It defines Health as a, 'State of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (Tridimentional state)
- It declares that the attainment of highest level of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic and social condition
- It recognizes that the health of all people is fundamental to the attainment of peace and security and to the abolition of wars
- It fixes the responsibility on the governments of the countries to provide adequate health and social welfare measures for the benefit of their citizens
- It also recognizes that understanding and active co-operation of the people is of utmost importance in the improvement of health of the people.

- It affirms that the health of one country is of benefit to all other countries
- It suggests that healthy development of a child is of basic importance. The ability to live harmoniously in a changing total environment is essential to such development
- It also suggests that health education of all the people is essential to fullest attainment of health.

The international conference held at Alma-Atta (capital of Kazakhstan) during 1978, has influenced WHO very much to achieve the Global Social target, 'Health For All by 2000 AD', identifying Primary Health Care as the strategy.

Membership

Membership is open to all the countries. The countries which do not maintain the international relations are admitted as associate members. Member countries contribute yearly to the budget and are entitled to the services of WHO. During 1948, WHO had 56 members. By 1996 WHO had 190 Member States and two Associate Members (Puerto Rico and Tokelau).

Organizational Profile

WHO structure resembles like that of a national government in having a Parliament, i.e. World Health Assembly, a Cabinet, i.e. Executive Board, and a Secretariat.

- *World health assembly*: It is the governing body. It represents all the member states, each member state can send 3 delegates, each delegate has the right of one vote. The assembly meets once a year, usually in the month of May, at the headquarters Geneva. It may hold its meeting in other places also (14th meet was in Delhi in 1961). The main task of the assembly is to lay down the international health policy and programs, to review the progress of the previous year, to approve the budget and appoint the Director General, nominated by the Executive Board. Technical discussions are also held on some topic of global interest.
- *Executive board*: It consists of about 30 technically qualified expert members in the field of health. They are designated by but do not represent their governments. One-third of the membership is renewed every year. The Executive Board meets twice a year, once in January and once soon after the meeting of assembly, i.e. after May.

  The board implements the policy decisions of the assembly. Board also has the power to take actions to deal with any emergencies such as epidemics, floods, earthquakes, etc.
- *Secretariat*: It is the administrative wing of WHO, headed by the Director General, who is the chief technical and administrative officer of the organization and under whom five Assistant Director – Generals are working.

Secretariat looks after the routine official work of WHO. The main function of the secretariat is to extend technical and administrative support to the member states in planning, programming and implementing their National Health Programs. Each Assistant D-C is in charge of various divisions assigned by the Director General.

There are 14 divisions as mentioned below:

1. Division of Epidemiological Surveillance and Health Situation and Trend Assessment.
2. Division of Communicable Diseases.
3. Division of Vector Biology and Control.
4. Division of Environmental Health.
5. Division of Public Information and Education for Health.
6. Division of Mental Health.
7. Division of Diagnostic, Therapeutic and Rehabilitative Technology.
8. Division of Strengthening of Health Services.
9. Division of Family Health.
10. Division of Non-communicable Diseases.
11. Division of Health, Manpower Development.
12. Division of Information Systems Support.
13. Division of Personnel and General Services.
14. Division of Budget and Finance.

The message given by the First Director General, Dr Brock Chisholme, a man of wide vision, was 'We must think and act in terms of mankind as a whole. We must be ready to give up the old ideas, certainties and devotions in order to place the welfare of all people everywhere on the same level of values, regardless of where on this little earth one happens to have been born himself. In other words we must try to attain an equal degree of loyalty to all members of the world community, irrespective of race, religion and color and any group characteristics.

The Logo (Emblem) of WHO is shown below:

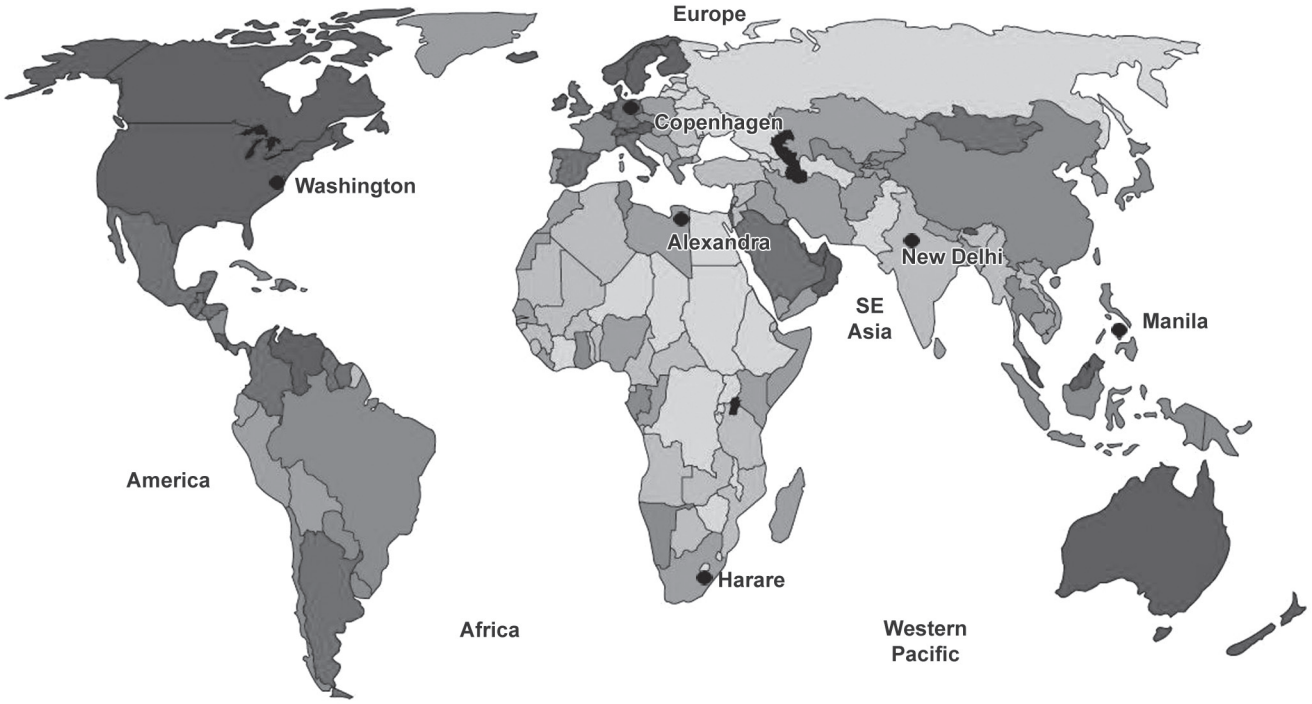


Fig. 41.1 WHO regional offices and the areas that they serve

Regional Offices

There are six regional offices, each headed by a Regional Director. These offices are the integral part of WHO.

WHO Regional Organizations (Fig. 41.1)

Region	Headquarter	Number of member countries
South-east Asia	New Delhi (India)	11
Africa	Harare (Zimbabwe)	46
America	Washington DC (USA)	35
Europe	Copenhagen (Denmark)	51
Eastern Mediterranean	Alexandria (Egypt)	22
Western Pacific	Manila (Philippines)	28

South-east Asia region covers India, Sri Lanka, Nepal, Bhutan, Korea, Bangladesh, Myanmar, Thailand, Indonesia, Maldives and Mangolia. South-east Asian Regional Office (SEARO) is in New Delhi (India).

Each regional organization has a regional committee, composed of the representatives of the member states. The Regional Director is assisted by technical and administrative officers and members of the secretariat. The regional committee meets once a year to review the progress of the health work in the region and prepares plan of action which is amalgamated into the world plan by the Director General of WHO at Geneva.

Functions of WHO

WHO has a wide and varied field of activity covering all the areas of public health, which are grouped under three major areas.

Health Services

WHO provides assistance, guidance and coordination to the member countries in the prevention and control of communicable diseases, non-communicable diseases and epidemics and also in delivering Primary Health Care. One of the major achievements of WHO is eradication of Smallpox (1977). At present, there has been a commitment for eradication of poliomyelitis. In 1974, Expanded Program of Immunization was launched. In 1978, it resolved a Global Social Target 'Health for All by 2000 AD'. In 1991 September, Children Vaccine Initiative was launched in collaboration with UNICEF, World Bank and Rockfeller foundation, with the objective of making availability of a single vaccine that would immunize the child against all childhood diseases. In 1995, a global program to control of tuberculosis was launched. DOTS was identified as the strategy. WHO is also currently directing the global battle against AIDS.

With the appearance of many newly emerging and re-emerging diseases, WHO has started a division on Disease Surveillance and Control, in the headquarters. It compiles health information from all the member countries and disseminates in the form of statistical reports.

WHO has prescribed International Health Regulations to prevent international spread of diseases.

The publication on International Classification of Diseases by WHO helps in uniform codification and categorization of diseases, which facilitates international comparison and standardization of morbidity and mortality data. ICD is updated once in 10 years.

The activities have also extended into the fields of vector biology and control, immunology, quality control of drugs and biological products and laboratory technology.

WHO promotes the development of comprehensive National Health Programs. It provides assistance for improving the quality and coverage of maternal health, child health, nutrition and family welfare services. In the area of environmental health, WHO provides assistance for the control of air pollution, water pollution, soil pollution and food contamination and also for the provision of basic sanitation and protected water supply. It collaborates with other International Health Agencies in the area of health.

Health Information and Literature

WHO publishes the morbidity and mortality statistics of the member countries in:

- Weekly Epidemiological Record
- World Health Statistics, Quarterly
- World Health Statistics, Annual.

And it publishes scientific journals and reports such as WHO Bulletin, Technical Report Series (TRS), WHO Chronicle, World Health, International Digest of Health Legislation, etc.

WHO Library is one of the Satellite centers of the Medical Literature Analysis and Retrieval System (MEDLARS) of the US National Library of Medicine. MEDLARS is the only fully computerized indexing system covering the whole of medicine on an international basis.

Health Research (Biomedical Research)

WHO encourages research activities in the biomedical field. It awards grants to research workers and institutions. In this connection it has established Regional and Global Advisory Committees and also network of collaborating centers. It also promotes training of workers.

UNICEF

It is the acronym (abbreviation) of United Nations International Childrens' Emergency Fund (UNICEF), established in 1946 to continue the work of UNRRA (United Nations Relief and Rehabilitation Administration) to provide rehabilitation of those children of Europe and China, victimized by the Second World War. Subsequently when the emergency situation was tided over in 1953, UNICEF was renamed as United Nations Children Fund, but still retaining the same abbreviation.

The emblem of UNICEF is shown below:

UNICEF is a specialized agency of the United Nations with headquarters at New York. The Chief executive officer is the Executive Director, who is appointed by the Secretary General, United Nations, in consultation with the Executive Board of UNICEF.

Regional Offices

There are nine regional offices. The different regions and their headquarters are:

Regions	Headquarters
Europe	Geneva
Eastern and Southern Africa	Nairobi
West and Central Africa	Abidjan
America and Caribbean	Bogota
East Asia and the Pacific	Bangkok
Middle East and North Africa	Amman
South Asia	Kathmandu
Japan	Tokyo
Central and Eastern Europe, Commonwealth of Independent states and Baltic states	Geneva

Functions

In the beginning, UNICEF worked in collaboration with WHO and assisted in the prevention and control of communicable diseases like malaria, tuberculosis, leprosy, STIs, etc. Subsequently it shifted its attention to primary health care with focus on MCH – services. Four areas of special emphasis by UNICEF are child health, child nutrition, child welfare and child education.

Child Health

UNICEF provides aid for the production of vaccines. In India it supported BCG immunization program from the start. It also assisted in the manufacture of DPT vaccine, helped in errection of Penicillin plant at Pune, donated a DDT plant, and plant to prepare iodized salt. It took considerable interest in the provision of safe and sufficient water and sanitation in rural areas to improve the quality of life. It has given sufficient inputs for carrying out Immunization Program.

Child Nutrition

UNICEF helped the 'Applied Nutrition Program' in the form of supplementing the child feeding with low cost protein rich food, mainly in the rural areas for better child nutrition. It has supplied equipment for diary plants. It has also given specific aid for the control of deficiency diseases by the provision of vitamin A solution, iodized salt and iron and folic acid tablets. Recently it has been encouraging the national nutrition policies.

Family and Child Welfare

UNICEF has taken measures to improve the care of the children both within and outside their homes through means such as Day care centers, Child welfare and youth agencies and women's clubs.

Child Education

UNICEF is providing assistance for basic primary education and parent education. It supplies laboratory equipment, library books, audiovisual aids, etc. for educational institutions.

Since 1976, UNICEF has been participating in 'Urban Basic Services' (UBS), with the objective of providing basic services, like sanitation, water supply, nutrition and education to the mothers and children of urban low income families.

In September 1990, UNICEF organized a convention of the 'Rights of the Child', which was ratified by 180 countries including India. The convention spells out the civil, political, economic and cultural rights of the child. Some of these are right to life, right to survival, right to development, right to highest standard of attainable health and the right to constitute into an association or union.

The June 1991, UNICEF promoted 'Baby Friendly Hospital Initiative' with the primary objective to create awareness and promotion of breastfeeding practices and in this connection, in collaboration with WHO developed 'Ten Steps To Successful Breastfeeding'.

Currently UNICEF is promoting a campaign, known as 'GOBIFFF' campaign to encourage the following strategies for a 'Child Health Revolution'.

- G for Growth monitoring
- O for Oral Rehydration Therapy
- B for Breastfeeding
- I for Immunization
- F for Family Planning
- F for Female literacy
- F for Ferrum (iron) and folic acid supplementation.

Thus, greater attention is being given by UNICEF to the concept of 'whole child', meaning their long-term personnel development and to the development of countries in which they live. This approach is also known as 'Country Health Programming'.

UNITED NATIONS DEVELOPMENT PROGRAM

The United Nations Development Program (UNDP) was established in 1966. It constitutes the main source of funds for technical assistance.

The main objective is to strengthen the human and natural resources of the poor countries including India, for their development. Its projects include several areas such as agriculture, industry, education and science, health, social welfare, etc. It works in collaboration with all other international health agencies. It supports research and cooperative activities to combat health problems threatening socioeconomic development.

FOOD AND AGRICULTURAL ORGANIZATION

Food and Agricultural Organization (FAO) was the first specialized agency of UN established after Second World War in 1945 in Quebec, Canada, which subsequently moved to Rome.

The chief aim is to alleviate global malnutrition and hunger.

The strategies are:

- To promote food production by improving the efficiency of agriculture, pisciculture (fisheries) and forestry, so

that production of food keeps pace with the increase in population.
- To improve the nutritional status of the people of all countries by adequate distribution of food in the communities.

In this context, FAO initiated 'A World Freedom from Hunger Campaign during 1960 and disseminated nutrition information and education to the people.

In December 1992, an International Conference on Nutrition was held in Rome in collaboration with WHO. They have jointly sponsored a large number of expert committees on Food and Nutrition. Several projects have been developed on nutrition education, food quality and safety, micronutrient deficiency and nutrition surveillance.

FAO also shares interest in the control of brucellosis and other zoonoses.

INTERNATIONAL LABOR ORGANIZATION

This was established in 1919, with its headquarters in Geneva, Switzerland as an affiliate of League of Nations to improve the working and living conditions of working population all over the world. After the dissolution of the League, International Labor Organization (ILO) developed a closed association with WHO in the field of health and labor.

Functions

- To promote the health and safety of the working population
- To improve the living standards of workers
- To promote their economic and social stability.

ILO has developed an International Labor Code, which lays down minimum desirable standards for the health, welfare, safety (living and working conditions) of the workers throughout the world.

ILO also provides assistance to organizations interested in the betterment of living and working conditions (employment standards) of labor population.

UNITED NATIONS FUND FOR POPULATION ACTIVITIES

The United Nations Fund for Population Activities (UNFPA) has been helping nearly 130 countries in dealing with the population control. It began operations in 1869.

This has been assisting India in achieving population control since 1974. It provides assistance in all areas of Family planning program including infrastructure development, manufacture of contraceptives, population education programs, etc.

UNFPA has been instrumental in introducing innovative approaches to RCH program.

UNITED NATIONS EDUCATIONAL SCIENTIFIC AND CULTURAL ORGANIZATION

The United Nations Educational Scientific and Cultural Organization (UNESCO) was formed during 1945 and currently has 188 members. The main objective is to get peace and security in the world by promoting collaboration among nations through education, science, culture and communication. It published World Education Report annually.

UNITED NATIONS HIGH COMMISSION FOR REFUGEES

The United Nations High Commission for Refugees (UNHCR) was established in 1950 to provide protection and assistance to refugees. Refugees are defined as those people who are outside their countries of origin because of a fear of persecution, based on their race, religion, nationality, political opinion or membership in a particular social group and who cannot or do not want to return home.

UNHCR has two basic objectives—to protect refugees and seek ways to help them restart their lives in a normal environment.

In addition to refugees there are about 25 million internally displaced persons, i.e. those who have fled their homes usually during a civil war but still staying in their home countries, whom also UNHCR provides help.

WORLD BANK

It is an International Bank for Reconstruction and Development. It was established in 1944 to raise the standard of living of the people of the poorly developed countries by providing loans on those projects aimed at socioeconomic growth, such as electricity, transports, water supply, agriculture, health, education, communication and population control.

World Bank is the largest source of development assistance in the whole world, focusing on the poorest people in the poor countries. It is owned by 183 members countries. It provides nearly 16 billion US dollars every year in loans to its client countries. Currently in India the World Bank is supporting National Program for Control of Blindness, National AIDS Control Program and Revised National Tuberculosis Control Programme.

UNITED NATIONS JOINT PROGRAM ON AIDS

The United Nations Joint Program on AIDS (UNAIDS) is a joint United Nations program on HIV/AIDS. The different organizations working together for the control of this pandemic disease are UNICEF, UNDP, UNFPA, UNDCP, UNESCO, WHO and the World Bank. The Intercountry office for the South Asia Region is based at New Delhi.

UNITED NATIONS INTERNATIONAL DRUG CONTROL PROGRAM

The United Nations International Drug Control (UNDCP) was established in 1961 to enhance the effectiveness of UN system for drug control, because the drug abuse is on increase and it has an adverse effect on human health. It collaborates with WHO in its program, specially in the prevention of transmission of HIV/AIDS among the Intravenous Drug Users (IDUs).

UNITED NATIONS ENVIRONMENT PROGRAM

The United Nations Environment Program (UNEP) was established in 1972 by UN General Assembly for International Cooperation relating to human environment. It is playing a significant role in the protection of the environment. It conducted a conference on 'Earth Summit' held in Rio De Janeiro (Brazil) in 1992. It is estimated that by 2025, one-third of the world population will suffer from lack of water and will resort to use polluted water, resulting in many health hazards. UNEP is also addressing these problems.

INTERNATIONAL ATOMIC ENERGY AGENCY

International Atomic Energy Agency (IAEA) was established in 1957. Its objectives are mainly to enlarge the use of atomic energy for health, peace and prosperity throughout the world. In the field of health, it collaborates with WHO on the use of nuclear techniques in medicine, biology and health related environmental research.

WORLD FOOD PROGRAM

World Food Program (WFP) is the world's largest international food aid organization, serving in 84 countries since 1963, working with the goal of achieving, 'A world in which every man, woman and child has access at all times to the food needed for an active and healthy life. Without food, there can be no sustainable peace, no democracy and no development.' It was founded in 1963 as the food aid arm of the United Nation.

WFP's objectives in India are:

- To improve nutrition and quality of life for the most vulnerable
- To make sustainable improvements in household food security for the poorest especially for women and children.
- To strengthen channels for locally produced food grains and support local entrepreneurship
- To advocate for ecorestoration

Beneficiaries

- Poor women and children at risk
- Poor forest dependent population.

A blend of pre-cooked maize and soya fortified with micronutrients (iron, calcium and Vit. A) called CSB (Corn Soya Blend) has been developed in India in the name of 'Indiamix' distributed through existing infrastructure of the ICDS-projects.

Composition of Indiamix: 40 percent maize, 40 percent wheat and 20 percent full fat soyabean.

Nutritive Value

Nutrients	-	Amount per 100 g
Protein (g)	-	20
Fat (g)	-	06
Carbohydrate (g)	-	60
Energy (kcal)	-	390
Calcium (mg)	-	191
Iron (mg)	-	15
Vitamin A (mcg)	-	1454

BIBLIOGRAPHY

1. Mathur JS. A Comprehensive Textbook of Community Medicine 1st edn, 2008.
2. Maxcy Rosenau. Public Health and Preventive Medicine. Toronto, Canada 1992.
3. Park K. Park's Textbook of Preventive and Social Medicine 18th edn, 2005.

CHAPTER 42

Bilateral Agencies

These are the agencies working under the bilateral agreement of India and some foreign countries.

COLOMBO PLAN

This was the outcome of a meeting of Commonwealth Foreign Ministers, held at Colombo in 1950. It consisted of Foreign Ministers of 20 developing countries of South and South-east Asia and also representatives of six developed countries namely UK, USA, Australia, New Zealand, Canada and Japan.

Colombo plan provides assistance to the developing member countries in industrial and agricultural sectors, with a view to improve the standard of living in these countries. Some funds are earmarked for health also. All India Institute of Medical Sciences (AIIMS), New Delhi, received financial assistance from New Zealand. Several other institutions were supplied cobalt therapy units by Canada under the Colombo plan. Many fellowships for training of health personnel have also been provided from time-to-time.

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

The United States Agency for International Development (USAID) was established in 1961 in order to continue the activities carried out previously by Technical Cooperation Mission (TCM). USAID provides assistance to large number of countries in the world. It has supported several public health programs in India such as Malaria eradication, medical education, nursing education, health education, water supply, sanitation, control of communicable diseases, nutrition and family planning. USAID has established a branch in Delhi. Currently it is providing assistance for the control of HIV/AIDS in India.

SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION

The Swedish International Development Cooperation (SIDA) Agency is assisting National TB Control Program since 1979. The assistance is provided in the form of X-ray units, microscopes and anti-TB drugs. SIDA also supported the pilot study of Short Course Chemotherapy during 1983–1984 and also the pilot phase I of RNTCP in 5 states during 1993.

DANISH INTERNATIONAL DEVELOPMENT AGENCY

The Danish International Development Agency (DANIDA) was established by the Government of Denmark. It is providing assistance in three major health programs in India-DANLEP, DANTB and DANPCB, i.e. respectively leprosy, tuberculosis and blindness.

DANIDA Assisted National Leprosy Eradication Program

DANIDA Assisted National Leprosy Eradication Program (DANLEP). This was launched in four districts in three states of Madhya Pradesh, Orissa and Tamil Nadu in 1986. It assisted through infrastructural support, health education, human

resource development, program monitoring and prevention and care of deformities.

DANIDA Assisted Revised National Tuberculosis Control Program

DANIDA Assisted Revised National Tuberculosis Control Program (DANTB). This was initiated in 1996 and is continued.

DANIDA Assisted National Program for Control of Blindness

DANIDA Assisted National Program for Control of Blindness (DANPCB). This was initiated in 1978. It is assisting in different phases. In phase I, it strengthened the infrastructure of primary health centers. In phase II, it set-up District Blindness Control Societies in order to develop human resources and to decentralize the services. In phase III, it is continuing the gains of the earlier two phases and it is proposed to set-up National Eye Care Resource Center through this assistance.

Other bilateral government agencies active in India are the Swedish, Canadian and Norwegian agencies for International Development.

NON-GOVERNMENT (NON-UN) AGENCIES

Ford Foundation

It is one of the very important Non-Governmental Organizations working actively in India. It has been active in the development of rural health services and family planning.

Activities

- It established orientation training centers at Singur, Poonamallee and Najafgarh to provide training to medical and paramedical personnel, from all over India, in public health.
- It has helped Research-cum-Action projects, which are concerned with the improvement of environmental sanitation, with reference to designing and construction of hand flushed, acceptable sanitary latrines in rural areas.
- It has also helped the projects in rural health services and rural development.
- Calcutta water supply and drainage scheme master plan was prepared.
- Ford Foundation also contributed for the establishment of National Institute of Health Administration and Education (NIHAE), New Delhi, which is now known as National Institute of Health and Family Welfare, which provides training for health administrators.

Rockefeller Foundation

This philanthropic organization was established in USA in 1913 by Mr John D Rockefeller with the objective of promoting the well-being of mankind all over the world.

In the early days it confined to medical education and public health. Later it expanded its fields to social sciences, humanities and agricultural sciences.

It started functioning in India from 1920, with a scheme for the control of hookworm disease in then Madras presidency. Since then Ford foundation has been associated with several medical and public health programs in India.

Activities

It has helped in the establishment of All India Institute of Hygiene and Public Health, Calcutta; All India Institute of Medical Sciences, New Delhi; King George's Medical College, Lucknow; Christain Medical College, Vellore; Christian Medical College, Ludhiana, SGS Medical College, Bombay; Field Demonstration Project, Ballabhgarh; National Institute of Virology, Pune, etc.

- It sponsors educational visits for advanced training of health professionals of India to other countries through fellowship and travel grants.
- It sponsors the visits of specialists from USA.
- It provides grants-in-aid to the selected institutions for carrying out researches, libraries and medical education.
- Currently it is giving active support for the improvement of agriculture, family planning and rural development.

COOPERATIVE FOR AMERICAN RELIEF EVERYWHERE

It is now renamed as Center for Assistance and Relief Everywhere (CARE). It is the largest, independent, non-profit based, Non-Governmental International Organization, founded in 1945 in North America, by the American donors to send food to the people of Europe, devastated by Second World War.

After the end of the Second World War, CARE extended the program of providing food needs for the developing countries, emergency aid and long-term development assistance to all countries.

Cooperative for American Relief Everywhere (CARE) began its operation in India in 1950, by funding, through the following services:

- Mid-day school meal program.
- ICDS – scheme.
- Educational and vocational training.
- Distribution of garden tools, pump sets and seeds for raising vegetable gardens in schools.
- Improvement of medical care by supplying medical equipment, mobile vans, X-ray machines, diagnostic sets,

eye glasses, glass-frames, drugs, books and medicines to Indian hospitals.
- It is helping in the projects such as Nutrition and Health Project, Anemia Control Project, Adolescent Girl's Project, Child Survival Project, Reproductive and Family Health Project, Konkan Integrated Development Project, etc.

Red Cross

This was founded by John Henry Dunant, a Swiss businessman, who was touched by the intense suffering and neglect of wounded soldiers of the battle of Solferino, North Italy, which was one of the most savage battles of the history, in 1859 Appalled by the thousands of wounded and dying soldiers, Dunant recruited volunteers from the nearby villages to help relieve their suffering. Dunant devoted his time, money and his talent to the cause of the wounded till he went bankrupt. He wrote a book 'Un Souvenir de Solferine' that stirred the conscience of the world and campaigned widely for the establishment of a voluntary society which would render aid to those wounded in war, without distinction of nationality.

As a result of Dunant's efforts, determination and persuation, he succeeded in holding an international conference, in 1864, at Geneva and a treaty was signed for the relief of the wounded and the sick soldiers. This resulted in the constitution of International Committee of Red Cross (ICRC), the founder organization of Red Cross, having branches all over the world. However, recognition came in 1901, when Sir Dunant received the first Nobel Prize for peace. In 1919, the League of the Red Cross Society was created with headquarters at Geneva, coordinating with 90 National Red Cross Society. It is the biggest relief organization in the world with two hundred million members and tens of thousands of employees.

World Red Cross Day is celebrated on 8th May of every year.

Thus, Red Cross is an independent, Non-Governmental, International Organization, concerned with offering humanitarian assistance in war-time and peace-time disastrous situations. Thus, Red Cross offers relief and rehabilitation services not only to the wounded and disabled individuals afflicted by war, but also later, it was extended to the people affected in famine, earthquake, floods and other natural or man-made calamities.

The Red Cross Society of India was established in 1920, by an Act of Indian legislature with the three objectives of improvement of health, prevention of disease and mitigation of suffering. Its activities are:
- Provision of amenities to soldiers in time of war.
- Organizing disaster relief services, in the form of milk, medicines, foods, vitamins, clothes, blankets, etc.
- Maintaining blood banks and promoting blood donation for the benefit of those wounded in wars or disasters.
- Development of maternity and child welfare services.
- In peacetime, it provides to the patients of military hospitals with such amenities as newspapers, periodicals, musical instruments and other comfort goods.
- It maintains Red Cross Home at Bengaluru for permanently disabled ex-servicemen, which is one of the pioneer institutions of its kind in Asia. It provides nursing and rehabilitative care of the disabled and paralytic ex-servicemen.
- It contributes to health care by providing equipment, drugs and supplies to the hospitals.
- It conducts health education campaigns.
- It provides First-aid services to the deserving cases and also training in First-aid through St John Ambulance Association of India.

The Junior Red Cross is one of the most active sections of the Society. It gives an opportunity to lakhs of boys and girls, all over India, to be associated with the activities such as upliftment of villages, provision of First-aid, control of outbreaks of diseases, building up of an international fraternity of youth, thus promoting international friendliness, understanding and cooperation.

Freedom from Hunger

This organization was established in 1946. It is working in 14 countries across the globe. It brings innovative and sustainable self-help solutions to the fight against chronic hunger and poverty.

Aga Khan Foundation

This was founded in 1967 by his Highness, Aga Khan. This foundation works in 11 countries including India. The overall program focuses on four major development areas—health systems, education (including early childhood care and development), rural development and income generation to alleviate poverty and NGO enhancement.

Save the Children Fund

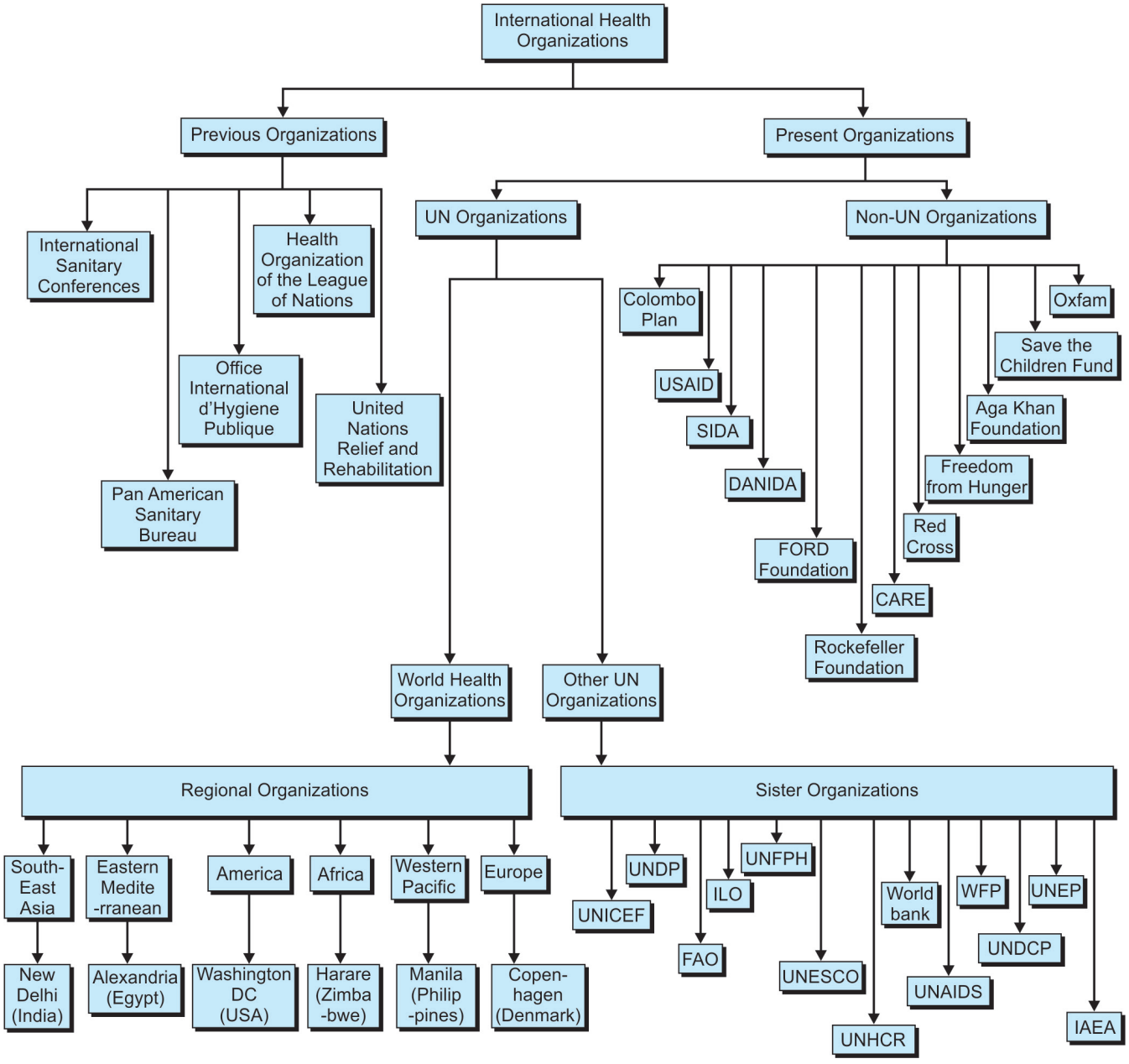
This is UK based charity, works in more than 70 countries. It was founded in 1919 to provide emergency relief to the children suffering from malnutrition as a consequence of First World War. Health care, education and welfare are the three main areas of work of this organization.

Oxfam

This is a confederation of autonomous NGO's committed to fight poverty and injustice in the world and work in many developing countries including India. Development activities and advocacy are the main planks of the work carried out by Oxfam.

The masterchart of international health organizations present and past are shown in **Flow chart 42.1**.

Flow chart 42.1 International Health Organizations: Past and Present



Other Voluntary Organizations

- International Planned Parenthood Federation
- Population Council
- International Leprosy Association
- International Agency for the Prevention of Blindness
- International Union against Cancer
- World Federation of the Deaf
- World Federation of the Medical Education.

BIBLIOGRAPHY

1. Dhaar GM, Robbani I. Foundations of Community Medicine 1st edn, 2006.
2. Gupta MC, Mahajan BK. Textbook of Preventive and Social Medicine, 3rd edn, 2003.

CHAPTER 43

National Health Programs

Ever since India became free, Government of India has been putting efforts (since 1947) earnestly to improve (to promote) the health status of the people by improvement of sanitation, living conditions, nutritional status and by control/eradication of diseases, both communicable and noncommunicable, getting assistance from various international organizations such as WHO, UNICEF, World Bank, and also from foreign agencies like SIDA, DANIDA, NORAD and USAID in the form of various technical and material assistance.

As per the recommendations of Bhore Committee, Government of India formulated and launched specific programs called 'National Health Programs' right from the inception of Five Year Plans (from 1951) for controlling/eradicating health problems.

The National Health Programs (NHPs) are of three kinds:

1. 100 percent centrally sponsored programs, but implementation is by the State Governments.
2. 50:50 centrally sponsored programs, i.e. the implementation is by the State Government However 50 percent of the expenses are incurred by the Central Government and remaining 50 percent by the State Government.
3. *Vertical programs*: In this type both the implementation and incurring expenditure is by the Central Government only.

It is easier to get international funds for the centrally sponsored programs.

Further, the central Government does not prelude the state Government from running their own scheme. For example, some states have their midday school meal program in addition to the central one.

Some of the NHPs have ceased, some got merged with others and some are recently introduced, as follows:

- The National Smallpox Eradication Program (NSEP) was launched in 1962. Smallpox reached zero incidence on 24 May 1975. India in 1977, was declared to have eradicated the disease by WHO. Since then NSEP has lapsed.
- The Applied Nutrition Program (ANP) was started in 1963. It was discontinued, during 6th Five Year Plan (1980-85).
- The National Cholera Control Program (NCCP), the National STD Control Program and the National Trachoma Control Program, were merged respectively with those for diarrheal diseases, AIDS and blindness and renamed as National Diarrheal Diseases Control Program (NDDCP), National AIDS control Program (NAIDS CP) and National Program for the Control of Blindness (NPCB) respectively.
- Some of the NHPs have been renamed as follows:
  - National Family Planning Program as National Family Welfare Program.
  - National Goiter Control Program as National Iodine Deficiency Disorders Control Program.
  - National Leprosy Control Program to National Leprosy Eradication Program and Since 2000 to Modified Leprosy Elimination Campaign (MLEC).
  - Expanded Program of Immunization to Universal Immunization Program.
  - National Malaria Control Program to National Malaria Eradication Program and then to Modified Plan of Operation of Malaria Control and now to National Anti-malaria Program.
  - State schemes for the control of Japanese Encephalitis, Dengue fever/Dengue Hemorrhagic fever have been upgraded into National Control Programs since 2003–04.

The National Health Program have been grouped into the following groups:

RELATED TO COMMUNICABLE DISEASES

1. National Anti-malaria Program (NAMP) (1999)
2. National Filaria Control Program (1955)
3. National Kala-azar Control Program (1991)
4. National Japanese Encephalitis Control Program (2003–04)
5. National Dengue Fever/Dengue Hemorrhagic Fever Control Program (2003–04)
6. National Leprosy Eradication Program (1983)
7. National Guinea-worm Eradication Program (1983)
8. National Polio Eradication Program (1995)
9. Universal Immunization Program (1985)
10. Revised National Tuberculosis Control Program (1993)
11. National Acute Respiratory Infections Control Program
12. National Diarrheal Disease Control Program
13. National AIDS Control Program.

RELATED TO NONCOMMUNICABLE DISEASES

1. National Program for the Control of Blindness
2. National Cancer Control Program (1975)
3. National Program for Control of Diabetes, Cardiovascular Diseases and Stroke.
4. National Mental Health Program (1982)
5. National Iodine Deficiency Disorders Control Program (1962).
6. National Program for Control and Treatment of Occupational Diseases.
7. National Program for the prevention and Control of Deafness.

RELATED TO NUTRITION

1. National Vitamin A Prophylaxis Program (1970)
2. National Nutritional Anemia Prophylaxis Program (1970)
3. National Special Nutrition Program (1970)
4. National Balwadi Nutrition Program
5. Mid-Day School Meal Program (1962)
6. Integrated Child Development Services Scheme (1975).

OTHER HEALTH PROGRAMS

1. National Tobacco Control Program
2. National Family Welfare Program (1953)
3. Reproductive and Child Health (RCH) Program
4. All India Hospital Postpartum Program
5. National Water supply and Sanitation Program (1954)
6. Minimum Needs Program (1974)
7. 20-Point Program (1975).

The first five (1 to 5) NHPs are together called as 'National Vector Borne Disease Control Programs'. These come under the national nodal agency of Directorate of National Anti-malaria Program (NAMP). The first three programs against malaria, filariasis and kala-azar were sponsored equally by State and Central Government till 2002-03. The other two programs related to JE and DF/DHF were sponsored by State Government. However, since 2003-04, Government of India launched National Vector Borne Diseases Control Program (NVBDCP) and has been sponsoring all the National Vector Borne Disease Control Programs. Emphasis has been paid more on the development of resources, standardization of diagnosis and treatment, improving quality of services and integration of vector control activities.

The differences between vertical and horizontal health program of India are shown in **Table 43.1**.

Table 43.1 Differences between vertical and horizontal health programs of India

Vertical programs	Horizontal programs
These are special health programs	These are integrated with general health services, starting from primary health centers
These are run by Government of India	These are run by State Health Department
These do get assistance from International Health Organizations	These do not get assistance from International organizations
These are unipurpose programs	These are multipurpose programs
Expert training is given to Medical Officers with special incentives	Routine training is given to paramedical workers
These are 'Target oriented''Crash' Programs	These are routine program
Examples: All National Health Programs except mentioned in the right column	Examples: Revised National Tuberculosis Control Program; Anti-malaria Program

NATIONAL ANTIMALARIA PROGRAM

History

Control of malaria in the country was first recommended by Bhore Committee in 1946. It was endorsed by the Planning Commission in 1951. Government of India, in April 1953,

launched National Malaria Control Program (NMCP), when malaria was the principal health problem. During 1953 malaria accounted for annual morbidity of 75 million cases, annual mortality of 0.8 million, proportional case rate of 10.8 percent, child spleen rate of 15.7 percent, child parasite rate of 3.9 percent and infant parasite rate of 1.6 percent.

The objective was to reduce the morbidity and mortality of malaria to such a low level that it should no more be a public health problem.

The strategy to achieve the objective was to interrupt the transmission of malaria by controling the vectors (anopheline mosquitoes) by indoor residual spraying with DDT, twice a year in endemic areas, where spleen rates were above 10 percent.

The NMCP was operated for 5 years (1953–58). During 1958, the problem of malaria was measured again. The annual incidence of malaria (which was 75 million during 1953) was reduced sharply to 2 million cases in 1958. Other malariometric indices also showed marked decline. The proportional case rate fell from 10.8 to 3.2. Thus malaria declined by more than 80 percent. It also paid rich dividends to the country in different fields like agriculture, land projects and industry. This was due to active functioning of 193 malaria program units, at rate of 1 unit for a population of 1 million.

NATIONAL MALARIA ERADICATION PROGRAM

Encouraged by the spectacular results of success of NMCP, it was decided by Government of India to eradicate the disease and therefore Government of India launched National Malaria Eradication Program (NMEP). But it was coupled with the fear that malaria vectors would develop resistance to insecticides, public might not cooperate for DDT spraying and malaria might spread to non-endemic areas. Weighing the pros and cons of the situation, Government of India decided in favor of eradication and launched NMEP during 1958.

The objectives were:

- Elimination of reservoir of infection (by case detection and prompt treatment), and
- Total ending of transmission of malaria, (by control of vectors)
- Prevention of re-establishment of malaria by 1968-69. (That means there should not be occurrence of malaria even in the presence of carrier mosquitoes).

The entire country was brought under NMEP including non-endemic areas, which were not covered under NMCP. The NMEP was carried out in the same 4 phases, as originally conceived for eradication of smallpox, namely preparatory phase, attack phase, consolidation phase and maintenance phase.

Preparatory Phase

This consisted of collection of data about the extent of the problem of malaria and to prepare for attacking the problem. Since the disease was just then measured during 1958, time was not wasted and so this phase was not taken up. The annual incidence was 2.0 million cases and proportional case rate was 3.2 percent.

Attack Phase

This was taken up directly and it was extended for 3 years from April 1958 to 61 April. The term 'Attack' implied on the attack of vector anopheline mosquitoes by the principal activity of spraying insecticides like DDT/BHC in all the human dwellings, twice a year. By 1959, entire country was covered. By 1960, Annual Parasite Incidence (API) came to 0.5 case per 1,000 population. Meanwhile a supportive activity was introduced, called 'Surveillance scheme (1960)'. This consisted of detection of cases by passive surveillance and presumptive treatment, by involving all the doctors working in hospitals, dispensaries and clinics.

Consolidation Phase

This phase was started when API was reduced to 0.1 per 1000 population, i.e. during 1961. The term 'consolidation' implies consolidation of the gains achieved during attack phase. The principal activity of this phase was stopping DDT spraying due to complete interruption of transmission and carrying out only active and passive surveillance and presumptive and radical treatment. The supportive activities were epidemiological investigation of cases and remedial measures for elimination of foci of infection including focal spraying, in case of focal outbreak, i.e. insecticidal spraying to be done in about 50 houses around *Plasmodium falciparum* infected house.

Active Surveillance

Under this, the surveillance workers (health workers male) were entrusted with the responsibility of detecting the cases of malaria actively. Each surveillance worker was allotted 10,000 population, distributed over 5 to 6 villages (or 2000 houses). He used to go to individual houses, once in a fortnight and ask two questions-anybody is suffering from fever in the family including guests and visitors on the day of his visit and also whether anybody had suffered from fever since his last visit. In either case with positive response, he takes blood smear and presuming that fever could be due to malaria, used to give 'Presumptive treatment' with 600 mg

chloroquine straight for adults and proportionately less for children. If the smear proves to be positive, he used to return and administer 'Radical treatment.' With 600 mg chloroquine and 15 mg primaquine on first day and only primaquine 15 mg daily from 2nd to 5th day. With this by 1961, API was reduced to 0.1/1000 population and the next phase was taken up **(Table 43.2)**.

Table 43.2 Presumptive and radical treatment of malaria (Under current anti-malaria program)

Type of treatment	Low-risk areas	High-risk areas
		(slide positivity rate is >3) *P. falciparum* is predominant or drug resistant cases/deaths due to *P. falciparum*
Presumptive treatment	Chloroquine 600 mg single dose for adults (4 tabs, each of 150 mg)	**Day 1:** Chloroquine 600 mg plus Primaquine 45 mg **Day 2:** Chloroquine 600 mg **Day 3:** Chloroquine 300 mg
Radical treatment	***P. vivax:*** **Day-1** Chloroquine 600 mg single dose + 15 mg Primaquine **Day 2-5 (4 days)** Primaquine 15 mg daily. ***P. falciparum:*** Chloroquine 600 mg Primaquine 45 mg	***P. vivax:*** Primaquine 15 mg, daily for 5 days ***P. falciparum:*** • No further treatment is required, after presumptive treatment • However in chloroquine resistant cases, single dose of the sulphadoxine (1500 mg) and pyrimethamine (75 mg) followed by 45 mg primaquine on the next day. (They are not given on the same day because of hemolytic crisis)

Severe and Complicated Cases of Malaria

- Hospitalization
- Drug of choice is quinine injection, 10 mg per kg body weight, IV drip in 5 percent dextrose-saline, to be run over 4 hours, 8th hourly. Switch over to oral dose as early as possible and total duration of treatment should be 7 days.
- Injection artemisinin may be used. Dose = 600 mg/day intramuscularly for 5 days.
- Injection artesunate, 1 mg/kg IM/IV 2 doses with an interval of 4 to 6 hour on first day followed by once a day for 4 days.
- Injection artemether, 1.6 mg/kg—in the same way as artesunate.
- Injection artether, 150 mg daily, IM for 3 days for adults only
- Mefloquine to be used only for *P. falciparum* cases resistant to chloroquine or other antimalarials.
- Sulphadoxine and pyrimethamine is not effective in *P. vivax* cases.

Note:

- Presumptive treatment is given to all the age groups and both the sexes including antenatal and postnatal women.
- Presumptive treatment is also given to fever cases reporting to drug distribution centers without obtaining blood smears.
- Children are given the drugs in proportionately smaller doses, starting with half a tablet for infants.
- Radical treatment is given for all cases proving microscopically positive.
- Radical treatment ensures complete cure and makes non-infectious.
- Infants are not given radical treatment.
- Infants and pregnant women are not given primaquine.
- Drugs must be administered cautiously as they are known to precipitate hemolytic crisis in glucose 6 phosphate dehydrogenase (G6PD) deficient individuals.

Passive Surveillance

This means cases of malaria to be detected by the doctors in the hospitals, nursing homes, dispensaries and such other static agencies by taking blood smear for examination from all those patients, coming with the complaints of fever, to rule out malaria and treat accordingly. This helped in detecting more cases.

By 1961, annual incidence came down to hardly 50,000 cases.

Maintenance phase: The word 'maintenance' implied maintenance of vigilance to detect re-entry of infection in those areas declared 'free' of malaria. This phase was started when no indigenous case of malaria was detected over a period of 3 years, including two years in the consolidation phase. The principal activity was a sustained vigilance to detect imported cases if any. The supportive activity was to eliminate the reservoirs. The vigilance activity was handed over to the State Government. Meanwhile 'Multipurpose Worker Scheme' was introduced. The responsibility of the malaria surveillance workers was handed over to multipurpose workers.

The scenario of malaria eradication was as follows:

- API came down to 0.1 per 1000 population,
- Annual incidence was hardly 50,000 cases,

- 25 percent of the population was under attack phase, 25 percent in the consolidation phase and 50 percent under maintenance phase.

Setbacks (Resurgence of Malaria)

From 1961, focal outbreaks of malaria began to occur and the annual incidence went on increasing year by year. By 1965, the cases reported were 1,00,000 (doubled).

By 1971, it was 1.32 million. The steady upward trend continued and by 1976, it touched an all time high of 6.4 million cases with 59 deaths.

Malaria came back with greater force, i.e., vectors developed resistance against DDT and parasites started developing resistance against chloroquine. Hence the term 'Resurgence'.

Causes

Resurgence of malaria was due to the following failures in the program.

- *Administrative failures*: These were due to shortage of money, manpower and materials.

Shortage of money was because of inadequate sanction of the budget and diversion of funds in favor of 'more obvious needs' such as family planning program.

Shortage of manpower was due to lack of field workers and deviation of malaria workers towards family planning program.

Shortage of materials were interruption in the supply of DDT from USA due to blockage of Suez canal and the shortage of other material such as drugs, spray equipment, vehicles, etc.

- *Technical failures*: These were due to the development of resistance by the vectors for insecticides and by the parasites to the drugs like chloroquine.
- *Operational failures*: These were inadequate surveillance activities, inadequate coverage with DDT spraying, non-cooperation of the public, premature take off to consolidation phase and maintenance phase, etc. resulting in the relaxation of efforts.

Modified Plan of Operation of Malaria Control

In response to alarming resurgence of malaria, Government of India appointed evaluation committees to suggest appropriate remedies to reverse the trend of malaria. The committee suggested a change over from eradication, to effective control. It was on the recommendations of this committee that the Government of India launched Modified Plan of Operation (MPO) with effect from April 1, 1977.

Objectives

- To reduce malaria morbidity.
- To prevent deaths due to malaria.
- To consolidate the achievements already made.
- To maintain agricultural and industrial production by undertaking intensive anti-malarial measures in the labor endemic areas.

The strategy adopted for achieving above objectives was based on API. Accordingly, the country was classified into two categories; area having annual parasite incidence of 2 or more and area having API less than 2 per thousand population. Certain changes were necessitated in the organization such as integration of the malaria organization with the state health system and re-inforcement of the integrated organizations.

- *Integration*: This consisted of re-alignment and re-constitution of malaria units, involvement of a chief medical officer for each district to carry out the work through medical officers of primary health centers. This resulted in the replacement of vertical approach by horizontal approach and the direct involvement of health infrastructure. The surveillance workers were replaced by multipurpose workers. The services were integrated with the routine health care services.
- *Reinforcement*: This consisted of strengthening the health infrastructure such as redesignation of malaria unit officers as District Malaria Officers, establishment of malaria laboratory in every primary health center manned by a trained laboratory technician. To improve the passive surveillance a network of Fever Treatment Centers (FTCs) and Drug Distribution Centers were established which are being run by voluntary workers from the community including school teachers, panchayat workers, dais and others. While DDC only supplies the anti-malarial drugs, the FTCs obtain a blood smear from fever cases and then supplies the anti-malarial drugs. Thus the reinforcement measures consisted of decentralization of anti-malaria activities including laboratory services, resulting in the reduction of the time lag between the collection of the blood smears and the collection of the laboratory reports. It also reduced the delay in the radical treatment of confirmed cases.

Urban Malaria Scheme

Urban Malaria Scheme (UMS) was launched during 1971, when it was realized that urban malaria was a significant problem and the vectors breed largely in man-made containers like over-head tanks, ornamental ponds, water coolers, flower-vases, building constructions, etc.

The objective was to control malaria by controlling the vector population through anti-larval measures.

The criteria for selection of the areas were:
- Population more than 50,000;
- Slide positivity rate (SPR) more than 5 ; API > 2 or
- Fever cases more than 30 percent.

Control strategies were:
- Early diagnosis and treatment of malaria cases
- Bioenvironmental management by source reduction measures such as emptying the water containers including overhead tanks, ponds, etc. once a week and observing weekly dry day.
- Controlling the larvae by weekly application of larvicidal oil, temephos, fenthion. Use of larvivorous fish as a good alternative method.

This scheme was further strengthened during 1976.

During October 1977, an additional component known as *'Plasmodium falciparum* containment program' was introduced to control falciparum malaria, by providing special inputs to strengthen the program getting assistance from Swedish International Development Agency.

Researches are encouraged by Indian Council of Medical Research (ICMR) to find out effective vaccines against malaria, effective drugs and better insecticides.

Health education to the public was given to extend their co-operation in the control of malaria.

Operational Details

1. For areas with API 2 or more, the following principal activities are carried out:
   - *Regular insecticidal spraying*: Two rounds of DDT spraying and if the vectors are refractory to DDT, 3 rounds of malathion recommended. If the vectors are refractory to both DDT and malathion, 2 round of synthetic pyrethroids are recommended. The dosage of DDT, malathion and pyrethroids recommended were 1.0, 2.0 and 0.25 g per square meter surface area respectively. BHC spraying was discontinued since 1.4.1997 in view of its adverse environmental pollution effects.
   - *Entomological assessment*: This is done by the entomological teams who study the behavior of the mosquitoes and identify the insecticides, which can give optimum results in an area. This is done periodically by the teams (i.e, to assess the susceptibility of the vector to insecticide).
   - Supportive activities are active and passive surveillance and presumptive and radical treatment.
2. *For areas with API less than 2*:

In these areas, the principal activities are active and passive surveillance and presumptive and radical treatment. The supportive activities are case follow-up, epidemiological investigation and focal spraying with DDT (BHC or malathion if a case of *P. falciparum* occurs in the area).

Follow-up used to be done by examining blood smears every month from all positive cases on completion of the radical treatment, for 12 months. If positive falciparum case is detected, a mass blood survey used to be carried out for identification of additional cases if any. The detected cases were given radical treatment and followed up.

MPO Achievement

1976: There were 6.4 million cases including 0.75 million falciparum malaria cases in the country with 59 deaths.

1977: Modified plan of operation (MPO) of malaria control was launched.

1980: API was 11.24.

1986: API became 3.22, annual incidence 2.1 million including 0.55 million cases of *F. malaria*. The problem was reduced to over 70 percet in 10 years. Then it remained static for 8 years. But during 1994, country witnessed sudden upsurge of malaria epidemics in Manipur, Nagaland and Rajasthan states with four-fold increase in malaria mortality.

During 1994, Government of India decided to change the nomenclature of the National Program and renamed it as 'National Malaria Action Program' (NMAP). Under this, 7 Northeastern states and states like Andhra Pradesh, Bihar, Gujarat, Maharashtra, Odisha and Rajasthan were selected in the country and the anti-malarial activities were intensified with additional inputs. It was 100 percent centrally sponsored program.

During September 1997, Government of India launched, 'Enhanced Malaria Control Project', (EMCP) with the support of world bank on September 30, 1997. The total cost of this project was ₹891 crores, spread over a period of 5 years. This benefited 100 selected districts and 19 urban areas.

The primary health centers were selected based on the following criteria:
- API of more than 2 for the last 3 years
- *P. falciparum* cases being more than 30 percent of total malaria cases
- 25 percent or more population of PHC being tribal:

The components under this project included were,
- Early case detection and treatment
- Control of vectors, (use of larvivorous fish)
- Personal protection methods (using insecticide treated mosquito nets)
- Epidemic planning and rapid response
- Intersectoral coordination.

Synthetic pyrethroids, bednets, rapid diagnostic kits, arteether injections, blister packs of drugs for radical treatment, are provided. Funds are provided for IEC activities and training. Village health guide is entrusted with the responsibility of distribution of chloroquine tablets to the

patients with fever, thus making the availability of the drugs within reach of the people. The EMCP was launched for a period of 6 years, i.e. up to March 2003. It was extended for 2 more years up to March 2005.

However during 1999, the program was renamed as National Anti-malaria Program. The components were:

- Malaria action program for rural areas
- Urban malaria scheme for urban areas
- Enhanced malaria control project for North-east states.

Roll Back Malaria

Roll black malaria (RBM) is a global partnership founded in 1998 by the WHO, UNDP, UNICEF and World Bank. The aim is to halve the world's malaria burden by the year 2010.

Political commitment is a key priority of RBM.

RBM is giving priority to four technical strategies:

- Prompt access to effective treatment
- Promotion of insecticide treated bednets and improved vector control
- Prevention and management of malaria in pregnancy and
- Improving the prevention of and response to malaria epidemics and malaria in complex emergencies.

RBM also seeks to encourage the research in new and better drugs, insecticides and malaria vaccines.

Goals

The goals for the malaria control set for the Tenth Five Year Plan are:

- ABER over 10 percent
- API 1.3 or less
- 25 percent reduction in malaria morbidity and mortality by 2007 and 50 percent by 2010.

REVISED NATIONAL DRUG POLICY (2010) FOR TREATMENT OF MALARIA

Preamble: Malaria is one of the major public health problems of the country. About 50 percent of the total (1.5 million confirmed cases annually) cases is due to *P. falciparum*. The rise in proportion is due to resistance to chloroquine, which was used as the first line of treatment for malaria cases. *P. falciparum* infections are known to result in complications.

National Drug Policy on Malaria was first formulated in 1982 and has subsequently been reviewed and revised periodically. The present policy of 2010 has been drafted keeping in view the availability of more effective antimalarial drugs and drug resistant status in the country. All fever cases suspected to be malaria should be investigated for confirmation of malaria by either microscopy or rapid diagnostic test (RDT).

Aims of the Policy

- To provide complete cure of the cases (both clinically and parasitologically).
- To prevent the development of complications and thus to reduce mortality.
- To prevent the development of relapses by administration of radical treatment.
- To interrupt transmission of malaria by use of gametocytocidal drugs.

To prevent the development of drug resistance.

Treatment of uncomplicated malaria:

1. *P. Vivax* cases should be treated with chloroquine for three days and primaquine for fourteen days. Primaquine is used to prevent relapse but is contraindicated in pregnant women, infants and individuals with G6PD deficiency **(Table 43.3)**.

   (*Note:* Patients should be instructed to report back in case of hematuria or high colored urine, cyanosis or blue coloration of lips and in such cases primaquine should be stopped. Fourteen days regimen of primaquine should be given under supervision). Care should be taken in patients with anemia.

Chloroquine: 25 mg/kg body weight divided over three days, i.e. 10 mg/kg on day 1 day 2 and 5 mg/kg on day 3.

+

Primaquine: 0.25 mg/kg body weight daily for fourteen days.

2. *P. falciparum* uncomplicated cases should be treated with Artesunate/Artemisinin combination therapy (ACT), i.e. artesunate 3 days + sulphadoxine – pyrimethamine on Day-1, accompanied by a single dose of primaquine on Day-2 **(Table 43.4)**.

Note:

- Each sulphadoxine–pyrimethamine tablet contains 500 mg and 25 mg respectively. Given on Day-1 only.

Table 43.3 Age-wise dosage schedule for treatment of vivax malaria cases

Age (years)	Chloroquine tablet (150 mg base)			Primaquine tablet (2.5 mg base)
	Day-1	Day-2	Day-3	Day -1 to Day – 14
<1	½	½	¼	0
1–4	1	1	½	1
5–8	2	2	1	2
9-14	3	3	1½	4
15 and above	4	4	2	6

Table 43.4 Age-wise dosage schedule for treatment of *P. falciparum* malaria cases

Age (yrs)	1st Day		2nd Day		3rd Day
	Artesunate (50 mg)	Sulphadoxine + Pyrimethamine	Artesunate (50 mg)	Primaquine (7.5 mg)	Artesunate (50 mg)
<1	½	¼	½	0	½
1–4	1	1	1	1	1
5–8	2	1½	2	2	2
9–14	3	2	3	4	3
15 and above	4	3	4	6	4

- Dose of sulphadoxine is 25 mg/kg body weight; pyrimethamine 1.25 mg/kg wt.
- Dose of Artesunate is 4 mg/kg body weight of 3 days.
- Primaquine 0.75 mg/kg wt, given on Day 2 only.
- Primaquine is contraindicated in pregnant women.
- ACT is not to be given during 1st trimester of pregnancy. However ACT can be given during 2nd and 3rd trimester of pregnancy.
- Uncomplicated falciparum malaria during first trimester of pregnancy with Quinine salt, 10 mg three times daily for seven days. Quinine may induce hypoglycemia. Therefore it is to be taken only after food and they should eat regularly. During 2nd and 3rd trimester, ACT to be given in **Table 43.4**.

3. Presumptive treatment with chloroquine is no more recommended. However in cases where parasitological diagnosis is not possible due to non availability of either microscope or Rapid Diagnostic Test (RDT), suspected malaria cases can be treated with full course of chloroquine, till the results are received. Once the diagnosis is available, appropriate treatment, as per the species, is to be administered.
4. Resistance should be suspected if the patient does not respond within 72 hours clinically and parasitologically. Such cases not responding to ACT should be treated with oral quinine with tetracycline/doxycycline. These instances should be reported to concerned District Malaria/State Malaria Officer/Regional Officer of HFW for initiation of therapeutic efficacy studies.
5. *Treatment of mixed infections (P. vivax + P. falciparum) cases:* All mixed infections should be treated with full course of ACT and primaquine 0.25 mg per kg body weight daily for 14 days.
6. Treatment of severe malaria cases.

Severe malaria case is an emergency. Treatment should be given immediately. Patient should be treated for associated complications also.

The guidelines are as follows:

- *Artesunate:* 2.4 mg/kg body wt IV or IM at the time of admission. Then at 12 hours and 24 hours and then once a day.

OR

- *Artemether:* 3.2 mg/kg body wt IM given on admission and then 1.6 mg/kg body wt per day.

OR

- *Arteether:* 150 mg IM daily for 3 days in adults only (not recommended for children).

OR

- *Quinine:* Loading dose of 20 mg/kg body wt on admission by IV infusion or IM in divided doses, followed by maintenance dose of 10 mg/kg body wt 8 hourly. The infusion rate should not exceed 5 mg/kg body wt per hour (loading dose of quinine may not be given if the patient has already received quinine).

The parenteral treatment in severe malaria cases should be given for minimum of 24 hours once started. After the parenteral artemisinin therapy, patients will receive a full course of oral ACT for 3 days.

Those patients who received parenteral quinine therapy should receive oral quinine 10 mg/kg body weight three times a day, including the days when parenteral quinine was administered, Plus Doxycycline 3 mg/kg body wt once a day or clindamycin 10 mg/kg body wt 12 hourly, for 7 days. (Doxycycline is contraindicated in pregnant women and children under 8 years of age).

OR

ACT as described.

Chemoprophylaxis

This is recommended for only selective group in high *P. falciparum* endomic areas. Use of Inseticide Treated Bed Nets (ITN)/Long Lasting Insecticidal Nets (LLIN) should be encouraged for pregnant women and other vulnerable population including military, paramilitary forces and travelers for longer stay.

- Short term chemoprophylaxis (up to 6 weeks):
  Doxycycline: 100 mg once a day for adults and 1.5 mg/kg wt for children (contraindicated for children below 8 years and not recommended for pregnant women). This should be started 2 days before travel and continued for four weeks after leaving the malarious area.

- Long term chemoprophylaxis (more than 6 weeks):
  Mefloquine: 250 mg weekly for adults and should be administered two weeks before, during and four weeks after exposure. (Mefloquine is contraindicated among those with history of convulsions, neuropsychiatric problems and cardiac conditions).

NATIONAL FILARIA CONTROL PROGRAM

National Filaria Control Program (NFCP) was launched during 1955 to control lymphatic filariasis in the endemic states of the country. It is endemic in 20 states and union territories. Non-endemic states are Jammu and Kashmir, Himachal Pradesh, Delhi, Sikkim and all North-Eastern states except Assam.

As per the survey made recently, about 420 million people are at a risk of infection, 25 million people have filarial parasites in their blood and about 19 million people are suffering from the disease.

The control strategy includes:

- Improvement of sanitation with a special emphasis on underground drainage system of sewage as a 'source-reduction' method of control of vectors
- Anti-larval operations
- Anti-parasitic measures by detection and treatment of microfilaria carriers,
- Organizing IEC campaigns for community awareness and participation
- Conducting annual single dose mass drug administration compaign using Diethyl Carbamazine (DEC) or DEC plus Albendazole combination.

NFCP is implemented through filarial control units, filarial clinics and survey units. Primary Health Care System provides treatment facilities. Thus vertical program has become horizontal program.

During 1978 June, the program was merged with urban malaria scheme for maximum utilization of available resources.

The Regional Filaria Training and Research Centers situated at Kozhikode (Kerala), Rajahmundry (AP) and Varanasi (UP), are under the control of Director, National Institute of Communicable Diseases, Delhi.

At present, there is no viable program for the control of filariasis.

Elimination of Lymphatic Filariasis in India

Elimination of lymphatic filariasis (ELF) from India by the year 2015 was set as a goal of National Health Policy 2002. It was resolved in the National Workshop held on January 5, 2004 in New Delhi to undertake MDA (Mass Drug Administration) in all the known 202 endemic districts commencing from June 5, 2004 to achieve the goal. WHO targets global elimination of LF by 2020.

Objectives

- To reduce eliminate transmission of lymphatic filariasis by mass drug administration of diethylcarbamazine citrate (DEC).
- To reduce and prevent morbidity in affected persons and
- To strengthen the existing health care services by involving NGOs, private and public sectors.

Salient Features of ELF Strategy

- Single day mass therapy with DEC at a dose of 6 mg/kg body weight annually.
- Management of acute and chronic filariasis and self care methods at door step.
- Information Education and Communication (IEC) activities are strengthened for inculcating individual/ community based protective and preventive measures for filarial control.
- Antivector measures to be continued as complimentary to antiparasite measures and microfilaria carriers are detected and treated with DEC for 12 days at 6 mg/kg body wt/day.

Mass Drug Administration

The International Task Force (WHO) has recommended that in mass treatment, DEC single dose, is given to almost everyone in the community irrespective of whether they have microfilaraemia or not, in the area of high endemicity, except children under 2 years, pregnant women and very sick patients.

Advantages of single dose mass therapy:

- It avoids the cost of a mass blood examinations program before treatment.
- It enhances the compliance as all the members of the community receive treatment.
- It is as effective as 12 day therapy.
- It involves decreased delivery cost.
- It does not require complex management infrastructure.
- It can be integrated into existing primary health care system.
- Single dose mass treatment has eliminated filariasis in some countries like Japan, Taiwan, South Korea and Solomon islands.

Guidelines for implementing mass drug administration:
These encompass a four pronged attack on the disease as follows:

- A single day mass DEC treatment at 6 mg per kg body weight once a year.
- Management of acute and chronic episodes (i.e., morbidity management) at the doorstep of patients.
- Strengthening Information Education and Communication (IEC) activities.
- The existing control measures in NFCP towns to be supplemented by single dose annual treatment with DEC.

Since it is not feasible do to weigh every individual in the field to calculate the exact amount of drug to be administered, it is convenient to adjust the dose schedule as per different age groups as follows.

DEC is now supplied to all MDA districts as 100 mg tablets. Age-wise dose schedule (Annual single dose MDA) streamlined.

Age (in years)	Dose of DEC	Number of tablets
<2	Nil	Nil
2–5	100 mg	1
6–14	200 mg	2
15 and above	300 mg	3

Note: Out of 202 endemic districts, 195 districts under DEC alone and in the 7 districts (six in Tamil Nadu and one in Kerala) are under co-administration with DEC + Albendazole 400mg to all eligible population except children below 2 years, pregnant women and critically ill persons.

This streamlined dose has been approved by National Task Force.

Drug delivery strategies: These are many as follows:

- House to house administration,
- Booth administration, (booth should not be located beyond one km from the community),
- Special population groups in places like schools, hospitals, offices, industries, prisons, etc.
- Community aggregations like market places, bus stands, railway stations, fairs, etc.

Consumption of DEC tablets by more than 85 percent population is the most crucial aspect in this program to achieve success. Therefore the recommended approach is 'supervised drug administration by door to door visit supplemented with drug administration at booths' preferably on a single day with three day mopping up operations. Every village must be provided with drug administrator, preferably with readily available biscuits to avoid consuming the drug on an empty stomach and to increase the drug compliance.

Critical areas: The critical areas which require focused attention in implementation of MDA are:

- Mobilization of adequate trained human resources
- Estimation of the quantity of the drug needed at each level, place indent with National Vector Borne Diseases Control Program well in advance and distribute to peripheral areas.
- Plan and implement IEC activities.

The drug requirement is be estimated as follows:

DEC = 100 mg tabs. Multiply the total population by 2.5.

Albendazole = 400 mg tabs. Multiply the total population by 1.

Nongovernmental organizations, community Based organizations, faith based organizations and Panchayats should also be involved in the elimination of lymphatic filariasis program. They also play an important role.

Bottle necks of MDA program:

Low compliance: Coverage of 40 to 60 percent is due to fear of side reaction.

Continued suppression needs adulticidal effect of MDA: To overcome this alternative dosage schedule are being planned to enhance acceptability and efficacy.

New strategy to achieve LF elimination:

- Lowering the dose of DEC tablets may help to reduce side reactions to enhance compliance.
- Lowering the interval of MDA (bi-annual) and increasing dose of Albendazole 800 mg tackles the more persistent amicrofilaramia leading to effective transmission block.

NATIONAL KALA-AZAR CONTROL PROGRAM (NKCP)

Kala-azar is currently endemic in states of Bihar, Jharkhand, West Bengal and Uttar Pradesh. The trends indicate the growing menace of this disease. There were 17806 cases with 72 deaths in 1986 due to Kala-azar. It rose to 77,102 cases with 1419 deaths in 1992. However, during 1995, it declined to 22,625 cases and 277 deaths, indicating arrest of progress of this disease.

The strategy of Kala-azar control includes:

- Control of vectors (sandfly) by undertaking indoor residual insecticidal spraying operations twice annually.
- Early case detection and complete treatment
- IEC campaigns for community awareness and community involvement.

The Directorate of National Anti-Malaria Program has a Kala-azar control cell, which monitors the implementation of the control activities in the endemic areas.

This program is making a significant progress. Encouraged by the results of the program, Government of India is envisaging the elimination of Kala-azar by the year 2010. To achieve this goal of elimination, Government of India has decided to provide 100 percent central support from the year 2003–04.

NATIONAL JAPANESE ENCEPHALITIS CONTROL PROGRAM (NJECP)

Japanese encephalitis is endemic in states of Andhra Pradesh, West Bengal, Assam, Tamil Nadu, Karnataka, Bihar, Haryana, Kerala and Uttar Pradesh. In 1995, there were 2974 cases and 622 deaths due to JE.

The operational strategy for the control JE comprises:

- Early case detection and prompt management
- Control of vectors (*Culex vishnui* mosquitoes)
- Sentinel surveillance including clinical surveillance of suspected cases
- Identification of high-risk groups
- Development of a safe and standard indigenous vaccine
- IEC campaign for community participation.

The Directorate of National Anti-malaria Program monitors the control activities.

NATIONAL DENGUE FEVER/DENGUE HEMORRHAGIC FEVER CONTROL PROGRAM

During 1996, an epidemic of dengue fever was reported in Delhi. Since then, epidemics have been reported from other parts of India.

The technical assistance for investigation, prevention and control of Dengue/DHF outbreak is provided to the State Government through Directorate of NAMP and NICD, Delhi.

NATIONAL LEPROSY CONTROL PROGRAM

Initially, the program for leprosy control was launched as National Leprosy Control Program (NLCP) during 1955, as a centrally aided program. The objectives were:

- To make the infectious case, non-infectious (to arrest transmission)
- To reduce the magnitude of the problem.

The strategies formulated were:

- To detect cases of leprosy early and to provide treatment with sulphone monotherapy through trained workers, on ambulatory basis.
- To give health education to the patient, family and community at large.

Sulphone chemotherapy was carried out by administering progressively increasing doses of the drug, initiated with 10 mg daily which was gradually increased to the standard dose of 100 mg daily over a period of 6 months by appropriate monthly increments.

Even after two decades, the NLCP could not give the desired results and the leprosy scene did not change much. The program lacked momentum due to various reasons, such as sulphone monotherapy resistance, administrative shortfalls in manpower, frequent transfers of medical officers, lack of interest in doctors, delay in release of funds, etc. Thus NLCP proved to be input oriented rather than output oriented program.

NATIONAL LEPROSY ERADICATION PROGRAM

Eventually a breakthrough was achieved in 1981, when WHO recommended the use of combined chemotherapeutic regimens (multidrug therapy) for the treatment of leprosy. Based on the recommendations of the Working Group, Government of India switched over from NLCP to National Leprosy Eradication Program (NLEP) during 1983 with a goal to eradicate leprosy from India by 2000 AD introducing multidrug therapy as the mainstay of the eradication process. During 1981, the prevalence rate of leprosy in India was 57/10,000 population. During 2004, it was reduced to 2.4/10,000 population.

At the outset, the objective of NLEP was to achieve elimination of leprosy in the country by the year 2000, by reducing the case load of the disease to 1 or less per 10,000 population with the following strategies.

- Intensification of early case detection by population survey, school survey, contact survey, etc.
- Multidrug chemotherapy (MDT),
- Health education,
- Rehabilitation services.

Multidrug Treatment

Multidrug chemotherapy used to be initiated only after confirmation of the disease and classified as multibacillary (infectious) and paucibacillary (non-infectious) categories. The treatment used to be given in a phased manner (2 phases) as follows:

Multibacillary Leprosy

- Intensive phase (lasting for 14 days)
  - Rifampicin 600 mg daily (supervised)
  - Clofazimine 300 mg daily (supervised)
  - Dapsone 100 mg daily (supervised)

- Continuation phase (lasting for 2 or more years).
  - Rifampicin 600 mg once a month (supervised) (pulse dose)
  - Clofazimine 50 mg daily and 300 mg (supervised) once a month.
  - Dapsone 100 mg daily (unsupervised).

Where clofazimine is totally unacceptable owing to discoloration of skin lesions, it used to be replaced by 250 to 375 mg of self administered daily dose of ethionamide and protionamide.

Duration of treatment used to be for a minimum of 2 years or until 2 consecutive skin smears taken at monthly interval become negative, whichever is later.

The follow-up was done once in 6 months for 5 years.

Paucibacillary Leprosy

Rifampicin 600 mg once a month (supervised)
Dapsone 100 mg daily (unsupervised)

MDT is very effective with high cure rate and zero relapses. It prevents deformities and lepra reactions.

Duration of treatment was for one year and follow up was once in 6 months for 2 years.

Infrastructure

National Leprosy Eradication Program was implemented through the establishment of following infra-structures:

- Leprosy control units
- Survey education treatment centers
- Urban leprosy centers
- Mobile leprosy treatment units.

Leprosy Control Unit (LCU)

This is established in leprosy endemic areas with the prevalence rate of 5 or more per 1000 population, each unit serving a population of 4.5 lakh. Each unit had a staff pattern of 1 medical officer, 2 non-medical supervisors, and 20 para-medical workers, (PMW), each PMW covering a population of 15,000 to 20,000 and is expected to examine 8000 persons per year by house to house survey in his areas of jurisdiction. Each PMW was specially trained to institute domiciliary treatment. Thus it was a 'vertical program.'

Survey Education Treatment Centers

One Survey education treatment (SET) center is established for a population of 25,000 in those endemic area, where the prevalence rate of leprosy is less than 5 per 1000 population. They are attached to the Primary Health Center. Each center is manned by one para-medical worker (PMW), one non-medical supervisor for every 4-5 paramedical workers and the MO of the attached PHC is the administrative, controlling officer. Only one para-medical worker is attached to a SET center. Thus 'Horizontal Program' is recommended for low endemic districts.

Activities under SET:

Survey: The whole population is surveyed by the PMW to detect cases of leprosy. The school children are also surveyed. During the survey, the investigator (PMW) looks for hypopigmented patches for the loss of sensation over the body, in good day light, with minimum clothes and palpates peripheral nerves for thickening. Such cases are then referred to MO for further confirmation.

Education: The PMW gives health education to the patient that leprosy is curable and he should take treatment correctly and completely. He educates the family that not all cases are infectious, it is caused by bacteriae, there is treatment and that the patient should be shown sympathy and should not be thrown out of the family.

Treatment: All paucibacillary cases are treated with a combination of dapsone (DDS) and rifampicin and all multi-bacillary cases with dapsone, rifampicin and clofazinine. This is called multidrug therapy (MDT).

Urban Leprosy Centers

Such Urban leprosy centers (ULC) were established in urban endemic areas, one for every 50,000 population. It is manned by a nonmedical supervisor, who functions under the supervision of the medical officer.

Mobile Leprosy Treatment Unit

Such unit provides services to leprosy patients in non-endemic areas. Each such unit consists of one medical officer, one nonmedical officer, one nonmedical supervisor, two paramedical workers and a driver.

All these organizations (infrastructures) work under the administrative control of the State Program Officer, placed in the Directorate of Health Services. The State Program Officer (i.e., State Leprosy Officer) is the chief co-ordinator and the technical advisor to the concerned State Government.

At the central level, the Leprosy Division of the Directorate General of Health Services, New Delhi is responsible for planning, supervision and monitoring of the program. The division is under the control of a Deputy Director General who advises the Government on all antileprosy activities.

Progress of National Leprosy Eradication Program

With the introduction of multidrug therapy (MDT), it opened a new avenue in the control of leprosy in the country. With MDT services under the NLEP, a large number of leprosy cases are being discharged as 'Disease cured.' For the first time in 1987, the number of MDT cured cases was 10 percent more than the number of new cases detected and this percentage of cured

cases gradually increased subsequently. It became 25 percent in 1988, 38 percent in 1989 and over 90 percent in 1991–92.

The annual case load, which was 4.29 lakh during 1994, was reduced to 2.2 lakh during 2004. The overall prevalence rate which was 57.6 per 10,000 population during 1981, brought down to 2.3 per 10,000 by 2004.

Program Assistance

Nongovernment organizations (NGOs) also have contributed on functioning of the program. More than 290 NGOs are working in the field of leprosy throughout the country.

Besides the NGOs, several international agencies contribute to the leprosy elimination effort in the country. Among these WHO extends money, man-power and material assistance to NLEP. It supplies drugs in the form of blister packs separately for multi-bacillary and paucibacillary leprosy cases and made available free of cost in all the primary health conters. World Bank has offered financial assistance to the program. Support has also come from Danish International Development Agency (DANIDA) and International Federation of Leprosy Elimination (IFLE).

Research is carried out mainly in central JALMA Institute of Leprosy at Agra and the Central Leprosy Teaching and Training Institute at Chingelput, Chennai, India.

Modified Leprosy Elimination Campaign (MLEC)

The NLEP was appraised in April 1997 and observed that even though there was good progress at national level, it was uneven in some states. So it was decided to launch leprosy elimination campaign. (Elimination of leprosy means reducing the prevalence rate to such a low level, that it is no longer a public health problem, i.e, to less than 1 case/10,000 population). It is presumed that at this low level, transmission of *M. leprae* would be reduced and the disease will extinct.

The multidrug treatment regimen for leprosy was modified under elimination compaign with effect from November 1, 1997, as recommended by WHO Leprosy Elimination Advisory Group of Expert Committee.

The multi drug treatment (MDT) is given free of cost in all the Government Hospitals, PHCs and Community Health Centers. The drugs are available in blister packs. Each blister pack contains drugs required for one month. The blister packs are different for Paucibacillary and Multi bacillary leprosy and for adults and children.

Regimen for Paucibacillary Cases

1. Single skin lesion—single dose
   Adults: Rifampicin—600 mg
   Ofloxacin—400 mg
   Minocycline—100 mg
   Children: Half the adult dose
   Follow-up: Once in a year for 2 years.

Note: If there is no improvement, treatment to be extended for 6 months, with Dapsone daily and Rifampicin once a month as below.

2. Single nerve lesion with 2–5 skin lesions.
   Adults: Dapsone—100 mg daily self-administered
   Rifampicin—600 mg, once a month, supervised.
   Children: Proportionately less
   Duration of treatment: 6 months
   Follow up: Once a year for 2 years.

Regimen for Multibacillary Cases

Adults: Dapsone – 100 mg daily. Self administered.
Clofazimine – 50 mg daily or 100 mg on alternate days. Self administered.
Clofazimine – 300 mg ⎫ monthly (Pulse) dose
Rifampicin – 600 mg ⎭ (Supervised)
Children: Proportionately less
Duration of treatment: 12 months
Follow up: Once a year for 5 years.

This campaign comprises a package of four activities namely:

- Teaching and training to all health staff
- Intensified IEC activities
- Case detection by house to house visits to detect new leprosy case and
- Correct and complete treatment.

The goal was to eliminate leprosy by the year 2005. Several such rounds of campaigns have been executed. First round of campaign led to detection of 4.63 lakh cases. Second campaign was carried out from January to March 2000 with detection of 2.13 lakh cases. Third campaign was carried out from October 2001 to February 2002 with detection of 1.65 lakh cases. Fourth campaign was carried out from August 2002 to March 2003 leading to detection of 1.04 lakh cases.

The fourth campaign was different from the first three campaigns in that the states were divided into three categories.

Category I: Eight states were taken up. In areas with prevalence rate of more than 5/10,000 population, active search by house to house visit was taken up and in areas less than 5/10,000 population, voluntary reporting centers (VRCs) were organized.

Category II: This included 14 moderate to low endemic states, where extensive IEC activities were taken up along with training of health personnel and active search of new cases.

Category III: This included 13 very low endemic states where extensive IEC activities and passive detection of leprosy cases in health centers were carried out.

The fifth campaign was carried out during December 2003 to March 2004 in six high priority areas namely Bihar, Chhattisgarh, Uttar Pradesh, Maharashtra, Andhra Pradesh and West Bengal states. The activities carried out in these states were as follows:

a. *For urban areas:* Voluntary Reporting Centers were organized and IEC in slum areas.
b. *For rural areas:*
   - In areas with leprosy prevalence rate of more than 5 per 10,000 population active search for the cases and
   - In areas with prevalence rate of less than 5 per 10,000 population, VRCs and Special Action Project for Elimination of Leprosy (SAPEL) were established for early case detection and treatment.

SAPEL constitutes an important initiative aimed at providing MDT services to those patients living in remote areas or under difficult conditions as well as those belonging to underserved population including tribal areas. The main purpose is to reach the undetected cases and cure them (reach the unreached).

Leprosy Elimination Monitoring

Leprosy Elimination Monitoring (LEM) consists of assessing the performance of elimination campaign on various issues like case detection, quality of services like treatment, IEC activities, drug supply, management, etc. This is carried out by National Institute of Health and Family Welfare (NIHFW), New Delhi, every year in 12 endemic states, for three years since June 2002.

So far 15 states have reached the goal of elimination of leprosy, i.e., prevalence rate is reduced to less than 1 per 10,000 population. WHO Technical Advisory Group had suggested a Pilot testing of Validation of Elimination of Leprosy by Lot Quality Assurance Sampling Technique.

NATIONAL GUINEA WORM ERADICATION PROGRAM (NGEP)

During 1984, a total of 40,000 cases of dracunculiasis were reported from 7 endemic states of Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Madhya Pradesh and Rajasthan. Then Government of India launched NGEP during 1984 with assistance from WHO with the following strategies:

- Active surveillance for case detection and treatment
- Vector control (of Cyclops) by chemical (Temephos) treatment of water
- Provision of safe drinking water on priority in edemic areas
- Health education of the public.

Simple epidemiology of guinea worm disease (Dracontiasis), each method of vector control and public cooperation by health education helped to control the disease easily so much so the incidence of the disease was brought down to 'zero' by August 1996. Consequently, International certification team from WHO visited India from 9th to 25th November 1999 to assess guinea worm situation in the country. The team presented its report to International Commission in February 2000 for certification of Dracunculiasis Eradication in India, where upon WHO declared India as a guinea worm free country, on 15th February 2001 and advised the Government to maintain surveillance of the guinea worm disease till its global eradication. Since then continued surveillance has failed to detect new case of the disease. This is a major national achievement of recent times.

UNIVERSAL IMMUNIZATION PROGRAM

During May 1974, WHO launched a global immunization program called 'Expanded Program of Immunization' (EPI) to protect all the children of the world against 6 major, vaccine preventable, killer diseases namely diphtheria, pertussis, tetanus, tuberculosis, measles and poliomyelitis with 3 doses of DPT and OPV and 1 dose each of BCG and measles vaccine during infancy, starting from 3rd month of infancy, extending up to 16 years of age and also to protect all expectant mothers of the world with 2 doses of tetanus toxoid to prevent neonatal tetanus, as a continuous on going program.

During January 1978, Government of India launched the same EPI program in India, with the same schedule with same objectives of reducing the morbidity and mortality among children. Meanwhile Government of India became signatory to Alma-Atta declaration of achieving the Global Social target of 'Health for All by 2000 AD' in which the goal was to achieve universal immunization coverage of the children and expectant mothers.

Since the momentum of the immunization program was slow, it was observed that Infant Mortality Rate was not coming down proportionately. Therefore it was felt to strengthen the existing program by concentrating more on the infants and expectant mothers (and not children up to 16 years of age). Eventually on 19th November 1985 (Late Prime Minister Mrs Indira Gandhi's birthday), Government of India redesignated the EPI program as 'Universal Immunization Program' (UIP) with the objectives of eliminization of neonatal tetanus and paralytic poliomyelitis by 2000 AD with the following strategies:

- 100 percent coverage of expectant mothers with 2 doses of tetanus toxoid
- At least 85 percent coverage of infants with 3 doses of DPT and OPV and one dose each of BCG and MV by 2000 AD.

Thus, UIP became a time bound (i.e., 2000 AD) and target oriented (mothers and infants) program. To achieve these goals, the immunization schedule was changed and immunization was recommended from birth-itself. Meanwhile a reliable surveillance system was developed. Immediate reporting of cases of neonatal tetanus and poliomyelitis was made mandatory. This resulted in significant decline in the incidence of vaccine preventable diseases and also IMR. The country became self sufficient in the production of the vaccines. The cold-chain system for the storage, distribution and transportation of the vaccines was also developed. During 1992, under the National CSSM program (vide below), the objectives were elimination of neonatal tetanus and eradication of poliomyelitis.

NATIONAL POLIOMYELITIS ERADICATION PROGRAM (NPEP)

Historical Perspective

Government of India (GOI) launched Expanded Programme of Immunization (EPI) in the year 1978. During 1985, the EPI was upgraded into Universal Immunization Program (UIP) by concentrating immunization services to infants and pregnant mothers. During May 1988, World Health Assembly passed a resolution to achieve the goal of Global Eradication of Poliomyelitis by the year 2000, which was the second landmark in the field of immunization. (First landmark was eradication of smallpox). Accordingly, Government of India also had to set the goal of eradication of poliomyelitis by the year 2000 AD.

During 1992, GOI upgraded the Maternal and Child Health (MCH) services into a national program called "Child Survival and Safe Motherhood" (CSSM) program and set the goal of eradication of poliomyelitis under primary immunization of "Child Survival" component of the CSSM program, by 100% coverage of infants with routine immunization. During December 1995, GOI introduced a strategy, called "Pulse Polio Immunization Programme" (PPIP), complimented by Acute Flaccid Paralysis (AFP) surveillance activity during 1997 and also Mop up round of Immunization. GOI has committed to sustain and maintain this massive effort until the wild polio virus is eliminated from the nature.

Strategies of Polio Eradication

- Routine immunization
- Supplementary immunization
- Acute flaccid paralysis surveillance.

Routine Immunization

This is the immunization of all infants with three doses of OPV in all the hospitals and primary health centres, as a routine during 6th, 10th and 14th week. Such coverage of routine immunization among infants must be sustained and maintained at a high level of 100% because unimmunized children maintain the foci of infection. High level of immunization coverage will not only reduce the incidence of poliomyelitis to a very low level but also will set a stage for eradication of poliomyelitis. Countries which are polio free, must also continue to maintain a high level of routine immunization coverage to protect themselves against importation of polio virus. No nation will be free of poliomyelitis until all the countries in the world become free, because of jet travel days. By 1996, 150 countries became polio free.

Supplementary Immunization

This has three components:

1. Pulse polio immunization
2. Subnational immunization
3. Mop-up immunization.

Pulse polio immunization (PPI): This concept was introduced by Government of India during 1995. The term "Pulse" denotes sudden, simultaneous, mass administration of OPV to all under five children in the entire country, with cent percent coverage, with 2 doses of OPV, each of 2 drops, with six weeks interval, on the indicated days (polio Sundays) during the lowest transmission season, October to February, irrespective of the previous polio immunization status. These indicated dates are called as National Immunization Days (NIDs).

- These doses are only supplementary and not substitutes to the routine immunization.
- There is no minimal interval between the routine immunization and Pulse Polio Immunization. (That means even if the child had received routine OPV on the previous day of PPI – Sunday, it has to be given PPI dose).
- There are no contraindications for PPI.

This concept of PPI came into vogue because inspite of very good coverage of routine immunization under UIP (Universal Immunization Program) a small percentage (of about 10%) of children are not covered. They can act as reservoir. Since it is not possible to identify this small percentage of unimmunized children, it was recommended by GOI that there must be cent percent coverage of all <5 children, on a particular day, (Polio Sunday) so that not even a single unimmunized gut should be available to the polio virus.

To start with during 1995, it was only one day booth activity and the target age was fixed upto 3 years. In the next year 1996, the target age was extended to 5 years. GOI has committed to maintain this Herculean task until the wild virus is eliminated from the nature and the disease is eradicated.

Mechanism: The polio virus can remain alive outside the human body for several days to several weeks but cannot multiply. For the virus to multiply and continue its progeny, it has to pass through the unimmunized gut within 48 hours of its excretion. Since there is 100% coverage of under fives

on PPI days, and not even a single unimmunized gut is available, the polio virus cannot multiply and dies on its own in a natural way. Moreover the immunized child, when drinks contaminated water containing wild polio virus, it is acted upon by IgA of the gut, becomes avirulent and is excreted as vaccine progeny virus. Thus PPI, helps in the replacement of wild polio virus by vaccine progeny virus and thus in the eradication of poliomyelitis. However, PPI will be effective only if there is high level of routine immunization coverage of more than 85%, preferably 100%.

With the concept of PPI, there was reduction in the incidence of poliomyelitis but not to satisfactory level. There were continuous outbreaks of poliomyelitis. Inspite of PPI, many children were missed on PPI day. So GOI intensified PPI programme during 1999 from one day booth activity to three days programme called "Intensified Pulse Polio Immunization Programme" (IPPIP). It was intensified in order to detect and immunize the "Missed and Eligible" children, who were not immunized in the booth, on the first day of the program. To detect the missed and eligible children, all children who got OPV on the first day, are marked with gentian violet on the little finger. So it became an extra effort to reach the unreached.

On the second day "House to House" visit is made by the health worker and mark "X" for those houses, which were locked, who were not cooperative or target child is not having gentian violet mark on the little finger and mark "P" for those houses, where target children are immunized or target children are not available.

On third day, visit is made only for those houses marked "X" and immunize the missed and eligible children, mark the little finger with gentian violet, wipe off the "X" mark and convert into "P" mark.

With IPPI programme, there was drastic reduction in the incidence of poliomyelitis in the country from 1999 to 2001. The distribution and location of the polio virus in India over the years is shown in the **Figure 43.1**.

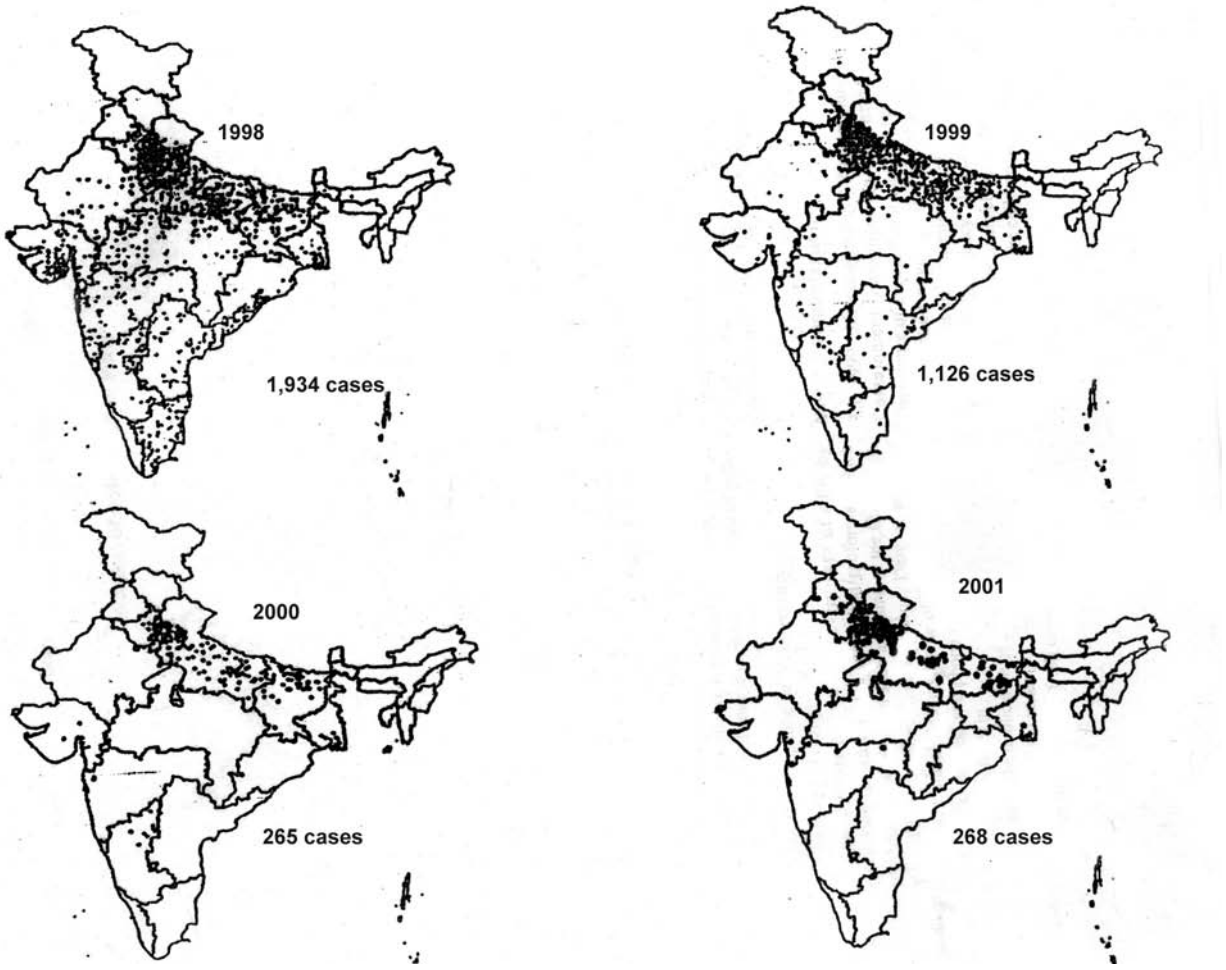


Fig. 43.1 Location of poliovirus in India, 1998-2001
Source: National Polio Surveillance Project

Subnational immunization: During 2002, there was set back of poliomyelitis. Large number of polio cases were reported from North India **(Fig. 43.2)**. there was widespread and dispersed transmission. So the program was further intensified from 2 rounds of immunization during December and January to 4 rounds, from October, November, December to January, each round with three days activity and called it as Sub National Immunization (means extra immunization carried out in sub part of the country). These days are called as "Sub National Immunization Days (SNID).

The very purpose of intensification of the program is not to miss any child for OPV and to cover cent percent immunization.

With pulse polio and sub national immunization, there was remarkable decline in the incidence of poliomyelitis in the country, by 2005 **(Fig. 43.3)**.

Subsequently during 2006, there was set back of poliomyelitis, in Bihar and UP inspite of 4 rounds of sub-national immunization and the number of cases reported were 784. During 2007, 2008 and 2009, the number of cases reported were 874, 559 and 732 respectively **(Figs 43.4A and B)**. Following barriers were identified for increase in the number of cases, such as technical, administrative, social, cultural and demographic barriers.

Technical barriers were limitation of the vaccine itself, associated conditions in the children such as malnutrition, diarrhoeal diseases, enterovirus infections etc, interfering with the vaccine.

Administrative barriers include maintenance of cold chain, failure of vaccine vial monitor (VVM) as a surrogate marker of the vaccine potency.

Social barriers like gender, caste, purdah system also limited the acceptance of the vaccine.

Cultural barriers were the various myths and blind beliefs regarding immunization.

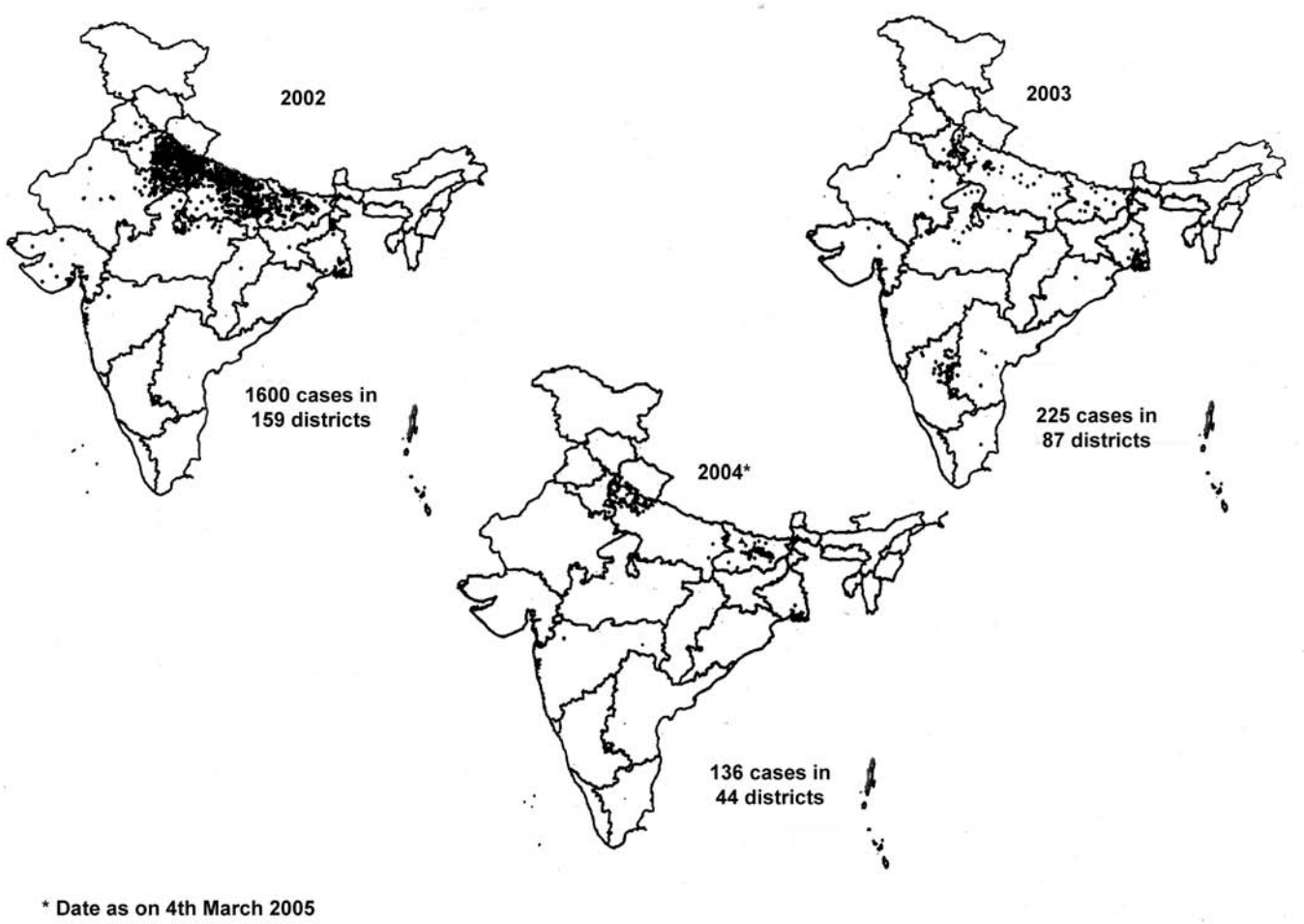


Fig. 43.2 Location of poliovirus in India, 2002–2004
Source: National Polio Surveillance Project

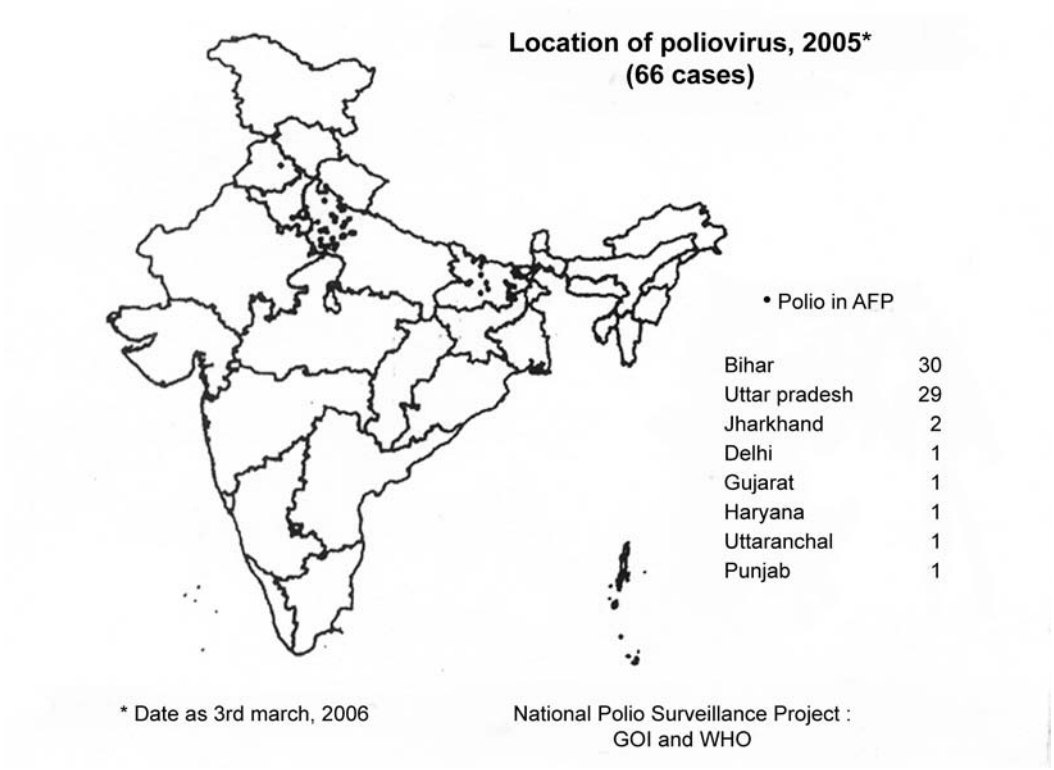


Fig. 43.3 Location of poliovirus 2005

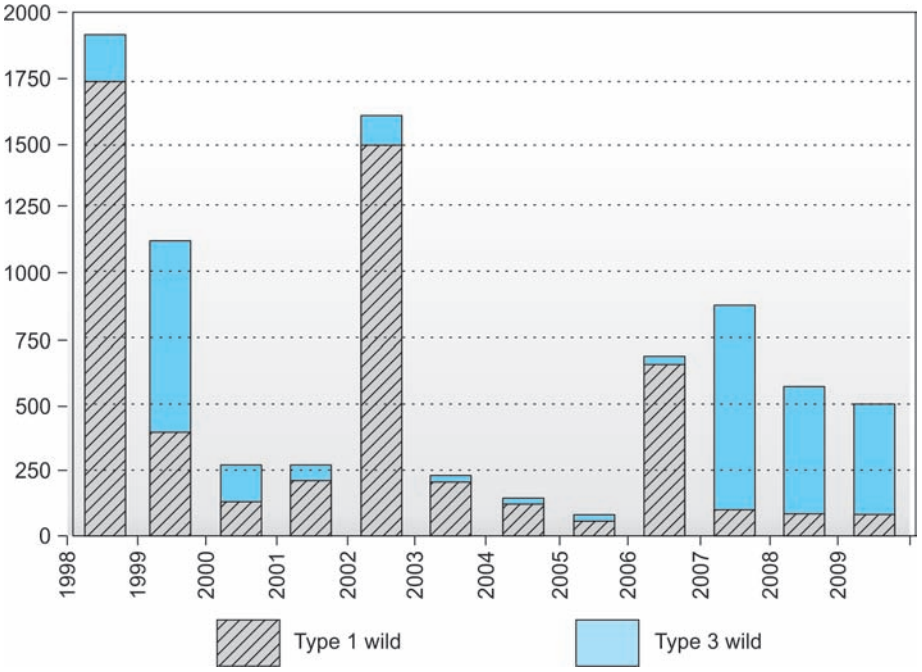


Fig. 43.4A Distribution of polio cases in India according to type of polio virus, over the years

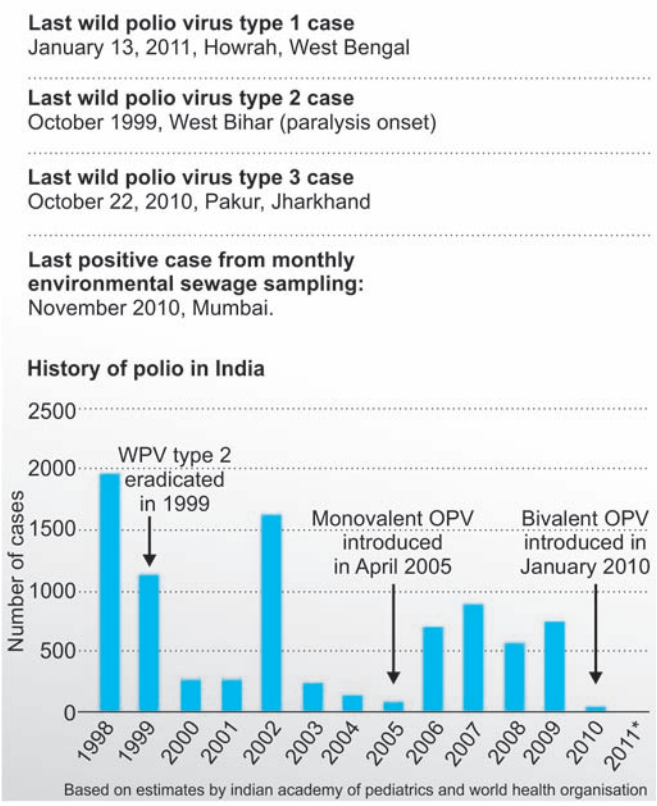


Fig. 43.4B Distribution of polio cases in India over the years and the milestones of history of polio

Demographic barriers are poverty, illiteracy, ignorance, indifferent attitude towards immunization, migration of the population etc.

To overcome these barriers, expert group, recommended six national immunization days and nine subnational immunization days, specially in Central Bihar and Western Uttar Pradesh. Since there was nothing wrong with the quality of the vaccine, following measures were recommended for Bihar and Uttar Pradesh states.

- To focus on better conversion of "X" marked houses,
- To consistently vaccinate the children,
- To effectively improve the microplans,
- To improve IEC activities and social mobilization,
- To make senior officers accountable for their areas,
- To maintain high level of AFP surveillance,
- To use Salk Vaccine (IPV) in the routine immunization and
- To use Bi-valent Vaccine (containing type 1 and type 3 viruses, because type 2 was eliminated during 1999) in pulse polio programme.

With these measures there was remarkable decline in the incidence of polio in India (Fig. ???). Uttar Pradesh and Bihar have not reported any case of polio since April 2010 and September 2010 respectively.

Mop-up immunization: It was felt during 1999 that there was more than 85% immunization coverage in the country and not even a single case of polio is expected. If at all a case of poliomyelitis occurs in an area where immunization coverage is more than 85%, it is considered as an "Epidemic" of poliomyelitis and is a "Public Health Emergency". The medical officer of that area should immediately notify to the concerned Dist. Immunization Officer and carry out containment measures as a Fire Fighting Action on War Foot Step, within 48 hours of reporting of the case, by immunizing all under fives living within 5 km radius of the infected house in the rural area or about 2000-3000 children in the urban area, irrespective of their immunization status, with two rounds of OPV with 4 weeks interval. This is called "Mop up round of immunization" or "Outbreak Response Immunization" (ORI). Meanwhile active search is also made to detect other AFP cases if any.

Acute Flaccid Paralysis (AFP) Surveillance

AFP means sudden onset of flaccid paralysis of the limb (of lower motor neurone type) of four weeks duration, in a child below 15 years of age, with loss of tone and deep tendon reflexes and the limb is floppy or flaccid without sensory loss. Such AFP cases are not only due to poliomyelitis but also due to Guillian Barre Syndrome, transverse myelitis or traumatic neuritis. (Thus all AFP cases are not polio, but all polio cases are AFP cases).

Surveillance means case detection. AFP surveillance means detection, reporting and investigation of all AFP cases and not just only polio cases. In otherwords AFP surveillance means surveillance for suspected or possible polio case.

AFP surveillance is an activity introduced during 1997, to detect the last case (final reservoir) of poliomyelitis, so as to enable to declare the country as polio free, if zero incidence is maintained for three consecutive years, from the date of detection of last case. It is like a manhunt for polio virus. This is a greatest challenge to health system to detect the last case of polio. It is being conducted by a network of Surveillance Medical Officers (SMOs).

Objectives:

- To identify the high risk areas
- To focus immunization in those high risk areas
- To certify the country as polio free.

High risk area is a one where

- A case of poliomyelitis has been reported during the last one year
- The living conditions are very poor with over crowding
- The sanitation is very poor
- The surveillance activity is very poor and
- The immunization services are very poor.

Types of surveillance:

- *Routine surveillance:* This means immediate reporting (notification) of a case of AFP in a child below 15 years of age, to district immunization officer by a health care personnel. Dist. Immunization Officer (DIO) will inturn inform the Surveillance Medical Officer, who will inturn inform the National Surveillance Center. Suppose AFP case does not occur, then also the medical officer of Primary Health Center has to send the report as "Zero Case", every week. This is called "Zero reporting". Thus routine surveillance is a continuous ongoing activity. Zero reporting is as important as case reporting. This assures that surveillance activity is going on.
- *Active surveillance:* This is done by a designated person from the department of health, who makes weekly visits to the department of Pediatrics and Neurology to enquire about a new AFP case.

Components of AFP Surveillance

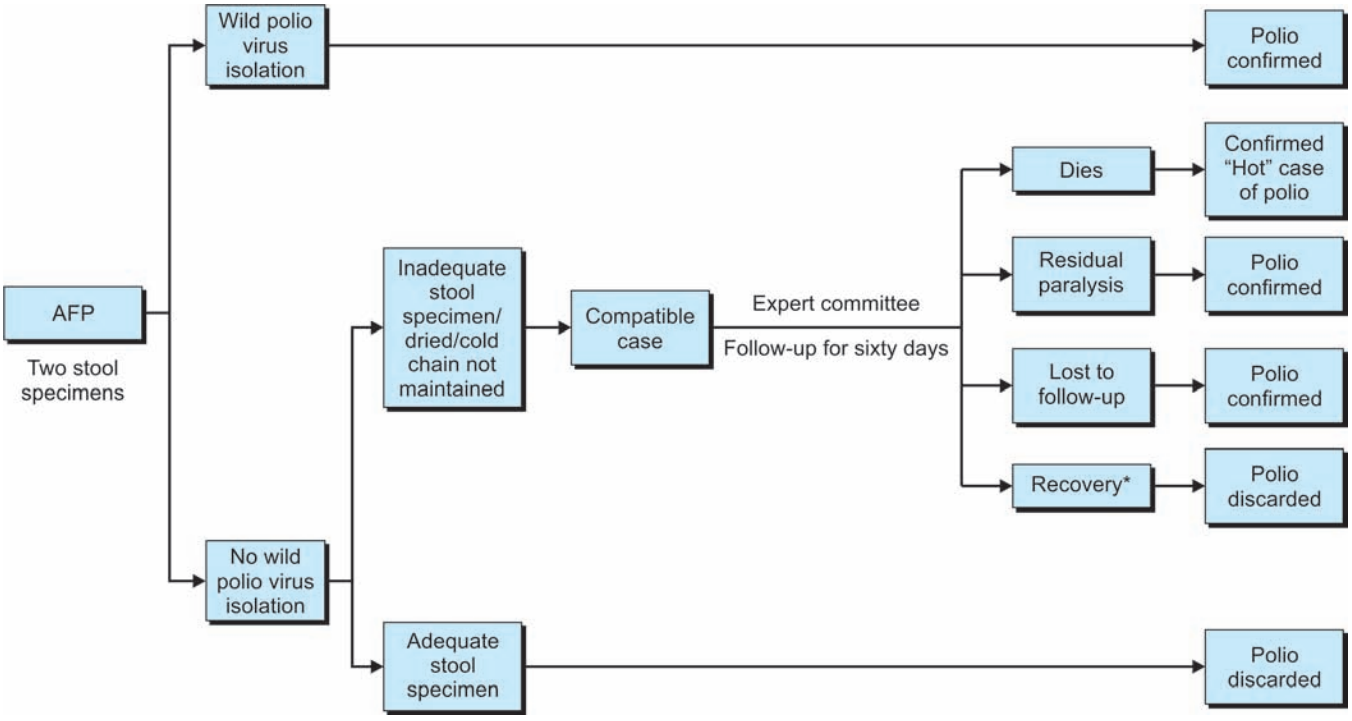
- Investigation of AFP case
- Line listing
- Reporting.
- *Investigation of an AFP case:* This consists of sending two stool specimens, each of 8-10 gms, collected at least 24 hours apart, within 14 days of onset of paralysis, to WHO accredited laboratory in a good condition (i.e. in a special screw capped bottle, no leakage, no dessication, with adequate documentation and in reverse cold chain) for isolation of the polio virus. No preservative or transport media is used. Special stool specimen carriers have been provided to Districts for this purpose.

  If the case is clinically suspected and the virus is not isolated for a variety of reasons such as inadequate specimen, sample dried, cold chain not maintained etc, such a case is called as "compatible" case. It is neither confirmed not discarded as poliomyelitis case. Such a compatible case will be reviewed by an expert committee, consisting of a Pediatrican, a Virologist and a Neurologist, who will follow up the case for 60 days and then decide whether to confirm or discard as polio case, as shown in the figure **(Flow chart 43.1)**.
- *Line listing:* This consists of recording the related data of an AFP case in a prescribed proforma, which provides information such as name of the case, age, sex, address, immunization status, date of onset of paralysis, clinical findings, name of the reporting officer with his contact number and address.

Line listing helps in:

- Avoiding duplication of the case,
- Follow up of the case,
- Detection of only fresh case,
- Identification of high risk area and
- Implementation of containment measures.

Flow chart 43.1 AFP case classification and follow-up of compatible case



* Recovery from paralysis occurs in cases of Guillian Barre Syndrome, transverse myelitis and traumatic neuritis.

- *Reporting:* All AFP cases must be reported to the concerned District Immunization Officer by the quickest possible means, who inturn will inform the State Surveillance Officer, who in turn will inform the National Surveillance Centre.

Ever since the battle against poliomyelitis was begun since 1970s, today India is free from all the three types of viruses. Type 2 virus was first to be eliminated during October 1999, then type 3 virus during October 2010. The year 2011 has been very crucial for polio eradication, as we got only one case of poliomyelitis, the last and the lowest ever recorded, was on January 13, 2011, when the stool sample showed that 18 months old girl, Ruksar Khatoon, in Howrah, West Bengal had polio. Thus India appears to have achieved a Herculean task. Since then the incidence of polio is zero in India. If only zero incidence is maintained for three consecutive years, India will be certified as "Polio free" country a greatest public health achievement. Since February 2013, India is no longer considered as "endemic to polio", a status it had harboured with three other nations – Pakistan, Afghanistan and Nigeria. If the test for isolation of the virus from the environmental sewage sampling also becomes negative, India will officially be deemed to have stopped transmission of indigenous wild polio virus.

But still, we need to be more vigilant as there is a constant threat for its spread. Community participation is the need of the hour. It remains the chief corner stone.

The end game strategy consists of:

- Social mobilization
- Introduction of Salk Vaccine (IPV) in the routine immunization
- Sensitive surveillance
- Mop up round of immunization
- Hoping to declare polio free India in February, 2014
- To stop OPV administration from 2018.

We must continue our commitment to eradicate poliomyelitis and look forward for a day, when no child will be killed or crippled by polio virus.

REVISED NATIONAL TUBERCULOSIS CONTROL PROGRAM (RNTCP)

National TB Control Program

National TB Control Progroam (NTCP) was launched by Government of India during 1962 following the observations made in two survey reports, one submitted by ICMR, done during 1955-58, that TB was a major public health problem, 1.5 percent of the population above 5 years was suffering from radiologically active TB and 0.4 percent of them infectious.

Another survey report submitted was by National TB Institute (NTC) Bangalore during 1955 to 56 and the observations were:

- That nearly 50 percent of the cases do not come to health care facility for treatment
- That domiciliary treatment is as effective as institutional treatment
- That the expenditure incurred for treating 20-25 TB cases in the sanitorium, can suffice to serve the population of about 1500 through establishment of TB clinics.

Objectives of NTCP

- Short-term objectives:
  - To detect and treat as many cases of TB as possible among outpatients
  - To vaccinate the newborns with BCG
- Long-term objectives:
  - To reduce the problem of TB in the community to such a low level that it ceases to be a public health problem, i.e. one infectious case should infect less than one new person annually and the prevalence of infection among children below 14 years should be brought down to les than 1 percent from 30 percent level then.

Organization and Administration

The organizations established for NTCP has 3 tiers: central, district and peripheral.

Central Level Organization

In addition to National TB control Division in the Directorate General of Health Services, two important central institutions responsible for NTCP are NTI, Bengaluru and TB Research Center (TRC), Madras (Now Chennai).

NTI, Bengaluru provides training, research and monitoring operations to all the personnel involved in TB control activities. It also issues necessary technical guidance as and when necessary.

TRC, Madras (Chennai) has contributed by developing the appropriate strategy for NTCP.

District Level Organization

The functional unit of the NTCP is District TB Control Program (DTP) and the structural unit is the District Tuberculosis Unit/ Center. It supervises, plans and co-ordinates all the primary health centers, TB clinics, hospitals and dispensaries in case detection and treatment activities. It provides training to all the field staff and serves as a referral center. Over and above the sanctioned strength of staff members, a BCG team was also attached to carry out vaccination activities. Thus DTP used to be the 'backbone' of NTP.

The treatment used to be free and offered on domiciliary basis from all the health institutions. The registered patients

were supposed to come and collect the drugs of their quota for the month on fixed dates. When the patients were failing to collect the drugs on the due-date, a letter used to be written to him/her (first defaulter action) and in the event of no response for one week, a home visit used to be paid by the health staff (as a second defaulter line of action).

Peripheral Organization

This comprises chest clinics, primary health centers, general hospitals and dispensaries. Primary health centers used to identify symptomatic cases and refer them to nearest chest clinics for investigation and diagnosis, where upon the clinics used to refer back the confirmed cases to PHC for treatment and follow-up.

Patients complaining of fever, cough, chest pain, hemoptysis were considered as 'symptomatics'. Those cases whose sputum is positive for AFB (TB bacilli) were considered as 'Open Cases' and those symptomatics whose sputum negative and radiologically positive, were considered as 'Suspected Cases'. Conventional chemotherapy (long course chemotherapy) was given for all the cases for minimum of 1½ years. There were 5 types of treatment regimens (R_1–R_5) and the drugs were given in divided doses:

R_1 = INH + Thiacetazone
R_2 = Streptomycin + INH
R_3 = INH + PAS (Para Amino Salicylic acid)
R_4 = INH + Ethambutol
R_5 = Streptomycin + INH + Thiacetazone or Ethambutol.

Short course chemotherapy was introduced during 1972. It was centered around Rifampicin and INH. Those patients who were able to come to the center twice weekly for 6 months, were given Regimen-A, consisting of Str + INH + Pyrazinamide for 2 months followed by R and H for 4 months and those who were unable to do so, were put on Regimen-B, Consisting of E + H + R + Z for 2 months followed by H + T for 6 months.

Inspite of a nation wide network of facilities, NTCP failed to yield satisfactory results. Situation of TB remained same. It remained as a major public health problem only. The goal of reducing the problem remained a distant dream.

Meanwhile during 1980s, situation started becoming worse with the emergence of HIV/AIDS.

Revised National TB Control Program (RNTCP): It was in 1992 that Government of India, WHO and world Bank together reviewed NTP and remarked the limitations of the program. Based on those remarks, the program was revised and launched as 'Revised National TB Control Program' (RNTCP) on a pilot project during 1993, with the view to cover the whole country in a phased manner (Described under epidemiology of TB). By 1997, it covered the whole country.

NATIONAL ACUTE RESPIRATORY INFECTIONS CONTROL PROGRAM (NARICP)

National ARI control program was taken up as a pilot project in 25 selected districts in India during the year 1990 and to expand in a phased manner later. During 1992-93, this program was included as one of the components of Child-Survival Safe Motherhood (CSSM) program, which is now upgraded as Reproductive and Child Health (RCH) program with the following objectives.

- To reduce the morbidity and mortality due to ARI—pneumonia among under-fives (which was about 4 million deaths annually then)
- To avoid delay in getting the treatment for those cases of ARI requiring hospitalization
- To reduce the number of cases needing hospital admission (i.e. by correct ARI case management at home).

Strategy

- Standard case management by health workers
- Education of mothers to treat cases at home with home remedies in the early stage
- Education of mothers to recognize fast and difficult breathing early and to seek referral
- Reduction of inappropriate use of antibiotics in treating ARI
- Sustain high coverage with immunization specially Measles, DPT and BCG vaccines
- Surveillance of pneumonia cases and deaths
- Training of health workers to:
  - Assess children with cough and cold
  - Initiate correct case management
  - Give advise to parents for home care
  - Refer appropriate cases to higher centers.

The health workers were trained in order to make this program as an integral part of Primary Health Care. Training modules are distributed to them after training them.

Administrative Set-up

National level	–	Deputy commissioner (Nodal officer) of MCH
State level	–	State MCH and EPI officers
District level	–	District Health Officer Assisted by District MCH Officer
PHC level	–	Medical Officer
Gross root level	–	Health worker

NATIONAL DIARRHEAL DISEASES CONTROL PROGRAM (NDDCP)

This was started during 1978 with the objective of reducing the morbidity and mortality due to diarrheal diseases. The chief aim was the promotion of Oral Rehydration Therapy (ORT).

The strategies were:

- Education of the mothers to use home available fluids with the onset of diarrhea among under five children
- Education of mothers to use ORS and to continue feeding
- Training of health workers, village health guides and Anganwadi workers in oral Rehydration Therapy
- Distribution of ORS packets and booklets on 'Home Treatment of Diarrhea', published in various regional languages, to health workers and village health guides through PHCs
- Every village health guide is supplied with 100 ORS pockets and every health worker (subcenter) with 200 packets per year
- Establishment of Diarrhea Training and Treatment Units (DTTUs) in all medical colleges. These units not only treat cases of diarrhea with ORT but also serve as demonstration centers (ORT–Corners) for medical students, nurses and health workers.

The strategies of NDDCP are based on the following observations:

- Ninety percent of all diarrheal episodes can be managed at home
- Nine percent will develop 'some dehydration', which need to be managed with ORS packets
- Only 1 percent develop 'severe dehydration', needing hospitalization.

NATIONAL AIDS CONTROL PROGRAM (NACP)

Realizing the gravity of epidemiological situation of HIV/AIDS prevailing in the country, Government of India constituted in 1985, a task force to study the problem of HIV and advice on its control. What is alarming is the problem of HIV/AIDS is not just confined to the high-risk marginalized population group, it is also spreading in various directions from urban areas to rural areas, from promiscuous husbands to faithful wives and from infected pregnant mothers to innocent offsprings. In agreement with recommendations of task force, Government of India launched National AIDS Control program (NACP) during 1987. Subsequently in 1992, the Ministry of Health and Family Welfare setup a National AIDS Control Organization (NACO) as a separate body to implement and monitor the NACP activities in the country.

The goals of NACP for HIV/AIDS, for the Tenth Five Year plan are:

- 80 percent coverage of high-risk groups
- 90 percent coverage of schools and colleges by education
- 80 percent awareness among rural population
- Reduction of transmission through blood to less than 1 percent
- Establishment of at least 1 voluntary testing counseling center for every district
- Reduction of mother to child transmission
- Achieving zero level increase of HIV/AIDS new infections by the year 2007.

The NACP has moved through three phases:
Phase I (from 1987 to 1999)
Phase II (from 1999 to 2006)
Phase III (from 2006—preparations are going on).

Phase I (From 1992 to 1999)

Surveillance activities were launched in 55 cities in 3 states. National AIDS Control Organization (NACO) was set-up to carry out the program activities. Achievements were creation of awareness, establishment of state level structures for program implementation and blood safety.

Phase II (From 1999 to 2006)

NACP became 100 percent centrally sponsored scheme.

Aims

1. The focus was shifted from raising awareness to changing behavior among high-risk groups.
2. Decentralization of service delivery to the states.
3. To protect human rights by encouraging voluntary counseling and discouraging mandatory testing.
4. To support operational research.
5. To encourage management reforms (such as drugs and equipment procurement).

Objectives

- To reduce the spread of HIV infection in India and to reduce morbidity and mortality associated with AIDS.
- To strengthen India's capacity to respond to HIV/AIDS on long term basis.

[National AIDS Prevention and Control Policy (NAPCP) 2002 and National Health Policy 2002 have set an aim for bringing AIDS transmission to zero level (no new HIV/AIDS) by 2007].

Strategies (Components of NACP): These are shown in **Table 43.5**.

Table 43.5 Components of NACP

Prevention	Care	Surveillance
a. High-risk population • Target intervention • STD treatment • Condom programming • Multisectoral collaboration • Public private partnerships b. Low-risk population • Holistic IEC and social mobilization • Safe blood • Voluntary counseling and HIV testing • AIDS–vaccine initiative • Sensitizing youths and adolescents • Workplace interventions	Low cost care and support • Prevention of parent to child transmission • Management of HIV-TB coinfection • Treatment of opportunistic infections • Piloting ART • Postexposure prophylaxis	Evidence based planning • Annual sentinel surveillance • AIDS case detection • Mapping of high-risk • Behavioral science

Target Intervention

This consists of identifying the high-risk groups (target population) and providing peer counseling, condom promotion, treatment of STIs and enabling environment.

These measures to be delivered largely through NGOs, Community Based Organizations (CBOs) and the public sector.

CARE OF THE PEOPLE LIVING WITH AIDS (PLWA)

By ensuring:

- Protection of their rights
- Proper care and support in the hospitals and community
- Keeping confidentiality of HIV-status so as not to effect education and employment
- Encouragement and support for the formation of self-help groups
- Encouragement for the participation of NGOs
- Sensitization of medical and para-medical people not to discriminate, stigmatize or deny of services
- Proper counseling of HIV-positive pregnant mothers so as to enable her to take an appropriate decision regarding continuation of pregnancy and childbirth. There should be no forcible termination of pregnancy on the ground of HIV-status
- Clinical management of HIV/AIDS requires strict enforcement of biosafety and infection control measures in the hospitals as per the universal safety precautions guidelines.

'School AIDS education program' is an important activity undertaken in NACP. A training module called 'Learning for Life' has been prepared and distributed in all the states among higher secondary school children.

STI Treatment

This is recognized as one of the major strategies, to control HIV because STIs act as co-factor for HIV transmission. HIV is transmitted easily in the presence of another STI

The objective is to reduce STIs and thereby control HIV transmission and to prevent morbidity and mortality due to STIs by the following strategies:

- Development of adequate and effective program management
- Promoting IEC activities for the control of STIs
- Making arrangements for comprehensive care management through syndromic approach
- Increasing access to health care by creating new structures.

Condom Programming/Promotion

This is because nearly 85 percent of HIV-infections occur due to unprotected and multi-partner sexual contacts. Correct and consistent use of condoms is the most cost-effective means of controlling STIs including HIV/AIDS. It not only prevents STIs and HIV but also prevents unwanted pregnancy and enhances the pleasure associated with sex.

The concerned issues in condom promotion are:

- Sensitizing the clients and commercial sex-workers to use condoms
- Availability of low cost and good quality condoms to the people at the time and place, when they need it.

Three major areas in which NACO has significantly made progress in relation to condom programming are:

- Quality control of condoms (unlubricated condoms are phased out)
- Social marketing of condoms (increasing the acceptability and availability of condoms)
- Involvement of NGOs in the program.

Multisectoral Collaboration

World bank has been funding this national program since several years. Bilateral cooperation has been extended with countries like UK and USA.

The Departments which are collaborating are:

- Department of youth and sports (under ministry of human resource development).
- National Council of Education Research and Training (NCERT).
- Nehru Yuvak Kendra (NYK)
- Directorate of audio-visual publicity, All India Radio and Doordarshan under the Ministry of Information and Broadcasting.

Public Private Partnership

NGOs are continuing to participate in the program for providing care and support to People Living with AIDS (PLWA) and their families.

Holistic IEC and Social Mobilization

Since health education is the only measure of prevention of HIV, it is imperative to continue intensive communication efforts through IEC activities to raise the awareness, to maintain healthy practices and to adopt safe-sex. Thus IEC activities for HIV/AIDS is one of the biggest challenges. At the national level IEC division in NACO has been setup. At the state level IEC activities are decentralized.

Family Health Awareness Campaign (FHAC) is an effort to address the important issues specially to rural mothers about the reproductive health because Reproductive Tract Infections (RTIs) including STIs have increased the problem of HIV/AIDS in the country. Each campaign period is of 15 days.

The objectives of the campaign are:

- To raise the level of knowledge of rural mothers regarding HIV and its transmission during pregnancy, delivery and breastfeeding
- To create awareness about the services available for the treatment of STIs/RTIs
- To facilitate early diagnosis and prompt treatment of STIs and RTIs, which can significantly reduce the transmission of HIV/AIDS.

Safe Blood

Under the blood safety program, professional blood donation has been prohibited in the country since 1st January 1998. Only voluntary blood donation is encouraged. Only licenced blood banks are permitted to operate in the country. As per National Blood Safety Policy, testing of every unit of blood is mandatory for detecting infections like HIV, hepatitis B, syphilis and malaria. From 1st June 2001, it is mandatory to test blood for HCV also.

The objectives are:

- To ensure organized blood-banking services;
- To educate and motivate people about voluntary blood donation and
- To enforce quality control of blood before infusion.

PHASE III (From 2006 to 2011)

The primary goal of NACP III is to halt and reverse the epidemic of HIV in India over the next five years by integrating programmes for prevention, care, support and treatment. This will be achieved through a four pronged strategy:

1. Prevention of new infections:
   a. *Primary preventive measures:* Prevention of new infections in high risk groups (such as commercial sex workers, injecting drug users, men having sex with men) and also among the general population by seeking to bring them into ambit of health care services starting with testing at the ICTC (integrated counseling and testing center). Bridge population (like clients of sex workers, truck drivers, migrant workers, etc.) are also covered. The targeted intervention projects among high risk groups are aimed at effective behavior change. Intervention for general population focus on raising their awareness of HIV. Targeted interventions for high risk group facilitate prevention and treatment of STDs, as they increase the risk of HIV infection and link the HIV infected people to care, support and treatment services.
   b. *Secondary preventive measures:* This consists of prophylactic treatment for HIV infected people to prevent opportunistic infections and when opportunistic infections occur, it involves their treatment.
2. Providing greater care, support and treatment to the people living with HIV/AIDS (PLWHA)
   The services include management of opportunistic infections including control of tuberculosis, anti retroviral therapy, safety measures, positive prevention and impact mitigation. The total number PLWHA is expected to come down from 5.2 million to 3.8 million by 2011.
3. Strengthening the infrastructure system, human resources in prevention, care, support and treatment programmes at district, state and national level.
4. Strengthening the nationwide Strategic Information Management System.

Integrated Counseling and Testing Center (ICTC)

It is a center where a person is counseled and tested for HIV on his/her own free will or as advised by a medical provider.

It is called integrated because not only HIV counseling and testing is done for willing persons but also for TB patients and pregnant mothers for prevention of parent to child transmission (PPTCT) services, all under one roof. The mission is to identify people infected with HIV as early as possible and link them with appropriate services so that they may prevent future illness or treat current illness in a timely manner.

Before 1997, ICTC was called as Voluntary Counseling and Testing Center (VCTC). But under National AIDS Control Program (NACP), PPTCT services and screening of TB patients are integrated and in 1997, the VCTCs are remodeled as ICTCs.

Functions

- Early detection of HIV by rapid diagnostic tests.
- Providing basic information on modes of transmission and prevention of HIV/AIDS for promoting behavioral change and reducing vulnerability, i.e. counseling (pretest and post test).
- Linking people with other HIV prevention, care and treatment services so that they may prevent future illness or treat current illness in a timely manner (post exposure prophylaxis).

Types of ICTCs

At present there are two models of ICTCs in the country.

- *Stand-alone ICTCs:* These have full time counseling and testing personnel. These centers exist in all medical colleges, Dist. hospitals and 30 bedded Community Health Centers.
- *Facility Integrated ICTCs:* This does not have full time staff.
- It provides HIV counseling and testing as a service along with other services in the facility. The existing staff like auxillary nurse midwife (ANM), staff nurse or health visitor will undertake HIV counseling and testing. These centers are established in Primary Health Centers under NRHM and designated TB microscopy centers, where majority of clients are TB patients and tuberculosis is the most common opportunistic infection in people with HIV infection. So it will help to diagnose their status for accessing early treatment. The model of ICTC is shown in the diagram **(Fig. 43.5)**. The integration/linkages between ICTC and other centers are shown in the **(Fig. 43.6)**.

It is not the mandate of the ICTC to test everybody in the general population. Population who are more vulnerable to HIV or who practice high risk behavior are in need of ICTC services such as professional sex workers, men having sex with men, injecting drug users and those having multiple sexual partners. Next top priority groups are truck drivers, prisoners, migrants including refugees and street children, who constitute bridge population.

Counseling

This is a confidential dialogue between a client and a counseler aimed at providing information on HIV/AIDS and bringing

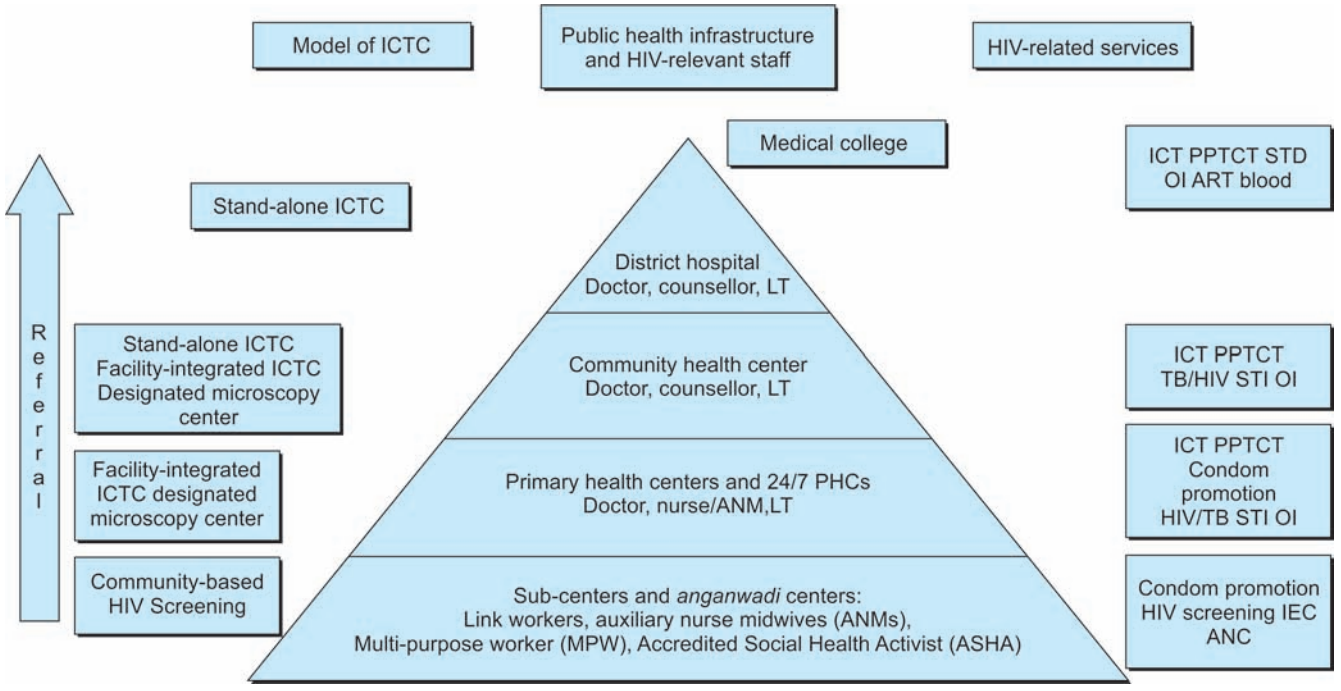


Fig. 43.5 Model of ICTC

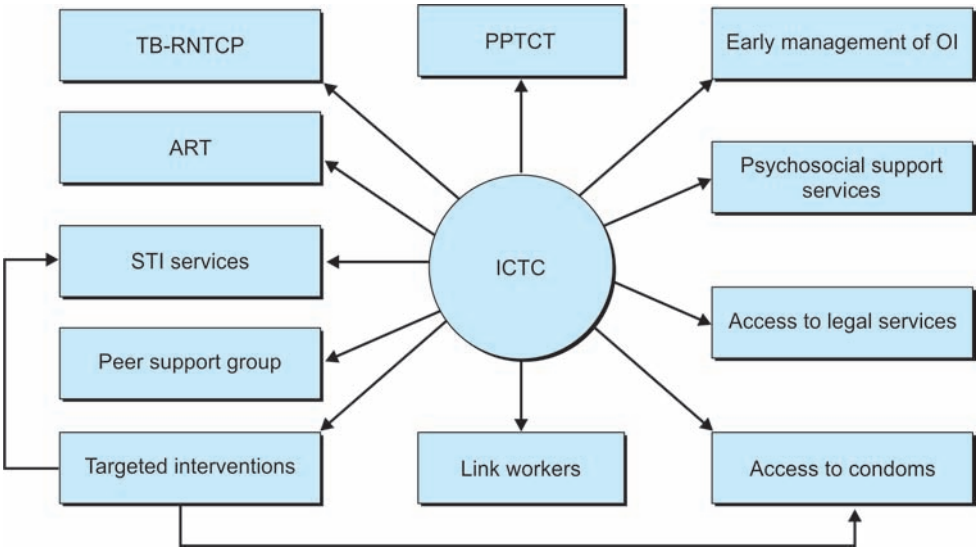


Fig. 43.6 Integration of ICTC with other centers

about behavior change in the client and also enabling the client to take decision regarding HIV testing and to understand the implications of the test results.

Pretest counseling: This provides an opportunity for educating about the risks of transmission and also to assess how the person may react if HIV test turns positive. It prepares the client for undergoing test and changing his/her behavior.

Post-test counseling: This consists of counseling the individual after doing the test, irrespective of the result.

If the result is negative, the person is supported with information and counseling to remain HIV negative by reducing the high risk behavior if any and in case of recent exposure, he/she is stressed the need to undergo test again after the window period.

If the result is positive, the person is informed gently and allowed to react. It is not a death sentence. It only means that the person is educated about taking special care to prevent progression to AIDS in himself/herself by taking ART treatment in the right stage and adhering to it. He/she is provided psychosocial support and linked to treatment and care. The person is also educated not to infect others by the following measures:

- By not donating blood, blood products or any organ
- By consistently using condoms, while having sex
- By not becoming pregnant
- By not sharing needles.

The client is then encouraged to tell spouse.

Testing strategies are different for different purposes.

- Mandatory—for transfusion safety
- Unlinked and anonymous—for epidemiological studies, such as monitoring the trend of HIV infection in a population
- Voluntary and confidential—for voluntary testing and for subclinical/clinical management
- For research purposes.

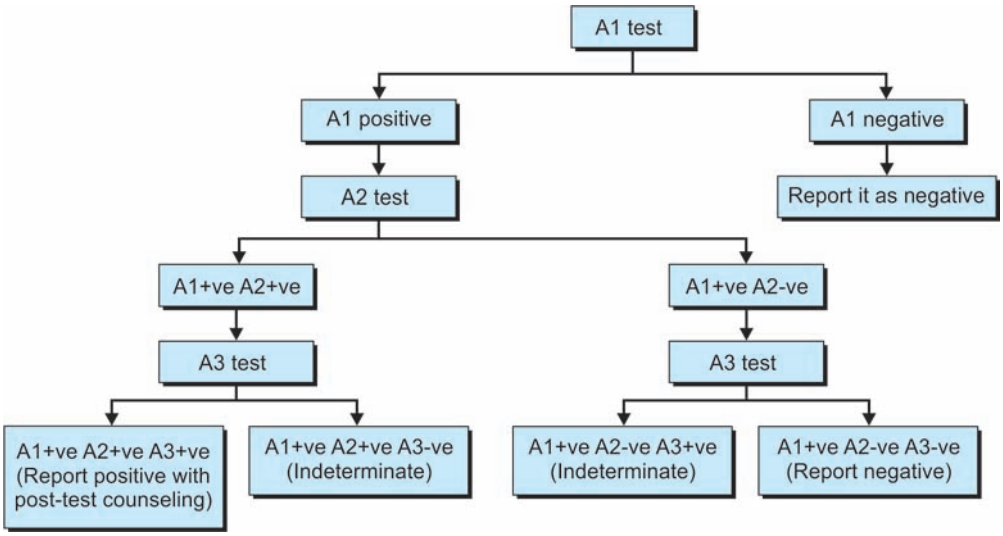
Informed consent for HIV testing: The client agrees to undergo HIV test through giving informed consent based on adequate understanding of the advantages, risks, potential consequences and implications of the test result. This permission is entirely the choice of the client and can never be implied or presumed.

HIV Testing at the ICTC

The tests done are called 'Rapid HIV tests', because the results are obtained within 30 minutes. It is done to detect HIV antibodies in the serum of the individual, which indicates that the individual has HIV infection. If the sample is negative in the first rapid test, it is declared as negative. If the test is positive, it could be false positive (that means the test result is positive but in reality the person is not infected with HIV). Such a result can result in lot of tension in the individual. So it is important to confirm the positive result. Therefore it is recommended that if first test is positive, the same blood sample must be tested with two other kits with different antigens (thus totally three tests) before the individual is declared as positive or HIV infected. If out of three tests, two kits show positive result and one negative, the result is declared as 'Indeterminate' **(Flow chart 43.2)**.

For an indeterminate test result, another blood sample should be tested again after 14 to 28 days with three different kits. If it continues to show indeterminate result, then the blood sample is subjected to Western Blot test to detect antibodies or Polymerase Chain Reaction (PCR) test to detect

Flow chart 43.2 HIV testing at ICTC



the virus itself if facilities are available or sent to National Reference laboratory for further testing.

Antibodies are usually produced 6 to 12 weeks after contracting the infection. So this period when no antibodies are detected is called 'Window period'. Therefore the test result is negative during window period, eventhough the person is HIV infected. So it is 'False negative' result. However the person remains infectious during window period. So it is retested after three months.

In case of a newborn to a HIV positive mother, a positive result upto the age of 18 months could merely mean the presence of maternal antibodies in the newborn, which disappears only after 18 months of age. So direct test like PCR is necessary to detect the presence of virus in the child.

Prevention of Parent to Child Transmission (PPTCT) Services

This is provided in ICTCs by counseling and testing pregnant women. It is observed that in the absence of intervention, if 100 HIV positive women give birth to 100 infants, then:

- 5 to 10 infants will be infected during pregnancy
- 10 to 20 infants will be infected during labour and delivery,
- 20 to 30 infants will be infected during breastfeeding (if breastfed upto 18 months). Thus the total number of children infected from mother would be about 25 to 40 percent in the absence of intervention.

The ICTC personnel should inform the pregnant mothers the benefits of testing and after obtaining consent should test them for HIV and help in reducing parent to child transmission.

However the mother is made aware of her right to 'opt out' of HIV testing, i.e. she can refuse to be tested. Under such circumstances, the clinical management should proceed as if she were HIV positive and suitable clinical protocol followed.

The PPTCT services in ICTC is shown in **(Flow chart 43.3)**.

Integration between ICTCs and TB Services

Tuberculosis being the most common opportunistic infection among People Living With HIV/AIDS (ALWHA), Government Policy since February 2008 is to routinely offer voluntary counseling and testing to all TB patients to know their 'HIV status' so that they take necessary preventive measures when needed.

HIV infected TB patients should be counseled to get their sexual partners tested for HIV and TB.

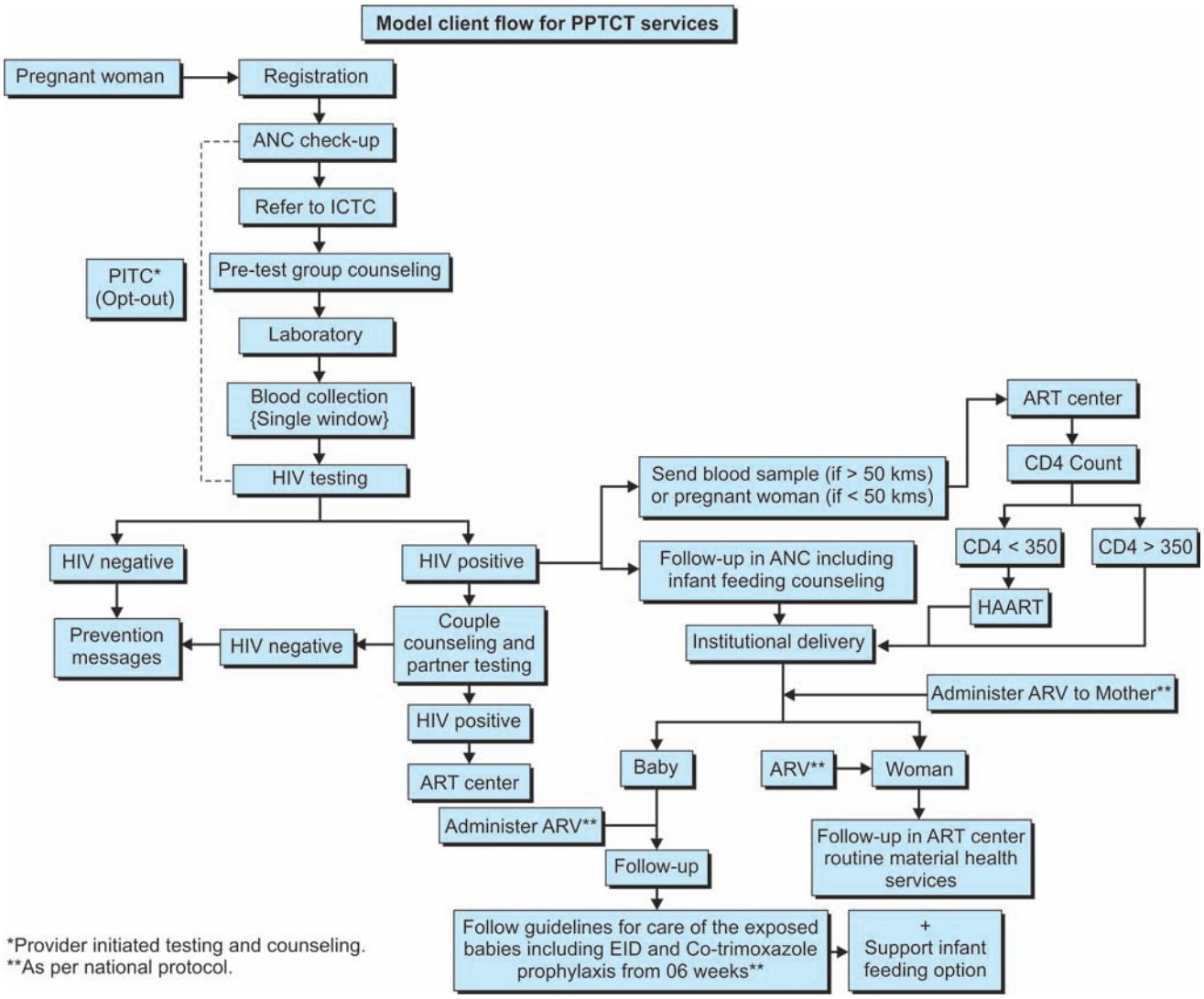
Though TB patients may be referred to ICTC, they have right to 'opt out' of being tested. If the patients opt out, they must be counseled about how to protect themselves and others from harm by using safer sex techniques, by not sharing syringes, etc. Then only they should leave the center. If the patients do get tested, then regular procedure for pre- and post-test counseling are to be followed.

AIDS—Vaccine Initiative

Vaccines against HIV are being developed and they are in various stages of clinical trial but at present none have proven effective.

Candidate vaccines need to be testing on healthy human volunteers, through sequential phases. Phase I and II provide data on the safety of the vaccines in inducing immunity. Phase III, on efficacy of the vaccine. More than 30 candidate vaccines have been tried since 1987.

Flow chart 43.3 PPTCT services in ICTC



- AIDSVAX, a gp 120 based vaccine has reached phase III clinical trial
- CTL (cytotoxic T-lymphocytes) vaccines will not stop an infection but kills infected cells and can hold down the viral level in the body
- A recombinant Adeno Associated Virus (TAAV) act as vector (harmless virus), which infects the cell naturally and evoke an immune response
- Modified Vaccine Ankara (MVA) also employed as a vector to prepare the vaccine
- A recombinant, genetically engineered, subunit HIV vaccine is also under process (Subunit vaccine is a one which contains a part of the virus).

Low Cost Care and Support

Funding for home based and community based care, including interventions for common opportunistic infections have been made.

Postexposure prophylaxis: following exposure to HIV, in case of high-risk, 3 drugs are given ZDV, Lamivudine and Saquinavir and in case of low-risk, 2 drugs are given ZDV and Lamivudine for 4 weeks.

Evidence-based Planning

HIV-sentinel surveillance: Sentinel sites/centers are located among the risk population areas, so that blood samples

are accessed at regular intervals through an 'unlinked anonymous' procedure. Vulnerable groups of populations are mapped out and taken care of.

Monitoring and Evaluation

A Computerized Management Information System (CMIS) at the National and State levels need to be established and staff should be trained. Baseline, mid-term and final evaluation and also Performance and Expenditure Annual Review (PEAR) should be conducted. HIV-Risk Behavior Surveillance Survey would be more informative for planning.

'3 BY 5' INITIATIVE

Globally about 40 million people are living with HIV/AIDS (PLWA). On December 1, 2003, WHO, UNAIDS and GFATM (Global Fund Against Tuberculosis and Malaria) announced a plan to reach '3 by 5' initiative, i.e. providing anti-retroviral treatment (ART) to 3 million PLWA, in the developing countries by the end of the year 2005.

This is only an interim target. The ultimate goal being universal access to ART for any one who needs it.

WHO's strategic framework for emergency scaling up of retroviral therapy has five pillars:

- Global leadership, strong partnership and advocacy
- Urgent, sustained country support
- Simplified, standardized tools for delivering anti-retroviral therapy
- Effective reliable supply of medicines and diagnostics
- Rapidly identifying and reapplying new knowledge and success.

NATIONAL PROGRAM FOR THE CONTROL OF BLINDNESS

National Program for the Control of Blindness (NPCB) was launched in the year 1976 as a 100 percent centrally sponsored scheme, incorporating National Trachoma Control Program, started during 1964. The ultimate goal of the program is to reduce prevalence of blindness in the country from 1.4 to 0.3 percent by providing 'Comprehensive Eye Care' through primary health care, since the cause of blindness being mainly cataract in India.

The major thrust of this program is on cataract operation.

Objectives

- To reduce the backlog of blindness through identification of cases and their treatment
- To develop eye care facilities in every district of the country
- To strengthen the quality of service delivery
- To develop human resource for providing eye care facilities
- To secure the participation of voluntary organizations in the provision of eye care services.

Operational Strategies

- Undertaking blindness surveys
- Performance of cataract operations
- Provision of postoperative care
- Establishment of eye-banks
- Establishment of training and IEC facilities
- Provision of supportive facilities.

Administrative Set-up

NPCB has five tier organizational framework operating at Central, Regional, State, District and Sub-district level:

- Central level — Ophthalmology cell, Ministry of Health and Family Welfare, New Delhi. This formulates policies and guidelines for all activities related to eye care.
- Regional level — Regional Institute of Ophthalmology (Dr Rajendra Prasad Center for Ophthalmic Sciences, New Delhi) constitutes the Apex institute. Ten other such regional institutes of Ophthalmology operate in the country. They contribute in the areas of man-power development, research and referral care.
- State level — State Ophthalmic cell, Directorate of Health and Family Welfare Services, Medical Colleges are designated as training centers. The mobile units attached to medical colleges undertake cataract surgery in the field areas.
- District level — District Blindness Control Societies (DBCS) comprising of representatives from government, non-government and private sectors participate in the national program by organizing eye camps in collaboration with NGOs and Private Practitioners. Such societies are formed under the Chairmanship of District Collector/ Deputy Commissioner. District Ophthalmic surgeons are posted at District Hospitals. Mobile services are provided through district mobile units attached

to District Hospitals. Nearly 575 DBCS have been functioning in the country.

- Sub district (Rural) level — Primary Health Centers are the basic units. Paramedical Ophthalmic assistants are posted to PHCs. Mobile camp services are provided by mobile ophthalmic units attached to community health centers.

Procurement and Supplies

The items procured from the center are suture materials, intraocular lenses (IOL) and the equipments required for IOL implantation. World bank supplies the major equipment such as indirect ophthalmoscopes, slit lamps, anterior vitrectomy units, keratometers, operating microscopes, scan biometer and 178 YAG Lasers. Medicines and other consumables as well as spectacles are procured by District Societies out of the grants provided.

The National Survey carried out on blindness during 2001-02 showed the prevalence of blindness to be 1.1 percent in general population. Cataract continued to be the leading cause of blindness (62.6%) followed by refractive error blindness (19.7%), glaucoma (5.8%), posterior segment pathology (4.7%) and corneal opacity (0.9%). Other causes were responsible for 6.2 percent of blindness.

The survey has also showed that the prevalence of blindness is reducing, dependence on eye camps has also reduced, involvement of MOs of PHCs has increased, the demand for modern techniques such as IOL implantation and sutureless surgeries has increased and about 84 percent of cataract operated persons receive free spectacles from the health facilities.

Program Components

These are as follows:

- **Cataract surgery:** The purpose of this component is to restore the vision of the affected persons, so that they can return to normal life. A cataract surgery rate of 400 operations per lakh population is required to clear the backlog. The percentage of IOL implantation has raised from 20 percent in 1997-98 to 83 percent during 2004-05.
- **Eye screening:** Under the school eye screening program, the children are first screened by the trained teachers. Those children suspected to have refractive errors are examined by ophthalmic assistants and corrective spectacles are prescribed. Poor children get the spectacles free of cost (It is observed in the school survey that nearly 6 to 7 percent of the children have refractive errors affecting their learning process).
- **Eye donation:** Under the hospital retrieval program, donation of eyes are motivated through the relatives to terminally ill patients, accident victims and other grave diseases. 'Eye Donation Fortnight' is organized from 25th August to 8th September every year to promote donation of eyes. Currently about 20,000 donated eyes are collected every year in India.
- **Voluntary organizations:** The organizations such as Rotary International, Lions International and such others have been active in conducting eye camps and in providing eye health education, preventive, promotive, curative and rehabilitative services for the control of blindness.
- **Vitamin A prophylaxis:** 5 mega doses of Vit. A in the form of syrup, administered orally, with an interval of 6 months, for all the pre-school children (0–3 years) are recommended under the National Vitamin A Prophylaxis Program to prevent nutritional blindness.
- **Training program:** This has been an ongoing program, since 1996-97 to all the ophthalmic surgeons in IOL implantation. The faculty members of the medical colleges are trained as trainers. The other training program includes training of district eye surgeons, nurses, ophthalmic assistants in their respective fields of services.
- **IEC activities:** This is a built-in component at all levels in the NPCB. Prototype IEC material, guidelines, and training manuals are supplied to all the states in their regional languages. Adequate funds are provided to district societies to carry out IEC activities. Special campaigns are undertaken during 'Eye Donation Fortnight' and on 'World Sight Day' on second Thursday of October, every year.

NPCB Achievement

- Rate of cataract surgery is increasing steadily
- IOL implantation has raised from 20 percent during 1997-98 to 83 percent during 2004-05
- Rate of detection of refractive errors among school children is increased
- Involvement of medical officers of PHC is increased
- 84 percent of cataract operated cases receive free spectacles.

Revised Strategy

- To make NPCB more comprehensive by strengthening the services for other causes of blindness like corneal blindness, glaucoma and refractive errors among school children
- To shift from eye camp approach to fixed surgical approach and from conventional surgery to IOL implantation
- To expand the world bank project activities (such as training programs, supply of materials, equipments, etc.) to the entire country
- To strengthen the participation of voluntary organizations in the program and to earmark geographic areas to NGOs and Government hospitals to avoid duplication of activities

- To enhance the coverage of eye care services in tribal and other underserved areas.

Targets for Tenth Five Year Plan

- To increase the rate of cataract surgery to 450 per lakh population
- To increase the rate of IOL implantation to more than 80 percent among the cataract surgery cases by the year 2007
- To develop 50 pediatric ophthalmology units
- To improve the facilities for early diagnosis and treatment of glaucoma and diabetic retinopathy
- To develop 25 fully operational eye bank network
- To develop human resources by providing training to personnel at various levels
- To supply ophthalmic equipments and grants to NGOs.

External Assistance

- World bank assisted cataract blindness control project for a period of 7 years, from 1995 to 2002. During this period 15 to 35 million cataract surgery was performed against the target of 11 million. Meanwhile the IOL implantation rate went up from 3 percent during 1993 to 75 percent in 2002. The project was 'Highly successful'.
- *Danish assistance to NPCB*: (i.e. by DANIDA = Danish International Development Agency).

  Danish assisted this program for a period of 5 years, from 1998 to 2003 by providing funds which were utilized for conducting training program, for the development of management information system, supply of equipments, materials for IEC activities, etc.
- *WHO assistance*: WHO assisted this program by arranging intra-country fellowships in corneal transplantation, vitreoretinal surgery, lasers in ophthalmology and pediatric ophthalmology. WHO also assisted in carrying out survey on childhood blindness in Delhi, training programs in district program management, study on situational analysis of eye care infrastructure and human resources in India, workshops for medical college faculty members and development of plan of action for 'Vision 2020: The Right To Sight' initiative.

'Right to Sight' Initiative (Vision 2020)

It is a global initiative launched to reduce avoidable (preventable and curable) blindness by the year 2020. The goal is to reduce the prevalence of blindness in India to 0.5 percent by the year 2012 and no child in India shall go needlessly blind after 2012. There must be a vision guardian for every 5000 population by 2020. Government of India has also committed to this initiative. The main features of the action plan devised for the country are:

- Identification of target diseases–such as cataract, refractive errors, childhood blindness, glaucoma and diabetic retinopathy
- Development of human resources – by increasing the capacity and skills of ophthalmic personnel
- Development of infrastructure and technology–the proposed structures for vision 2020 consists of 3 tier structures of eye care as follows **(Fig. 43.7)**.

First tier (at primary level) comprising 20,000 vision centers, second tier (at secondary level) comprising 2,000 service centers and third tier comprising 200 training centers and 20 centers of excellence.

NATIONAL PROGRAM FOR PREVENTION AND CONTROL OF DEAFNESS

In India, 6.3% of the population (63 million) are suffering from significant auditory impairment (loss). This is identified as the second most common cause of disability (first being the depression). Of these a large percentage is constituted by children between the ages of 0-14 years. This amounts to severe loss of productivity both physical and economical.

Therefore, Government of India, launched this program, on a pilot phase in 25 identified districts of 10 states and one union territory of India from July 2006 to June 2008, with a proposal to cover the entire country by 2012, in view of the preventable nature of the disability.

Objectives

- To prevent the avoidable hearing loss on account of disease or injury.
- Early identification, diagnosis and treatment of ear problems responsible for hearing loss and deafness.
- To medically rehabilitate persons of all age groups suffering with deafness.
- To strengthen the existing intersectoral linkages for community of the rehabilitation program, for persons with deafness.
- To develop institutional capacity for ear care services by providing support for equipment and material and training personnel.

The long-term objective is to reduce the total disease burden by 25% of the existing burden by the end of the Eleventh Five Year Plan.

Strategies

- To strengthen the service delivery including rehabilitation.
- To develop human resource for ear care.

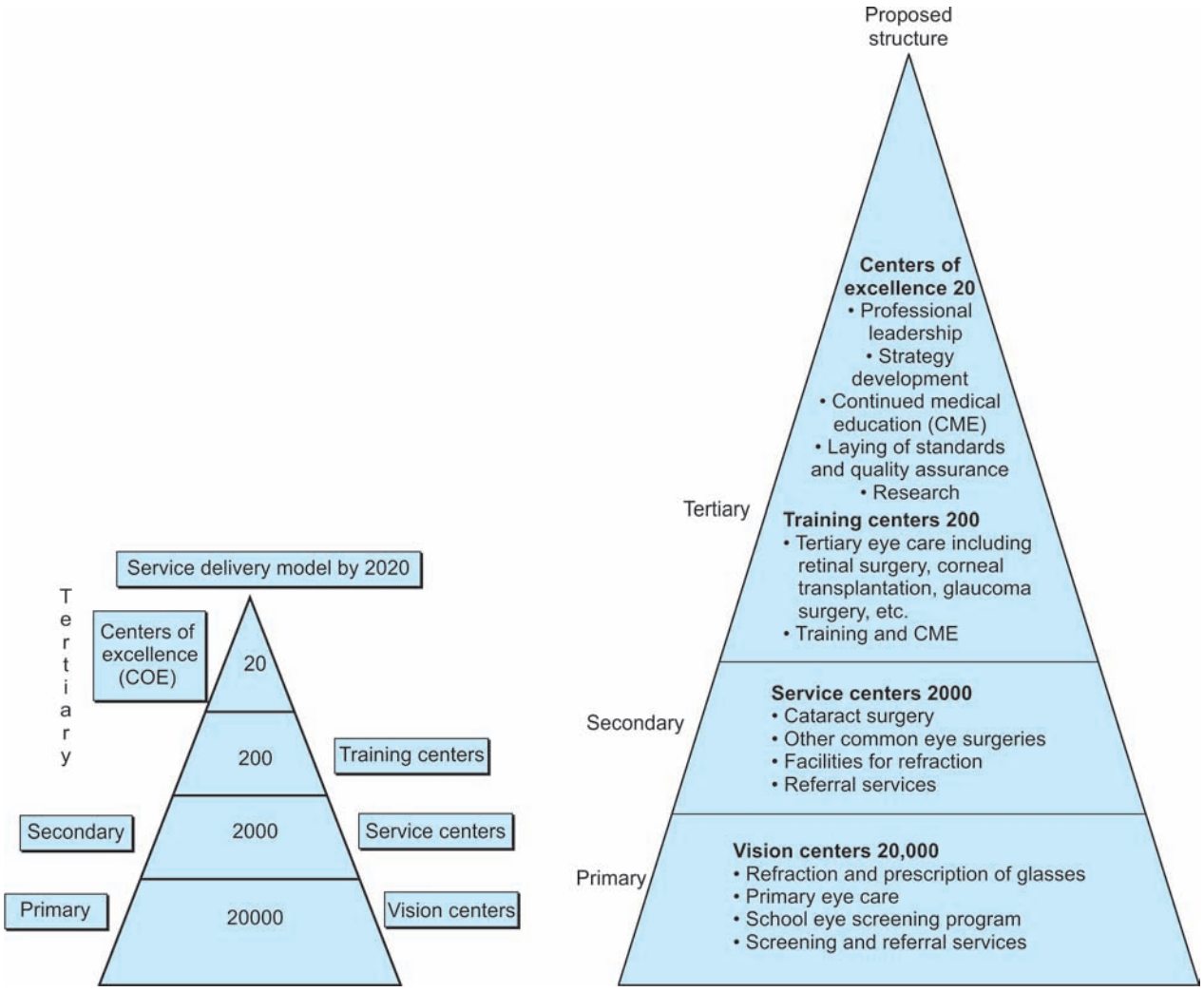


Fig. 43.7 Proposed structure for vision 2020: The Right to Sight

- To promote outreach activities and public awareness through appropriate and effective IEC strategies with special emphasis on prevention of deafness.
- To develop institutional capacity of the District Hospitals, Community Health Centres and Primary Health Centres selected under the project.

Components of the Program

- Manpower training and development
- Capacity building
- Service provision including rehabilitation
- Awareness generation through IEC activities
- Monitoring and evaluation.

Expected Benefits of the Program

- Direct benefit of various services like prevention, early identification, treatment, referral, rehabilitation for hearing impairment and deafness.
- Decrease in the magnitude of hearing impaired persons.
- Decrease in the severity/extent of ear morbidity or hearing impairment.
- Improved service network for the persons with ear morbidity or hearing impairment in the states and districts covered under the project.
- Awareness creation among the health workers/grass root level workers through the primary health centre medical officers and district officers.

- Community participation to prevent hearing loss through Panchayat Raj institutions, mahila mandals, village bodies etc.
- Creation of collective responsibility framework in the broad spectrum of the society.
- Leadership building in the primary health centre medical officers to help create better sensitization in the grass root level which will ultimately ensure better implementation of the program.
- Capacity building at the district hospitals to ensure better care.
- State of the art department of ENT at the medical colleges under the project.

NATIONAL CANCER CONTROL PROGRAM (NCCP)

Cancer is an emerging public health problem in the country mainly due to change in the life-style of the people. It is estimated that at any given point of time, nearly 20 lakh cases of cancer exist in the country and about 7 lakh cases are added every year.

Government of India launched NCCP during 1975 by way of granting rupees 2.5 lakhs to each of the Regional Cancer Institutes (11 in No.) in the country towards the purchase of cobalt therapy units for the treatment of cancer patients. It was further strengthened during 1984-85 by emphasizing on prevention, early detection of cancer and augmentation of treatment facilities in the country.

The following new schemes have been initiated from the year 1990-91:

- *Schemes for district project:* The scheme envisages carrying out IEC activities (i.e. cancer education), early detection and pain relief measures, by providing one time financial assistance of ₹15 lakhs to State Governments for each district project selected. 24 district projects were undertaken between 1992 and 1994. Voluntary organizations recommended by State Governments are also provided financial assistance for carrying out IEC activities.
- *Development of oncology wings:* The oncology department in the medical colleges are provided financial assistance up to ₹1 crore for the purchase of cobalt therapy units, brachytherapy unit, linear accelerator and for undertaking mammography.
- *Financial assistance to NGOs:* Assistance up to ₹ 5 lakhs to voluntary organizations is provided on recommendation by the State Government for carrying out cancer education and detection activities, preferably in rural areas and urban slums. Assistance was given to 33 NGOs.

Functions of the Organizations

- Education of the community about the hazards of tobacco and persuaded to give up its use and also 'danger signals' of cancer
- Education of the community to change their lifestyle leading to cancer
- Early detection of cancer cervix through exfoliative cytology and treatment of the detected cases
- Early detection of oral cancers by primary care workers
- Imparting training to medical and paramedical workers in the control of cancer
- Providing pain relief for terminal cancer cases.

NATIONAL PROGRAM FOR PREVENTION AND CONTROL OF DIABETES, CARDIOVASCULAR DISEASES AND STROKE (NPDCS)

Magnitude of the Problem

During the year 2005, NCD accounted for 53 percent of all deaths in the age group of 30 to 59 years in India. Of these 29 percent were due to cardiovascular diseases. It is estimated that by 2020, cardiovascular diseases will be the largest cause of disability and death, as a proportion of all deaths in India.

According to Diabetes Atlas 2006, published by International Diabetes Federation, the number of diabetics in India is currently around 40.9 million and is expected to rise to 69.9 million by 2025, unless preventive steps are taken.

Similarly, 118 million people were estimated to have high blood pressure during 2000, which is expected to go up to 213 million by 2025. Not only this, Indians succumb to diabetes, high blood pressure and heart attacks five to ten years earlier than their western counterparts, during their most productive years. This leads to considerable loss of productive years to the country, leading to huge economic loss as high as 237 billion dollars by the year 2015.

To contain the increasing burden of Noncommunicable Diseases, the Ministry of Health and Family Welfare, Government of India, launched National Program for prevention and control of Diabetes, Cardiovascular diseases and Stroke (NPDCS).

Objectives

- To prevent and control common NCDs through beahvior and lifestyle chanes.

- To generate awareness on lifestyle changes.
- To provide early diagnosis and management of common NCDs.
- To build capacity at various levels of health care for prevention, diagnosis and treatment of common NCDs.
- To train human resource within the public health setup, viz doctors, paramedics and nursing staff to cope up with the increasing burden of NCDs.
- To establish and develop capacity for palliative and rehabilitative care.

In the program it is envisaged in providing preventive, promotive, curative and supportive services (core and integrated services) for Cancer, Diabetes, Cardiovascular Diseases and Stroke at various government health facilities with provisions for expanding the diseases covered under the program to chronic lung diseases, geriatric diseases, etc. The package of services would depend on the level of health facility and may vary from facility to facility. The range of services will include health promotion, psycho social counseling, management (out and in patient), day care services, home based care and palliative care as well as referral for specialized services as needed. Linkages of District Hospitals to private laboratories and NGOs will help to provide the additional components of continuum of care and support for outreach services. The district will be linked to tertiary cancer care health facilities for providing comprehensive care. Health education program that promotes exercise, weight reduction, screening and early diagnosis are some of the key interventions that need to be promoted at various levels of health facilities. They have been captured in **Fig. 43.8**.

The following components are envisaged in the program.

1. District NPCDCS program (626 districts)
2. NCD focal centers at medical colleges (54 medical colleges)
3. State/UT NCD Cell (35)
4. National NCD Cell at Center
5. IEC/BCC
6. Capacity building and research
7. Intersectoral convergence
8. Monitoring (including MIS) and evaluation.

NATIONAL MENTAL HEALTH PROGRAM (NMHP)

Introduction

Psychiatric symptoms like worry, tiredness and sleepless nights are common among more than half of adults all over the world while one in seven experiences some form of diagnosable neurotic disorder.

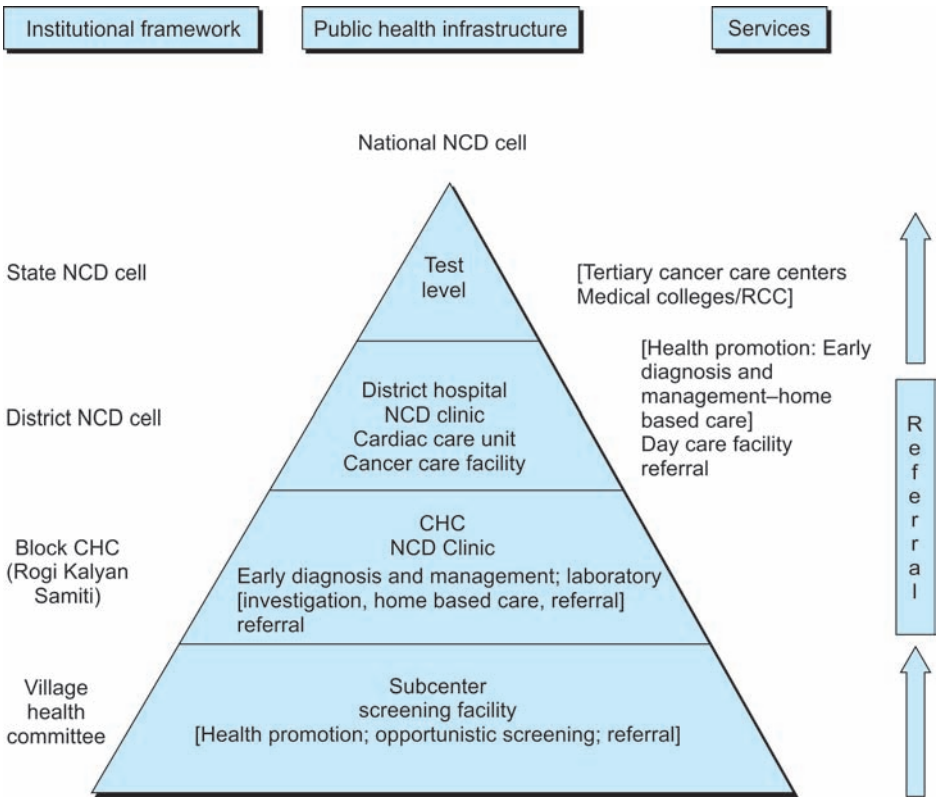


Fig. 43.8 Services available under NPCDCS at different levels

Magnitude of the Problem

It is estimated that Disability Adjusted Life Years (DALYs) loss due to mental disorder is much higher than some of the communicable diseases like malaria, tuberculosis, diarrhea, worm infestations, etc. and is expected to represent 15 percent of the global burden of diseases by 2020 and the common disorders being depression, general anxiety disorder and harmful use of alcohol.

WHO has decided to give priority to mental health during the year 2001, the beginning of 21st century by choosing World Health Day Theme, 'Mental Health : Stop Exclusion – Dare to care.'

In India, studies during the last two decades have shown that about 2–3 percent of population suffer from seriously incapacitating mental disorders or epilepsy. Most of them are in rural areas away from the modern mental health facilities. About 10 to 15 percent of the population suffer from other forms of emotional disorders appearing as physical symptoms. These are often missed because the doctors do not ask detailed mental health history. This results in subjecting the patients for unnecessary investigations and treatment.

Keeping in view the heavy burden of mental illness in the community and the absolute inadequacy of mental health care infrastructure in the country to deal with it, Government of India launched National Mental Health Program (NMHP) in 1982.

Aim

The aim of NMHP is to prevent and treat mental and neurological disorders by using mental health technology not only to improve quality of life but also overall national development.

Objectives

- To provide minimum mental health care for all, particularly to the most vulnerable and under privileged sections of the society.
- To encourage application of mental health knowledge for promotion of social welfare and in general health care.
- To promote community participation in the mental health services development and to stimulate efforts towards self help in the community.

Strategies

- Integration of mental health care services with primary health care services through NMHP.
- Provision of tertiary care institutions for treatment of mental disorders.
- Eradicating stigmatization of mentally ill patients and protecting their rights through regulatory institutions like the Central Mental Health Authority and State Mental Health Authority.

Components of NMHP

- Treatment of mentally ill patients.
- Rehabilitation of disabled mental patients.
- Prevention and promotion of positive mental health.

Organization

- The organizational framework for NMHP is constituted by tertiary care institutions, mental hospitals and supportive organizations.
- *Tertiary care institutions:* These are National Institute of Mental Health and Neuro Sciences (NIMHANS), Bengaluru, Central Institute of Psychiatry, Ranchi, and Institute of Human Behaviour and Allied Sciences, New Delhi. NIMHANS is the institution of international repute. It has 650 beds for patients care. It provides training and research opportunities to aspirants in various areas of psychiatry and neurosciences.
- *Mental hospitals:* There are state owned mental hospitals but have shortage of manpower. Private hospitals are also functioning. The nature of service is of custodial care rather than therapeutic care.
- *Supportive organizations:* These are: (a) Central Mental Health Authority oversees the implementation of Mental Health Act, 1987, which protects the mentally sick patients from stigmatization and discrimination, (b) The National Human Rights Commission monitors the structure and functions of the mental health hospitals in states.

DISTRICT MENTAL HEALTH PROGRAM (DMHP)

Government of India launched DMHP as a 100 percent centrally sponsored scheme for the first five years at the national level in 1996-97 during nineth five year plan as a pilot project.

Objectives

- To provide sustainable basic mental health services to the community and to integrate these services with other health services.
- Early detection and treatment of these patients within the community itself.
- To provide mental health care at the primary level only.

- To reduce stigma attached towards mental illness through public awareness.
- To treat and rehabilitate mental patients within the community after their discharge from the hospital.

Components

- Training programs of all workers in the mental health team at the identified Nodal Institute in the state.
- Education of the public regarding mental health to increase the awareness and reduce stigma.
- For early detection and treatment, outpatient services and inpatient services are provided.
- Providing valuable data and experience at the level of community to the state and center for future planning, improvement in service and research.

Services

- The District Mental Health team will provide services to mentally ill patients and their families as follows:
- Daily OPD services
- Ten bedded inpatient facility
- Referral services
- Liaison with Primary Health Center
- Follow-up of treated patients
- Community survey if feasible
- Remove stigma of mental illness by creating awareness in the community.

Thrust areas for 10th Five Year Plan:

- DMHP will be covering the entire country in a phased manner.
- Modernization of mental hospitals to modify their present custodian role.
- Upgrading the department of psychiatry in medical colleges and enhancing the curriculum of psychiatry at both undergraduate and postgraduate level.
- Strengthening the Central and State Mental Health authorities with a permanent secretariat to make their monitoring role more effective.
- Research and training in the field of community mental health, substance abuse and child/adolescent psychiatric clinics.

Comments

- Most of the mental health professionals are not aware of the National Program and so no initiative from them.
- There is shortage of professional manpower.
- Appropriate mental health care can be provided at grass root level by minimum training of health workers.
- Targets of the program has not been achieved, indicating the poor commitment of the government, psychiatrists and community at large.
- The program has given more importance for the curative aspects ignoring the preventive measures.
- The custodial nature of medical care in the hospital needs to be changed to a therapeutic approach.

Current Status

There are three Districts which have/are receiving 100 percent central assistance for DMHP under NMHP. This scheme is for a period of five years, after which the State has to take over the scheme. These Districts are – Muktsar, Hoshiyarpur and Sangrur **(Table 43.6)**.

Table 43.6 Districts receiving cent percent assistance under NMHP

Sl. No.	District	Nodal institute	Year of implementation	Remarks
1.	Muktsar	GMC, Amritsar	2003	Completed 5 years on 31.7.2008
2.	Hoshiyarpur	-'-	2007	-
3.	Sangrur	-'-	2007	-

NATIONAL IODINE DEFICIENCY DISORDERS CONTROL PROGRAM (NIDDCP)

This program was started in 1962 as National Goiter Control Program.

The sheet anchor of the program is universal iodization of common salt and its consumption. Even after three decades, the prevalence of the disease remained high. So it was clear that the program was a failure one. It was due to the difficulties such as production of iodized salt did not keep with the requirement and there were difficulties in the sale of iodized salt. Meanwhile survey reports revealed that the problem of goiter was not just restricted to 'Goiter belt' of Sub-Himalayan areas but were reported from the other parts of the country as well and the manifestations of the iodine deficiency were not just goiter and cretinism but consisted of a wider spectrum including still-births, abortions, mental retardation, deaf-mutism, squint and neuromotor defects. The survey in the country revealed that the prevalence rate of iodine deficiency disorders is about 10 percent and estimated that nearly 167 million persons are exposed to the risk of iodine deficiency of which about 71 million persons are already suffering from the various manifestations of iodine deficiency disorders.

Considering the magnitude of the problem and its disabling after effects, Government of India upgraded the National Goiter Control Program into National Iodine Deficiency Disorders Control Program (NIDDCP) during 1992. The essential component of the program is universal use of iodized salt in place of common salt.

Aim

To reduce the prevalence of IDD:
- To less than 10 percent among adults, by 2010
- To less than 5 percent among children 10 to 14 years
- To zero percent of cretins among the newborns by the year 2000.

Objectives

- To assess the magnitude of the IDD problem in the country
- To assess the impact of control measures after every five years
- To monitor the quality of iodated salt available to consumers and estimate their urinary iodine excretion pattern
- To conduct IEC campaigns for promoting community participation in the implementation of the program.

Administrative Set-up

a. Salt Commissioner, Central Office of Government of India, supervises universal iodization. He issues licences to salt manufacturers to produce iodized salt liberally containing 15 ppm of iodine, simultaneously imposes ban on the manufacture of non-iodized salt. Manufacturers are given subsidy for buying potassium-iodate.
b. A National Reference Laboratory for monitoring IDD has been set-up at the Biochemistry Division of National Institute of Communicable Diseases (NICD), Delhi for training medical and paramedical personnel.
c. About 100 IDD control cells and IDD monitoring laboratories have been established in the States to monitor the quality of iodated salt and urinary iodine excretion pattern.
d. UNICEF has donated testing kits to District Officers to test the quality of iodated salt at the consumer level.
e. To encourage the consumption of iodized salt, Directorate of Field Publicity, Doordarshan, All India Radio, Directorate of Advertisement and Visual Publicity and Song and Drama Divisions have been asked to conduct IEC programs vigorously.

NATIONAL PROGRAM FOR CONTROL AND TREATMENT OF OCCUPATIONAL DISEASES

Burden of Occupational Diseases and Injuries

There are 100 million occupational injuries causing 0.1 million deaths in the world according to WHO. It is also estimated that in India 17 million occupational non fatal injuries (17% of the world) and 45,000 fatal injuries (45% of total deaths due to occupational injuries in the world) occur each year. Out of 11 million cases of occupational diseases in the world 1.9 million cases (17%) are contributed by India and out of 0.7 million deaths in the world 0.12 (17%) is contributed by India.

This has been launched during IXth Five Year Plan. An outlay of ₹ 25 crores was proposed for the program during the entire plan period.

The scheme was started during 1998-99. Under the scheme following projects have been undertaken by National Institute of Occupational Safety and Health. (NIOSH), Ahmedabad, which has been identified as a nodal agency for the same.

Following research projects have been proposed to initiate by the Government
- Prevention, control and treatment of silica tuberculosis in Agate industry and occupational health problems of tobacco harvesters and their precaution.
- Evaluation of occupational health problems; Evaluation and Control.
- Child labor occupational health problems; Evaluation and Control.
- Capacity building to promote Research, Education and Training.
- Prevention and control of occupational health hazards among salt workers in remote desert areas of Gujarat and Rajasthan.
- Health risk assessment and development of intervention program in cottage industries with high risk silicosis.
- Hazardous process of Chemicals, Database generation, Documentation and Information dissemination.

National Institute of Occupational Safety and Health (NIOSH) has developed a priority list of ten leading work related illnesses and injuries. Three criteria were used to develop the list:
a. The frequency of occurrence of the illness or injury
b. Its severity in individual cases
c. Its potential for prevention.

NATIONAL VITAMIN 'A' PROPHYLAXIS PROGRAM

This was launched by Government of India during 1970, and merged as a component of National Program for the Prevention and Control of Blindness.

Aim

To prevent nutritional blindness among children.

Strategy

Until 1992, the strategy consisted of administration of 2 lakh IU of oral vitamin A concentration to children between 2 and 6 years, at intervals of 6 months.

With the commencement of National Child Survival and Safe Motherhood Program (CSSM) during 1992, the strategy was changed to administration of 5 mega doses of Vit. A concentrate orally to all children between 9 months and 3 years not only to eliminate nutritional blindness but also other consequences of Vitamin A deficiency. However it can be extended upto 5 years. Vitamin A prophylaxis schedule is shown in **Table 43.7**.

Thus the child is almost immunized against 'Xerophthalmia.'

Note: 2L IU = 1 spoon of 2 ml capacity is supplied alongwith Vit. A syrup.

In order to improve the coverage of the under five children, Government of India has linked vitamin A supplementation to UIP and ICDS activities. To offset the depletion of vitamin A caused by infections, all children suffering from measles, diarrhea and PEM are given massive dose of vitamin A. Pregnant and lactating women should also be covered under vitamin A supplement to ensure adequate transfer of the vitamin to every growing fetus and to every suckling infant.

NATIONAL NUTRITIONAL ANEMIA CONTROL PROGRAM (NNACP)

Described under Nutritional Anemia.

NATIONAL SPECIAL NUTRITION PROGRAM

This was launched by Government of India during 1970 to improve the nutritional status of children below 6 years and all pregnant and nursing mother, of urban slums, tribal areas and backward rural areas, by providing supplementary food, every day for 300 days in a year, supplying 300 K. Cals including 10 to 12 g of protein per child per day and 500 K. Cals including 25 g of protein per mother per day. This program is merged with ICDS scheme since 1975.

NATIONAL BALWADI NUTRITION PROGRAM (NBNP)

This was started during 1970, to improve the nutritional status of the Anganwadi (Balwadi) centers with the daily supplement of the food, same as above. This is also merged with ICDS scheme since 1975.

NATIONAL MID-DAY SCHOOL MEAL PROGRAM

Described under School Health Services.

NATIONAL INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS) SCHEME

Described under MCH services.

NATIONAL TOBACCO CONTROL PROGRAM

National Tobacco Control Program (NTCP) is a national effort to reduce tobacco related diseases and deaths:

During October 2007, Government of India launched NTCP in Assam, in a pilot phase with the following objectives.

- To implement tobacco control laws.
- To create awareness on the harmful effects of tobacco use.
- To eliminate exposure to environmental tobacco smoke.

Table 43.7 Vitamin A prophylaxis schedule

Dose no.	Age of the child	Dose (orally)	Remarks
1.	At 9th month	1,00,000 IU	Along with measles vaccine
2.	At 18th month (1½ yr)	2,00,000 IU	Along with Booster dose of DPT and OPV
3.	At 24th month (2 yr)	2,00,000 IU	Nil
4.	At 30th month (2½ yr)	2,00,000 IU	Nil
5.	At 36th month (3 yr)	2,00,000 IU	Nil

The main components are:

State Tobacco Control Cell (STCC): This is being set up in Delhi to facilitate, drive and monitor the proposed District Tobacco Control Program. The nodal officer at the state will be responsible for the coordination, monitoring and evaluation of the program at the district level. He is supported by two consultants to reduce tobacco use. Thus the Anti tobacco Act is enforced effectively.

District Tobacco Control Cell (DTCC): The district Tobacco Control Program comprises the following components:

- *Tobacco Cessation Center:* This provides counseling and pharmacotherapy to tobacco users for quitting the tobacco addiction. It also conducts training and awareness programs at schools and colleges to promote quitting and prevent initiation among youths.
- It also brings awareness of the adverse effects of tobacco consumption on the health by conducting rallies, street role play, etc.
- *Training:* The cell conducts training, workshop among school teachers, health workers, women self help group, civil society organization, etc. on tobacco epidemic, tobacco control laws and implementation of the schemes.
- *IEC activities:* There will be active involvement of the medias through poster display, article publications, rallies, street role plays, exhibitions, mela, etc. in regional languages. IEC materials will be developed and disseminated in local languages also.
- *School programs:* This is to create awareness of health hazards of smoking among school children.

Monitoring of tobacco control laws: This is done by small teams of trained school teachers, health workers, law enforcers, women self-help groups, etc. to cover small areas of each district.

NATIONAL FAMILY WELFARE PROGRAM (NFWP)

India is the first country in the world to launch a nation-wide Family Planning Program during the year 1952. The program was begun with the establishment of few clinics and distribution of materials on education, training and research. During the Third Five year Plan (1961-65), family planning was declared as 'the very center of planned development.' The emphasis was shifted from 'Clinic Approach' to the more vigorous 'Extension Education Approach,' for motivating the people for acceptance of the 'Small family norm.' The introduction of Lippe's Loop during 1965, led to the creation of a separate Department of Family Planning in 1966 in the Ministry of Health and the program became strong during 1966 to 69, i.e. the infrastructures such as primary health centers, sub-centers, urban family planning centers were strengthened.

During the Fourth Five Year Plan (1969–74), Government of India gave 'top priority' to the program. The program was integrated with MCH services in the PHCs and sub-centers. During 1970, the All India Hospital Postpartum Program and in 1972 the Medical Termination of Pregnancy (MTP) were introduced.

During Fifth Five Year Plan (1975–80) major changes took place in the program. During 1976, the country framed its first 'National Population Policy'. The ruling party Congress then introduced forcible sterilization campaign during 1976. It was a disaster. Many misappropriation took place. In June 1977, Congress Government was defeated and the New Janata Government ruled out compulsion, and coercion for all times to come. The Ministry of Family Planning was renamed as 'Family Welfare'. Since then it is running purely on voluntary basis.

The pace of the program was accelerated by the involvement of the local people at the grass root level with the launching of Rural Health Scheme during 1977. The village health guides, dais and opinion leaders were involved in the program.

Meanwhile during 1978, Government of India became signatory to Alma-Atta declaration of Health for All by the year 2000 AD.

The demographic goals targeted were:

- Net reproduction rate of 1
- Two Child Family Norm
- Birth Rate of 21/1000 MYP
- Death Rate of 09/1000 MYP
- Couple Protection Rate of 60 percent.

To achieve these goals, the Family Welfare Program was accorded a central place in health development during 6th and 7th five year plans, by strengthening the existing Maternal and Child Health-services including Universal Immunization Program and Oral Rehydration Therapy, thus aiming at the Welfare of the whole family.

During 1992, MCH services were upgraded into a National Program called 'Child Survival and Safe Motherhood (CSSM) Program to improve the quality of services.

During 1994, following an International Conference on Population and Development in Cairo, it was recommended to implement a comprehensive, unified 'Reproductive and Child Health (RCH) Program comprising Family Welfare, CSSM Programs, and also Prevention and Management of Reproductive Tract infections and the Sexually Transmitted Infections (RTIs and STIs) including HIV/AIDS. The main aim was to improve the quality of the services and to satisfy consumers, covering a wider range of population. Thus there was a paradigm shift from clinic based, target oriented approach to target free, client centerd (satisfied), need based, high quality approach.

Government of India launched RCH Program on April 1st, 1996. (explained further under RCH Program).

In this connection, Government of India evolved a more detailed and comprehensive National Population Policy

(NPP) during the year 2000, dealing with empowering the women for improved health, women education, child health, the unmet needs for Family Welfare services and health care for the underserved population groups like urban slums, tribal community, hill area population and displaced and migrant population, adolescent's health and education, increased participation of men in planned parenthood and collaboration with NGOs.

Evaluation of Family Planning

WHO has defined the following types for evaluation of family planning services during 1975.

1. *Evaluation of need:* By Maternal Mortality Rates
2. *Evaluation of plans:* By assessing the feasibility and adequacy of program plans
3. *Evaluation of performance:*
   a. *Services*: Such as distribution of contraceptives, IUD fittings, tubectomies, vasectomies, education, follow-up, motivation, etc.
   b. *Response:* Such as number of new acceptors
   c. *Cost-analysis:* Cost-effectiveness
   d. *Other activities*: Such as administration, manpower, data system, etc.
4. *Evaluation of effects*: Such as changes in their knowledge, attitude, behavior, etc.
5. *Evaluation of impact*: Such as:
   - Family size (number of living children)
   - Birth interval
   - Age of the mother at birth of the first child and last child
   - Birth order
   - Number of abortions
   - Changes in the birth rate and growth rate.

NATIONAL REPRODUCTIVE AND CHILD HEALTH PROGRAM (RCH-PROGRAM)

Historical Background

During 1950s Government of India introduced Maternal and Child Health (MCH) services as basic health services in Primary Health Centers because of their increased vulnerability and morbidity and mortality.

During 1952, National Family Planning Progamme was launched to control population growth in India. The services were target oriented resulting in burden on health workers, which ultimately affected the quality of work.

During 1972, abortion was legalized due to increased maternal deaths following illegal abortions.

During 1975, emergency was declared in India by the Government

During 1976, the disastrous forcible sterilization campaign led to the defeat of congress Government and the new Janatha Government during 1977, ruled out compulsion and coercion of Family Planning services and renamed the program as 'Family Welfare' program by providing a package of services to the mothers and children in an integrated manner, comprising Maternity services (Antenatal, Intranatal and Postnatal care), Nutritional services (supplementary nutrition), Immunization services and Family Planning services, for the welfare of the entire family.

During 1978 Government of India upgraded the immunization services and launched WHO recommended Expanded Program of Immunization (EPI).

During 1978-79, meanwhile Government of India became signatory to Alma-Ata Declaration of achieving the Global Social Target 'Health for all by 2000 AD'.

During 1985, Expanded Program of immunization was renamed as 'Universal Immunization Program (UIP)' by concentrating the services to infants and expectant mothers.

During 1992, to achieve the social target and to improve the quality of services to mothers and children, the services were integrated into a single composite Program called 'Child Survival and Safe Motherhood (CSSM)' Program, a time bound and target oriented National Program.

The time bound was 2000 AD and the target population was all mothers and under five children. The objectives of the CSSM Program were:

- To improve the health of the mothers and children below 5 years
- To reduce MMR, IMR and Child Mortality Rates
- To eliminate neonatal tetanus
- To eradicate poliomyelitis.

The interventions (strategies) were as follows:

Services for safe-motherhood:

a. Essential Obstetric Care comprising
   - Registration of all expectant mothers after 12 weeks of amenorrhea
   - Minimum 3 visits to Antenatal Clinic
   - Two doses of tetanus toxoid injections
   - Distribution of 100 tabs (1 packet) of IFA
   - Safe domestic deliveries observing five cleans
   - Postpartum services after delivery.

b. Early diagnosis and management of complications associated with pregnancy by early detection of high-risk mothers and their referral.

c. Emergency care for those mothers with obstetric complications such as premature labor, puerperal sepsis, retained placenta, malpresentations, malpositions, prolonged labor, rupture uterus, obstructed labor, post-partum hemorrhage, etc.

Services for child survival:

a. Essential care of the newborn

b. Primary immunization—100 percent coverage
c. Vitamin 'A' prophylaxis—(9 month–3 years)—100 percent coverage
d. Acute Respiratory Infections—correct case management at home
e. Diarrheal diseases—correct case management at home.

Services for eligible couples:
a. Promotion of contraceptive methods
b. Services for medical termination of pregnancy

During 1994, the services were evaluated and observed that IMR and MMR were not coming down to the expected level. Meanwhile it was observed that the incidence of Reproductive Tract Infections (RTIs) and Sexually Transmitted Infections (STIs) including HIV/AIDS were increasing among mothers and adolescent girls all over the world. Eventually when the International Conference on Population and Development (ICPD) was held in Cairo (Egypt), (1994), it was resolved to provide high quality of services to children and mothers, with a wider coverage of women population from puberty to menopause (15–44 years), in a client based, non-rigid, decentrallized, target-free, participatory, demand driven, approach. Accordingly during September 1996, the CSSM Program and Family Welfare Program were incorporated into a single, composite, National Reproductive and Child Health (RCH) Program to eliminate the overlapping of expenditure, to reduce the cost of inputs and to optimize the benefit of outputs. Government of India formally launched RCH Program on 15th October 1997. Thus RCH Program incorporates a paradigm shift from a rigid, target based, centralized, coercive system to a non-rigid, target free, decentralized, participatory, demand driven, client based approach system aimed at satisfaction of individual clients with a range of quality services.

In ICPD at Cairo, Fathallah, defined Reproductive Health as, '*A state of complete, physical, mental and social well-being and not merely the absence of disease or infirmity in all matters relating to reproductive system and its function and processes*'.

Fathallah explained reproductive approach based on the following points:

- People have ability to reproduce and regulate their fertility
- Women are able to go through pregnancy and childbirth safely
- The outcome of the pregnancy is successful in terms of wellbeing and survival of mother and infant
- Couples are able to have sexual relation free of fear of pregnancy and of contracting STIs including HIV/AIDS.

Objectives

- The immediate objective is to promote the health of the mothers and children to ensure safe motherhood and child survival
- The intermediate objective is to reduce IMR and MMR
- The ultimate objective is population stabilization, through responsible reproductive behavior.

Interventions/Strategies of RCH Program

- Prevention and management of unwanted pregnancies
- Maternal care (Safe motherhood)
- Child survival
- Prevention and management of reproductive tract infections and sexually transmitted infections (RTIs/STIs)
- Prevention of HIV/AIDs.

Thus the operational profile of RCH Program can be discussed under three broad service areas, namely maternal health, child health and reproductive health.

The framework of RCH program is shown in **Fig. 43.9.**

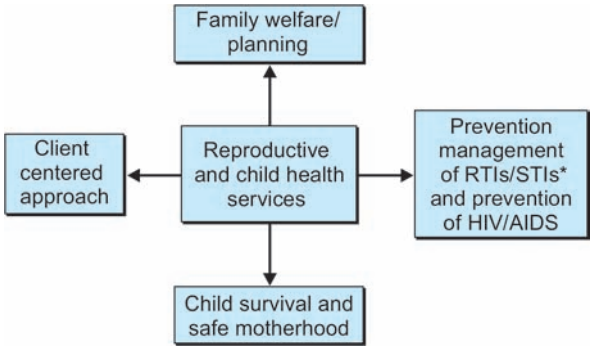
Maternal Health (Safe Motherhood)

The service components are obstetric care, infection control and nutrition promotion.

Obstetric Care

Obstetric care is provided to all pregnant mothers following their registration after 12 weeks of amenorrhea, starting from early pregnancy and spans over prenatal, intranatal and postnatal phases by periodical check-up all along the course of pregnancy, child-birth and puerperium. High quality of these services are now made available for high-risk mothers and also at-risk newborns by upgrading certain selected PHCs and Community Health Centers into First Referral Units (FRUs), at the rate of 4 to 6 per district. FRU is a health institution at Taluka level, where the services of an obstetrician (to take care of obstetric emergencies) and a pediatrician (to take care of at-risk newborns) including the facility for blood transfusion is available. Thus FRUs provide essential and emergency MCH care at Taluka level.

A trained female health assistant (ANM) is qualified to conduct health check-ups of normal antenatal and postnatal cases. A trained traditional birth attendant is qualified to



(*RTI/STI reproductive tract infections/sexually transmitted infections)

Fig. 43.9 Framework of RCH program

provide delivery assistance, to normal, uncomplicated cases. Pregnant mothers suffering from associated systemic diseases are referred to appropriate centers for expert management.

To promote institutional deliveries, provision has been made as additional honorarium to the staff to encourage round the clock delivery facilities at PHCs.

NGOs are involved in this program to make it peoples' program. They serve as complimentary agencies for optimizing, the functioning of RCH program.

Provision has also been made for the involvement of traditional practitioners of Ayurvedic and Unani medicine in this program, following an orientation course to update their knowledge and skills.

Infection Control Measures

- Women are advised to maintain hygiene of the genitals during menstruation to prevent urinary tract infections.
- They are educated to keep their parts clean by frequent washings and by using sanitary towels and to avoid using dirty linen.
- They are advised to prevent STIs by using condoms.
- Every pregnant mother is immunized against tetanus with two doses of tetanus toxoid.
- The Traditional Birth Attendant (TBA) is trained to observe five cleans while conducting delivery, to prevent puerperal sepsis.

Nutrition Promotion

- All mothers are given nutrition education.
- They are explained that pregnancy drains out their nutrient stores and unless substantial improvement is made in their daily diet, they would develop malnutrition which can impair their health and affect adversely the course of the pregnancy and its outcome.
- They are instructed to consume foods rich in iron content such as green leafy vegetables and fruits.
- They are also additionally motivated to consume one large IFA tablet daily, during the last trimester to prevent anemia and its consequences.

Child Health (Child Survival)

The service components are:

- Essential care of the newborn, including care of the at-risk newborn by prompt referral service. The neonatal care consists of care of eyes, nose, throat, skin, umbilical-cord and rectum.
- *Infection control measures*:
  - Starting from observing five cleans while conducting delivery
  - Early initiation of breast feeding, while avoiding prelacteal feeds
  - By adopting 'warm-chain' with the mother
  - By minimum handling and handling by barely minimum number of persons
  - By keeping the room clean, dust free and warm
  - By giving bath about one week after birth
  - By getting primary immunization during infancy
  - By educating the mother about Oral Rehydration Therapy of the child with the onset of diarrhea
  - By giving home remedy to treating upper respiratory infections of the child with ginger syrup and/or pediatric co-trimoxazole tablets.
- *Nutrition promotion*:
  - By promotion of breast-feeding to the child
  - By proper complimentary feeding after 6 months of exclusive breast-feeding, with fruits and vegetables
  - By five mega doses of Vit. A syrup between 9 month to 3 years, with interval of 6 months.

Reproductive Health

- *Fertility control*: The family planning services include :
  - Distribution of conventional contraceptives (condoms) and oral pills for newly married couples
  - Condoms, and IUDs for spacing after one child
  - Sterilization for either of the partners after two children, including services of laparoscopic surgery

  The supportive services provided are:
  - Monitory compensation of ₹200/- for female sterilization, (per acceptor) and ₹180/- per acceptor of male sterilization
  - Meeting expenditure incurred by state governments on sterilization services such as transportation, drugs, dressings, diet, etc.
  - Offering facilities for post-vasectomy semen testing, which can be availed any time after three months of vasectomy or after 20 episodes of ejaculation.
  - The services are made as 'Target free' approach.
- *MTP-services* (for prevention and management of unwanted pregnancies). This is provided not only in District and sub-divisional (Taluka) hospitals, but also now extended to PHC levels also under MTP-Act, 1971, because nearly 20,000 maternal deaths have been occurring per annum in our country, only due to illegal abortions. The aim is to reduce maternal deaths from unsafe abortions.
  - Involvement of adequately equipped and trained doctors of non-government clinics is also provided.
  - Supportive assistance is also provided by training the doctors in MTP technique, Supply of MTP equipment to hospitals and health centers and assistance of trained doctors to PHC, weekly, on fixed days.
- *Adolescent counseling*: Since adolescence is a stage of transition physically, mentally and emotionally, ignorance

can result in psychological problems among adolescent boys and girls. RCH program strives for dispelling misgivings, misconceptions and misapprehensions from their minds.

The scheme provides for counseling of adolescents on problems related to sex and sexuality including various forms of sexual dysfunction, sexual aberrations, sexual abuse, impotence, etc. Adolescent girls are educated on menstruation and menstrual hygiene.

They are also educated about the risks associated with unprotected sex such as transmission of STIs including Hepatitis B and HIV/AIDS, besides resulting in pregnancy.

They are also advised to consume nutritious diet for optimum growth and development.

- *Prevention and management of RTIs/STIs including HIV/AIDS.*

  These infections have a profound effect on the health of the mothers and children. These infections (RTIs/STIs) can cause infertility, pelvic inflammatory disease, ectopic pregnancy, low birth weight, still-births and childhood mortality. Presently the services for prevention and management of these infections are available only in Dist. Hospitals and teaching hospitals. Currently it is thought to provide such services in CHCs, PHCs and FRUs, by the dermatologists. This component has been linked with National AIDS Control Program. The National AIDS Control Organization (NACO) has been providing assistance to set-up RTI and STI clinics at district level by providing manpower (2 lab technicians) and materials (drug kits) to test blood and urine of the patients.

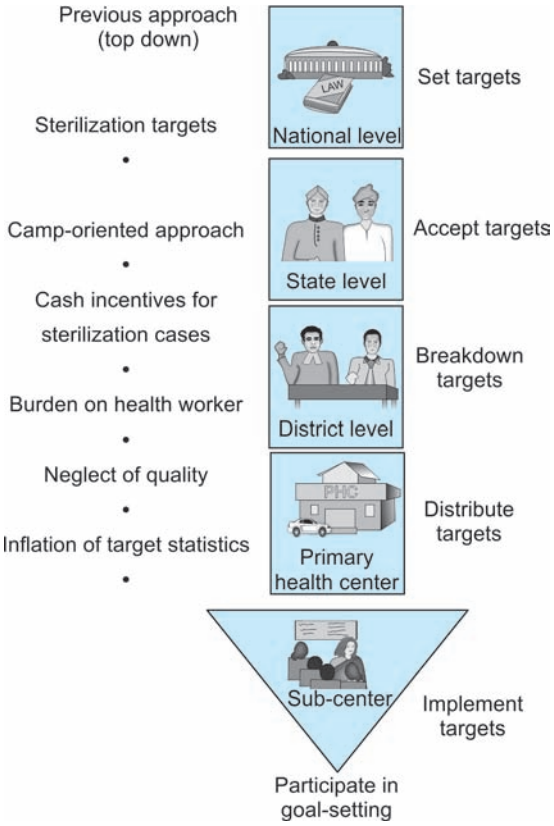


Fig. 43.10 'Topdown' approach of family planning program

Management Strategies of RCH Program

Bottom-up Planning

The previous approach in FP Program was 'Top-down' i.e. centralization of services **(Fig. 43.10)**. That means the targets were fixed at the national level (center). That used to be a burden on health workers affecting the quality of services, resulting in inflation of target statistics, specially with reference to tubectomies, vasectomies and IUD fittings. In RCH Program, it is 'Bottom-up planning,' (and not top-down), i.e. Decentralization of services **(Fig. 43.11)**. That means the planning of services is based on assessed needs. At the grass-root level the needs are assessed by the health workers and medical officers in consultation with the Mahila Mandals, Village Panchayats, and Nongovernment Organizations.

The aggregated needs of the villages will make up the PHC plan. Likewise the aggregation of FRUs, PHC plans will make up District-plan. Aggregation of District plans will make of state-plans. Thus 'Bottom-up' planning reflects the grass-root needs.

Decentralized Training

Training of health functionaries is incorporated in this program. The training improves the quality of service and satisfies the clients. The training is skill oriented and not knowledge oriented by didactic lecture classes. For that periodically refresher courses and work-shops are conducted at District Level.

Management Information and Evaluation System (MIES)

This has been proposed under RCH-Program.

The various indicators included are:

- Proportion of institutional deliveries and deliveries by trained personnel
- Number of health facilities providing emergency obstetric care
- Number of poliomyelitis and neonatal tetanus cases reported
- Number of IEC sessions on ARI and Diarrheal diseases
- Number of ARI cases among underfives, identified and treated

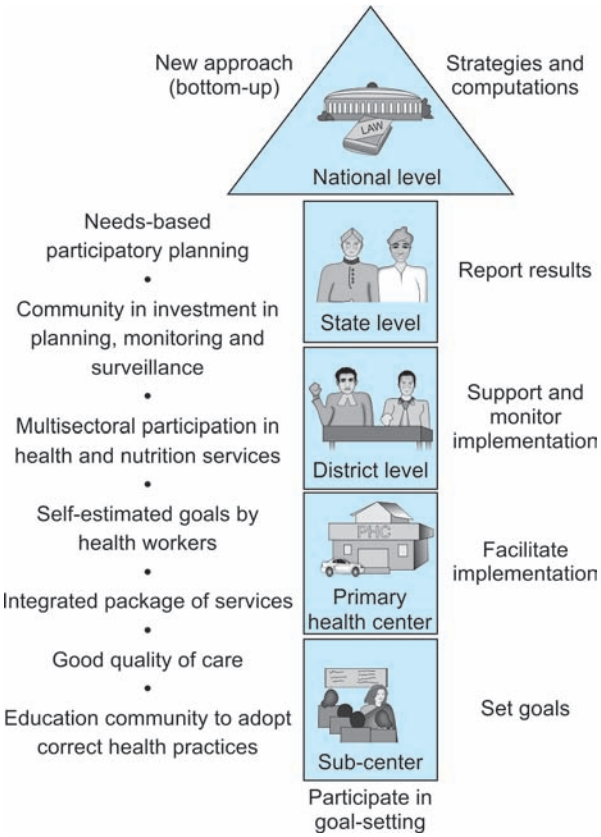


Fig. 43.11 'Bottom-up' planning of RCH program

- Proportion of acceptors of reversible methods with wife's age less than 30 years
- The total number of immunization sessions planned and held.

IEC and Community Participation

RCH program envisages IEC campaigns (Information, Education and Communication). Gender and sexuality issues, hitherto neglected will be the important components. Community participation will be elicited through the Panchayats, Mahila Mandals and other community groups.

To meet this gigantic task of achieving the goals, Government of India is enhancing the budget for RCH program. The World Bank and European Commission have also been supplementing the national fund.

Highlights of this New Approach

- Target free program from April 1, 1996
- Greater emphasis on quality
- Bottom-up approach, Decentralized participatory planning
- Integrated package of services to mothers and children
- Free distribution of condoms
- Comprehensive integrated training programs
- Increased involvement of NGOs
- Area specific IEC campaigns
- Rapid and independent evaluation
- Integrated approach
- Increased male participation
- Gender sensitivity.

REPRODUCTIVE AND CHILD HEALTH PROGRAM-II (RCH-II)

RCH-II is the continuation of RCH-I, which was for the period of 1997 to 2002. During the period of 2002 to 2004, planning for the implementation of RCH-II was going on and RCH-II was started from 1st April 2005 up to 2009, in order to strengthen/improve the quality of services and to achieve the Millennium Development Goals by overcoming the lacunaes of RCH-I.

AIM

The aim is to reduce Infant Mortality Rate (IMR), Maternal Mortality Rate (MMR), Total Fertility Rate (TFR) and to increase Couple Protection Rate (CPR) and Immunization coverage, specially in rural areas.

Goals

- Reduction of decadal rate of population growth between 2001 and 2011 to 1.62 percent.
- Reduction of IMR to <45/1000 livebirths by 2007 and to <30/1000 livebirths by 2010.
- Reduction of MMR to 1.5/1000 livebirths.
- Reduction of TFR to 2.1 by 2010.
- Increase of CPR from 44.8 percent (RHS 2002–03) to 65 percent by 2010.
- Increase of immunization coverage among children from 48.2 percent (RHS 2002–03) to 100 percent by 2010.
- Improvement in the coverage of full antenatal care from 44.5 to 89 percent by 2010.
- Improvement in the coverage of rural institutional deliveries from 39.8 percent (Rural Health Survey 2002–03) to 80 percent by 2010.

Lacunae of RCH-I

They were as follows:

- The outreach services were not available to the vulnerable and needy population.
- The management of financial resources were inadequate.
- The human resources (manpower) such as doctors, nurses, health workers, etc. were deficient.
- The management information and evaluation system was lacking.
- The effective network of First Referral Units was lacking.

- The maintenance of infrastructures was poor, such as lack of cleanliness, water supply, electricity, instruments, disposal of hospital waste, etc.
- The range and quality of services in PHCs/CHCs was poor.
- The concentration on neonatal and adolescent health was lacking.
- The community participation was minimum.
- There were regional variations in the implementation of RCH-I program.

Andhra Pradesh and Tamil Nadu were doing well. Whereas in Bihar, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, Chhattisgarh, Jharkhand and Uttaranchal the health status is poor. These eight states have been designated as Empowered Action Group (EAG) states.

Objectives

The main objective of RCH-II is to overcome the lacunae of RCH-I by the following measures:

- To improve the management performance.
- To develop human resources intensively.
- To expand RCH services to tribal areas also.
- To improve the quality, coverage and effectiveness of the existing family welfare services and essential RCH services with a special focus on the above mentioned EAG states.
- To monitor and evaluate the services.

COMPONENTS OF RCH-II

- Population stabilization
- Maternal health
- Newborn care
- Child health
- Adolescent health
- Control of RTIs/STIs
- Urban health
- Tribal health
- Monitoring and evaluation
- Other priority areas.

Population Stabilization

Strategies

- By incorporating the newer choices of contraceptive methods such as injectable contraceptives, non-steroidal hormonal pills (like centchroman) and female condom.
- By increasing the number of trained personnel like medical officer of PHCs and female health worker of subcenters.
- By converging the services at grass roots level by having linkage with ICDS.
- By public private partnership, i.e. by involving private doctors to provide contraception by paying incentives to them.
- Social marketing of contraceptives to be strengthened in rural areas through Rural Health Practitioners and Community mobilization through satisfied acceptor couples.
- Involving Panchayati Raj institutions, urban local bodies and NGOs.
  - By training one couple from each village to provide non-clinical family planning method of services.
  - By involving District Urban Development Authorities (DUDA), co-operative societies and industrial workers in providing family planning services.
  - By identifying NGOs to provide financial, technical and managerial support.
- By increasing the incentives for family planning acceptors as follows from:

  ₹300 to ₹400 for tubectomy
  ₹200 to ₹400 for vasectomy
  ₹400 to private providers for sterilization
  ₹75 for IUD fitting (only for women of below poverty line)
  ₹500 as compensation and medical termination of pregnancy to the women acceptors in case of failure of permanent method (tubectomy).

Maternal Health

The strategies to improve and strengthen the quality of maternal services are:

- Essential obstetric care
- Emergency obstetric care.

Essential Obstetric Care

This consists of strengthening the quality of antenatal care by ensuring the following:

- Three or more checkups including the investigations
- Two doses of tetanus toxoid
- One pack of Iron Folic Acid (IFA) tablets during the last trimester.
- Counseling on promotion of institutional delivery, danger signs of obstetric emergency and sensitization on breast-feeding and family planning methods.

Emergency Obstetric Care

This consists of operationalizing the First Referral Units to be fully functional round the clock (24 hours).

First referral unit (FRU): It is an upgraded PHC/CHC into a 30 bedded hospital, having a well furnished and equipped operation theater with a newborn care corner, a labor room, blood bank and laboratory to provide the services of obstetric

emergencies such as cesarean section, care of the newborn and sick children and facilities for blood transfusion.

Staff pattern of FRU

- Five specialists namely Obstetrician and Gynecologist, Pediatrician, Anesthetist, Surgeon and Physician.
- Seven Staff nurses
- One Pharmacist
- Two Laboratory Technicians.

Services of FRU

- Emergency obstetric care such as cesarean section
- Care of the newborn
- Care of the sick children
- Availability of ambulance
- Adequate supply of drugs to the patients.
- Facility for storage of blood
- Family welfare services including vasectomy, laparoscopic tubectomy and MTP
- Training of Medical Officers (MOs) in anesthetic skills for emergency obstetric care
- Training of Auxillary Nurse Midwives (ANMs)/Female health workers to provide obstetric first aid.

All these services should be provided round the clock. All CHCs and at least 50 percent of PHCs should become FRUs by 2010.

Newer Schemes

1. Training of MOs in the skills of obstetric management including cesarean section.
2. Training of Traditional Birth Attendants (TBAs) for one year and designated as Community Skilled Birth Attendant (CSBA).
3. *Prasoothi araike*: This is to promote antenatal care by giving ₹1000 at 6th month of pregnancy to BPL (Below Poverty Line) mothers and another ₹1000 at 9th month, total ₹2000.
4. Janani Suraksha Yojana (JSY) Scheme.

Janani Suraksha Yojana (JSY)

This is a modified version of National Maternity Benefit scheme for pregnant women of BPL families in both urban and rural areas. This scheme was launched on 12th April 2005 under National Rural Health Mission (NRHM). It is a benefit of cash assistance. It is 100 percent centrally sponsored scheme as a safe motherhood intervention for promoting safe delivery.

The main components of JSY are early registration, micro birth planning, referral transport (home to health institution), institutional delivery, post delivery visit and reporting, family planning and counseling.

Objective

The main objective is to reduce MMR, NNMR and IMR by promoting institutional deliveries as well as better antenatal care and postnatal care through Accredited Social Health Activist (ASHA).

Eligibility

- Pregnant women belonging to BPL (Below Poverty Line) families irrespective of caste, creed and community.
- Pregnant women of families having an annual income of less than ₹17,000.
- Women aged above 19 years, upto first two livebirths in High Performing States (HPS).
- Women undergoing sterilization soon after delivery, irrespective of birth order in Low Performing States (LPS) namely Uttar Pradesh, Uttaranchal, Madhya Pradesh, Chhattisgarh, Rajasthan, Bihar, Jharkhand, Odisha, Assam and Jammu and Kashmir.
- Pregnant women must and should have registered in PHC/Sub center and has received adequate antenatal care (i.e. 3 visits, 2 doses of tetanus toxoid and 1 pack of IFA tabs).

All women registered under JSY are issued JSY card and MCH card. Accredited Social Health Activist (ASHA) will work as a 'Link Worker' between the mothers of the community and the health system in these ten LPS. She is responsible for making available the institutional care for mothers during pregnancy, delivery and after birth of the child.

Benefits

Table 43.8 shows the financial benefit provided under JSY.

Table 43.8 Financial benefit provided under JSY

Category of states	Rural			Urban		
	To mother	To ASHA	Total	To mother	To ASHA	Total
Low performing states	₹700	₹600	₹1300	₹600	₹200	₹800
High performing states	₹700	–	₹700	–	–	–

- ₹500 if BPL mother delivers at home.
- ₹700 if she delivers in the hospital and ₹600/- to urban mother of LPS.
- ₹200 as conveyance allowance for transportation to referred center.
- ₹1500 for those mothers, who undergo cesarean section in a private hospital, in case the services of Government Doctor is not available.
- ₹175 for laparoscopic tubectomy.
- Incentive for ASHA should not be less than ₹200/- per institutional delivery for her transport assistance and for stay during delivery.

- If mother has not taken the help of ASHA, then mother will get the benefit of both the packages.
- ₹1500 will be available as advance during emergencies from Lady Health Assistant.
- All payments to ASHA would be from ANM only, within seven days of delivery.
- Services are provided round the clock.

All these services/benefits will be available not only in all the Government hospitals/PHCs/CHCs/FRUs but also in two identified private hospitals of each district, the list of which will be notified in the notice board of all the hospitals and sub centers. List of beneficiaries will be notified in the center. ANM will conduct the monthly meeting on 3rd of every month and submits the report to MO by 7th of that month.

Micro Birth Plan Maintained by ASHA

- Identification and registration of expectant mother.
- Filling up of MCH and JSY cards.
- Take necessary step to fix the service center and transportation.
- Inform dates of ANC visits, TT injection and EDD.
- Collection of BPL/Caste and other necessary certificates for submission to MO.
- Payment of cash benefit to mother and ASHA.
- Payment of last installment to ASHA.

Janani Shishu Suraksha Karyakrama (JSSK)

This is an upgraded scheme of Janani Suraksha Yojana (JSY) Scheme, because this scheme involves/extends services not only to mother but also to the Newborns during the first 30 days, who are unhealthy/at risk. This program was started on June 1, 2011 in Mewat District of Haryana State, as an important step/component of Health For All. The services are provided free of cost to all mothers and at risk newborns, born in all Government hospitals, including Primary/Community Health Centers, both for normal deliveries and cesarean sections, undergoing for the first time.

The following services are provided to the mother, free of cost:

- Normal delivery or cesarean section.
- Drugs and supplements like Iron and Folic acid tabs, Vitamin tabs, etc.
- Laboratory investigations of blood, urine and sonography.
- Food supply during their stay in the hospital/health center.
- Blood transfusion.
- Transportation facility from house to health center and to referral center if necessary and back to home after 48 hours of stay in the hospital.
- Exemption from all types of fees.

Free services to 'At-risk' newborns during the first 30 days only:

- Treatment and care
- Drugs and supplements like infusion, cotton, dressings, etc.
- Investigations if necessary.
- Blood transfusion.
- Transportation facility from house to health center and to referral center if necessary and back to home.
- Exemption from all types of fees.

Newborn Care and Child Health

Figure 43.12 shows the effective health interventions for the newborn starting from the pregnancy period, through delivery and the neonatal period.

Objectives

- Increase coverage of skilled care at birth for newborns in conjunction with maternal care.
- Implement by 2010 a newborn and child health package of preventive, promotive and curative interventions using a comprehensive IMNCI approach (Integrated Management of Neonatal and Childhood Illness) in the rural areas through AWWs/LHVs/ASHAs.
- Implement the medium-term strategic plan for the Universal Immunization Program.
- Strengthen and augment the existing services in areas where IMNCI is yet to be implemented.

IMNCI + Skilled care at birth + Immunization = 'IMNCI plus'.

Strategies

1. *IMNCI plus*: This approach consists of integration of immunization services, skilled care at birth and IMNCI **(Fig. 43.13)**.
2. Strengthening of health infrastructures in PHCs, CHCs and FRUs for care of infants and children.
3. Ensuring referral of sick neonates and children utilizing referral funds.
4. Permitting ANMs and AWWs to administer selected antibiotics like Gentamycin by ANM and co-trimoxazole by AWW.
5. Uninterrupted availability of drugs and supplies.
6. High quality supervision and monitoring.
7. Ownership of the state and district level program managers.
8. Efficiency of the administrative/financial system.
9. Community based interventions such as:
   - Mobilizing the families for JSY.
   - Promoting healthy home care practices for newborn and during illness like diarrhea.

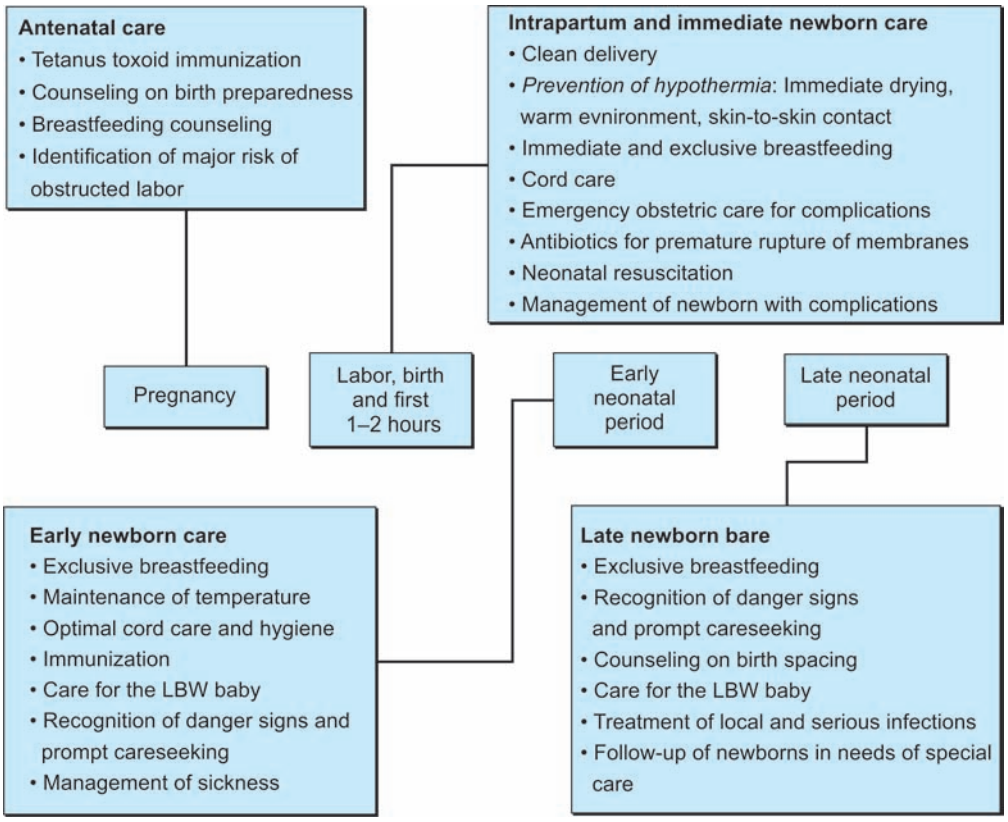


Fig. 43.12 Effective newborn health intervention

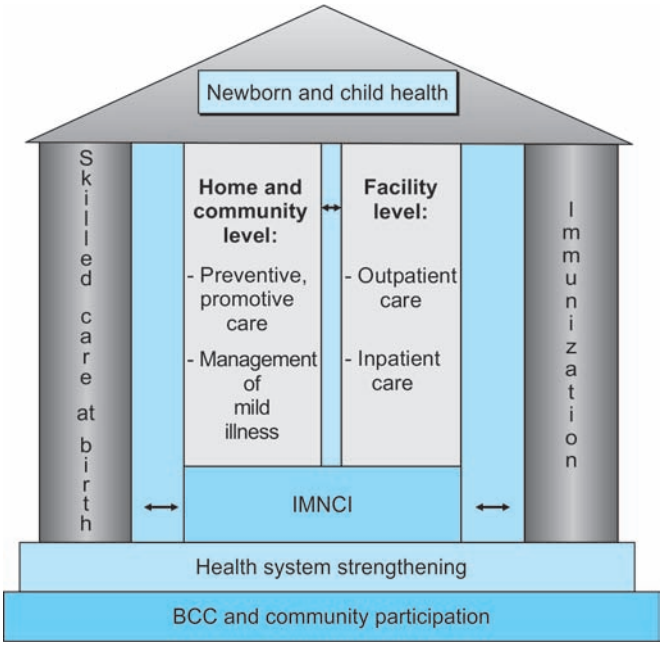


Fig. 43.13 Newborn and child health package in RCH II (IMNCI-plus)

  - Promoting early recognition of infant and childhood illness by educating family.
  - Improving referral of sick neonates and children.
10. Promoting infant and young child feeding (IYCF) by promoting breastfeeding practices and implementing IMS Act (Infant milk substitutes Act).
11. Vitamin A, iron and folic acid supplementation.
12. Strengthening the quality of UIP to eradicate poliomyelitis, to eliminate neonatal tetanus and to reduce mortality due to measles.

Adolescent Health

This is implemented on pilot basis in those districts, where more than 60 percent girls marry before the age of 18 years, presuming that the incidence of teenage pregnancy is high in those districts.

The adolescent health services are provided by counseling once a week in the clinic of SC, PHC and CHC. **Table 43.9** shows services provided for adolescents in the health center.

Table 43.9 Services provided for adolescents in the health center

Level of care	Service provider	Target group	Flow of service delivery activities	Services
Subcenter	HW(F)	Unmarried F Married F Unmarried M Married M	During routine subcenter clinics	• Enroll newly married couples • Provision of spacing methods • Routine ANC care and institutional delivery • Referrals for early and safe abortion • STIs/HIV/AIDs prevention education • Nutrition counseling including anemia prevention
Primary Health Center/Community Health Center	Health assistant (F)/LHV Medical officer	Unmarried male and female	Once a week, teen clinic will be organized at PHC for 2 hours	• Contraceptives • Management of menstrual disorder • RTI/STI preventive education and management • Counseling and services for pregnancy termination • Nutritional counseling • Counseling for sexual problems

Control of RTIs/STIs

RTIs/STIs are controlled by syndromic approach (discussed elsewhere).

Urban Health

This is improved by providing quality primary health care to the urban poor by establishing Urban Health Centers (UHC) at the rate of 1:50,000 population with 1 MO, 3-4 ANMs, 1 lab assistant, 1 public health nurse/LHV, 1 clerk, 1 chowkidar and 1 peon.

Second tier referral center could be District hospital/ Private nursing home by Public Private Partnership.

Tribal Health (Vulnerable Population)

These are the people who are underserved due to problems of geographical access and those who suffer social and economic disadvantages such as SC/ST and the urban poor.

Goal is to improve their health status.

Objective: To bring their health status at par with the rest of the population.

Strategies

- Assess their unmet needs of RCH services.
- Provide integrated and quality RCH services.
- Improve accessibility, availability and acceptability of RCH services.
- Promote community participation and intersectoral coordination.
- Promote and encourage the tribal system of medicine.
- Develop a sufficient number of first referral institutions capable of tackling emergencies including obstetric emergencies.
- Provide associated supplies, management and information.

Services

Table 43.10 shows services provided in tribal areas under RCH-II.

Table 43.10 Services provided in tribal areas under RCH-II

Tier	Services
Community level	Community based worker/ASHA to work as social mobilizer, educator and provider of non-clinical services and to work as Depot holder for contraceptives. To act as DOTS provider for the revised National TB Control Program, to take malaria slides, store and distribute anti-malaria drugs, create awareness about sanitation, safe drinking water and participate in the other health care programs.
Subcenter	ANC and PNC services, IFA distribution, delivery by skilled attendant, referral for institutional delivery, contraceptive distribution and referral for terminal methods, immunization, management of childhood illness, deworming, nutrition and health education for mothers, treatment of minor aliments including RTI/ STI, services under national program like DOTS, NMCP, counseling services.
PHC	All above + dispense ayurvedic, homeopathic, unani and tribal system of medicines.
Block PHC/ CHC	All above + Terminal method of FP EOC + elective abortion 1st trimester, MVA, screening and clinical based services for sickle cell anemia, Thalassemia, G-6 PD deficiency and Lab services.

Monitoring and Evaluation

Management Information and Evaluation System (MIES)

This is done by the following measures:

- Planning is done at various levels of Sub-center, PHC, CHC, District and State.
- Monitoring is done by establishing Consumer Need Assessment Approach (CNAA) cell at District and State level with an officer incharge.
- Quality assurance/assessment is done by INDIACLEN, which comprises the faculty members of medical colleges keeping the quality control of RCH services. It is piloted on three Empowered Action Group (EAG) states and two non-EAG states before implementation.
- Evaluation is done through District Surveys, National Family Health Survey (NFHS-III), focus studies and census report.
- Validation is by supervision and surveys **(Fig. 43.14)**.

ALL INDIA HOSPITAL POSTPARTUM PROGRAM

All India Hospital Postpartum Program (AIHPPP) is a maternity centered, hospital based approach to Family Welfare Program, by motivating the couples, women being in the reproductive age group, 15 to 44 yrs, for adopting a small family norm, through education and motivation, during antenatal, intranatal and postnatal periods.

The expectant mothers and nursing mothers constitute a captive audience and most receptive to the advice concerning herself and her child at this time than at other times. Therefore that period, specially 'lying-in' period (postpartum period) constitutes the period of highest motivation for family welfare and is the most opportune time for the efficient spread of information and service. With this point in view, Government of India, launched this program during 1969, following the recommendations of population council of New York in 1966.

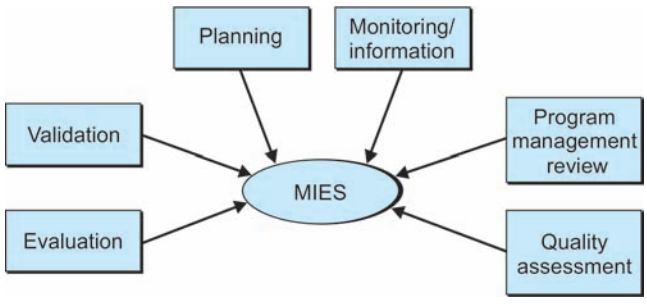


Fig. 43.14 Monitoring and evaluation

Objectives

- To improve the health of the mothers and children
- To reduce IMR and MMR.

Rationale

The AIHPPP is based on the rationale that:

- Recently delivered mothers are of proven fertility and are at risk of becoming pregnant again very soon
- Such mothers constitute very captive audience during 'lying-in' period to adapt family planning methods.

The program was extended to the entire country in a phased manner through hospitals and medical colleges through Postpartum centers. Later immunization services were also included.

Condoms and oral pills were distributed for newly married couples. IUDs were fitted to the mothers after birth of one child and sterilization used to be done for target couples (after 2 children). MTP services were also provided.

During 1992, this program was merged with CSSM program and under RCH program during 1997.

NATIONAL WATER SUPPLY AND SANITATION PROGRAM

This was launched during 1954 with the main object of providing safe water supply and adequate drainage facilities for the entire population of the country.

During 1972, a special program, known as 'Accelerated Rural Water Supply Program' was started as a supplement to the National Water supply and sanitation program.

During Fifth Plan this special program was included in the 'Minimum Needs Program' of the State Plans. The Government of India is supporting the efforts of the states in identifying 'Problem villages', through assistance under accelerated rural water supply program.

A problem village has been defined as a one where:

- No source of safe water is available within a distance of 1.6 km
- Where water is available at a depth of more than 15 meters
- Where water source has excess salinity, iron, fluorides and other toxic elements
- Where water is exposed to the risk of cholera.

During the year 1981, Government of India launched 'International Drinking Water Supply and Sanitation Decade Program'. The targets were:

- 100 percent water supply for both urban and rural population
- 80 percent sanitation facilities for urban areas
- 25 percent sanitation facilities for rural areas.

During Sixth Five Year Plan (1980–85), 1.92 lakh villages out of 2.31 lakh problem villages were provided with a safe water source of drinking water.

The latest assessment indicates that safe water is available to 80 percent of urban population and 47 percent of rural population and adequate facilities for waste disposal is available to 30 percent of urban and 1.0 percent of rural population.

The 20-Point Program of 1986 aims at providing safe potable water to all villages. A total outlay of ₹6522.47 crores was made during the Seventh Plan.

The role of the community volunteers in this program are:

- Inspecting supplies to detect source of contamination
- Devising and implementing methods for protection
- Advising water users on procedures that will diminish the contamination
- Taking water samples periodically to nearest laboratory
- Reporting the findings to local committee and Ministry of Health and Water Supply Agencies
- Informing the community of results of these measures
- Health education of the people about the prevention of pollution of water source by the following measures:
  - Preventing the people from defecating into or near the water supply/source
  - Discouraging the people from bathing, washing clothes or utensils or animals near the water source
  - Preventing the underground seepage from nearby latrines or soakage pits
  - Avoiding the people from using dirty containers.
- People are also educated about the following:
  - Protecting the water sources
  - Diseases transmitted through water
  - Need to drink chlorinated water.

MINIMUM NEEDS PROGRAM

Minimum Needs Program (MNP) was launched during the year 1974, with the objectives of providing certain basic minimum needs and thereby to improve the living standards of the people. It was the commitment of the Government for, 'the social and economic development of the community particularly the underprivileged and underserved population'. MNP was revised during 1980. The National Water Supply and Sanitation program was incorporated into MNP during 1987.

Components of the MNP

- Rural health
- Rural water supply
- Rural electrification
- Elementary education
- Adult education
- Nutrition
- Environmental improvement of slums
- Houses for landless laborers.

Basic Principles of MNP

- Preference of providing the facilities are to be given to those areas which are at present underserved, so as to remove the disparities
- And the services to be provided in a package manner.

Rural Health

Objectives: (to be achieved by the end of 8th Five Year Plan)

- One PHC for 30,000 population in plains and 20,000 population in tribal and hilly areas
- One Sub-center for 5,000 population in plains and 3,000 in tribal and hilly areas
- One Community Health Center (Rural hospital) for a population of one lakh or one community development block by the year 2000, by upgrading the existing PHC.

Rural Water Supply

This is carried out in association with point 7 of the twenty-point program (TPP), which is mainly concerned with providing clean drinking water specially for members of Scheduled Castes.

Rural Electrification

Electricity is made available to 60 percent of houses by 1990.

Elementary and Adult Education

The targets laid down were 100 percent enrollment of children between 6 and 14 years of age 1990 and achievement of 100 percent literacy rate among persons aged 15 to 34 by 1990.

Rural Nutrition

The objectives were:

- To extend nutrition support to 11 million eligible people
- To expand, 'special nutrition program, 'to all ICDS projects'
- To expand, 'the mid-day meal program', so as to cover all persons belonging to SC and ST and backward classes.

Improvement of Urban Slums

All slums of all cities with three lakh population or more will be provided with water taps, sewers, storm water drains, community bathing places, paved roads and street lights.

Rural Housing

This is carried out jointly with point 14 of Twenty Point Program. The services provided are free house sites given to landless farmers. They are also assisted in construction of the houses by providing them loan, at the rate of ₹2000 per square yard.

Rural Roads

Approach roads are constructed for the villages having a population of 1500 or more.

Rural Sanitation

Sanitary latrines are provided to those houses lacking them.

TWENTY POINT PROGRAM (20-PP)

This was launched on July 1, 1975. This was initiated by the Government of India as a special activity, as an 'agenda' for the national action, to promote social justice and economic growth.

It was revised on August 20, 1986. The objective is to improve the lot of the poorest of the poor and to provide them food, shelter, employment and healthy environment, by the following measures:

- Eradication of poverty
- Raising the productivity
- Reducing in equalities
- Removing social and economic disparities
- Improving the quality of life.

The points are as follows:

1. Alleviate poverty through creating community assets (tanks, ponds, roads, etc.) and expand rural employment through promoting rural industries, handicrafts and handlooms.
2. Promote agriculture through improved seeds, conservation of rain moisture and management of water resources.
3. Improve irrigation by management of catchment areas, prevention of water logging and co-ordinated use of surface and ground waters.
4. Increase the production of paddy, edible oil seeds, pulses, fruits and vegetables.
5. Distribute lands to the landless.
6. Abolish bonded labor.
7. Provide clean drinking water for all, particularly to the members of Scheduled Castes and Tribes.
8. Expand primary care facilities, control tuberculosis, leprosy, malaria, goiter and blindness. Ensure 100 percent immunization of infants and pregnant women. Maintain sanitation in rural areas.
9. Ensure two-child norm through voluntary acceptance.
10. Expand education
11. Provide justice to the members of Scheduled Castes and Tribes.
12. Ensure the equality of sexes.
13. Provide new opportunities for the youth in the field of sports, adventure, cultural activities and national integration.
14. Provide houses for the people. Use low cost materials in their construction. Loan facilities to be provided.
15. Improve slums.
16. Plant more trees and more forests.
17. Protect environment by judicious selection of sites for dams, and by the use of the least damaging techniques for their construction.
18. Show concern for consumers by consumers' protection movement.
19. Improve rural electrification.
20. Simplify the administrative procedures and attend to public grievances.

BIBLIOGRAPHY

1. Aarati Dhar. Editorial, The Hindu, Jan 13, 2012.
2. Anand Krishnan, Vivek Gupta, Ritvik, Baridalyne, Nongkyunrish, JS Thakur. How to effectively monitor and Evaluate NCD Programmes in India. IJCM 36, Supplement; Dec 2011 : S 58-59.
3. Arun K Yadav, Atul Kotwal, Hariom Gupta, Aniket Kulkarni and Ashok K Verma. India Without Poliomyelitis : Time to make it a Reality. IJCM. Vol 37 (1); Jan 2012 : p 1-4.
4. Babu BV, Acharya AS, Malik G, Jangid PK, Nayak AN, Satyanarayana K. Lymphatic Filariasis in Khurda Dist. of Drissa, India: An epidemiological study. Sout East Asian J Trop Med Public Health 2001;32:240-3.
5. Babu BV, Mishra S. Mass drug Administration under the progtram to Eliminate lymphatic fitariasis in Orissa, India. A mixed methods study to identify factors associated with compliance and non compliance. Trans R Soc Trop Med Hyg 2008;102:1207-13.
6. Central TB Division. TB India 2009. RNTCP Status Report, New Delhi.
7. Directorate General of Health Services. Revised National TB Control Programme. Technical guidelines for TB Control. Central TB Division, New Delhi; July 1999.
8. GOI MOHFW. NACO Phase III (2006-11) Strategy and Implementation Plan. Nov 2006.
9. GOI WHO Collaborative Programme. National Programme for Prevention and Control of Diabetes, Cardiovascular diseases and Stroke. A Manual for Medical Officers. 2008-9.
10. GOI. A Guide to Malaria and Its Control. MOHFW; New Delhi: 1999.
11. GOI. A Report on National Guineaworm Eradication Programme. Director, NICD; New Delhi : 2000.
12. GOI. DGHS. National Mental Health Programme Document, 1982.

13. GOI. Health Information of India 2000-01. MOHFW, New Delhi, 2003.
14. GOI. MOHFW. Revised National Drug Policy (2010) for Treatment of Malaria. NVBDCP. JIMA. Dec 2010 (108); 12: 844-5.
15. GOI. National CSSM Programme. Programme Interventions. MCH Division, MOHFW, New Delhi, 1994.
16. GOI. National Mental Health Programme for India. Central Council of Health and Family Welfare, New Delhi, 1982.
17. GOI. National Programme for the Control of Blindness in India. MOHFW; New Delhi: 2004.
18. GOI. National Programme Implementation Plan. RCH Phase II, Program Document. MOHFW. New Delhi 2004.
19. GOI. Plan of Operation for the All India Hospital Postpartum FP Programme. MOHFW; New Delhi: 1971.
20. GOI. RCH II and Family Planning – Program Implementation Plan. MOHFW. New Delhi. 2004.
21. GOI. Reproductive and Child Health Programme. Schemes for Implementation. MOHFW; New Delhi : Oct 1997.
22. GOI. Tenth Five Year Plan. 2002-07. Planning Commission, New Delhi.
23. http://phealth.gov.in
24. http://www.developednation.org/india/health.asp
25. http://www.nihfw.org
26. India Canada Collaborative HIV/AIDS Project. Participant's Manual level II. March 2006.
27. Kishroe J. National Health Programmes of India. 5th Edn. 2005.
28. NACO ICTC Team Training, Trainee's Hand Book. Apr 2010.
29. National Polio Surveillance Project. AFP Surveillance in India. Implementing the Plan of Action. 2004; 2005, 2007.
30. NIHFW – Documentation Services.
31. NRHM Bulletin Vol 7 (1) Nov-Dec 2011.
32. NRHM. State Program Implementation Plan. 2011-12.
33. Nutrition Foundation of India. National Goitre Control Programme. A Scientific Report (1): 1983.
34. Park K. Park's Text Book of Preventive and Social Medicine. 18th Edn. 2005.
35. www.mohfw.nic.in

SECTION 8

Allied Subjects

- Emerging and Re-emerging Infectious Diseases
- Disaster Management
- Integrated Disease Surveillance Project: 2004–2009
- Bioterrorism
- Global Warming
- Integrated Management of Childhood Illness
- Telemedicine in Public Health
- Tobacco and Health
- Public Health Acts

CHAPTER 44

Emerging and Re-emerging Infectious Diseases

An emerging infectious disease is disease that is caused by a newly discovered infectious agent or by a newly identified variant of a known pathogen, which has emerged and whose incidence in humans has increased during the last two decades and is threatening to increase in the near future. They are about 30 diseases and no vaccine or treatment exists for most of these diseases. So, prevention and control is also a major problem. Some of the emerging diseases are non-communicable also. Emerging infectious diseases are 'New diseases; New problems (New threats)'.

A re-emerging infectious disease is disease which was previously controlled but once again has risen to be a significant health problem. This term also refers to that disease which was formerly confined to one geographic area, has now spread to other areas.

Re-emerging infectious diseases are 'Old diseases; New Problems (New threats)'.

Re-emerging infectious diseases are due to the development of resistance by the organisms for the drugs or by the vectors for the pesticides/insecticides.

The factors responsible for emerging and re-emerging infectious diseases are:

- Improper planning of the township
- Population explosion, poor living conditions with overcrowding
- Industrialization and urbanization
- Lack of health care services
- Intense international travel
- Globalization, etc. (lifestyle, etc.)
- Indiscriminate use of antibiotics and development of resistance
- Increase in contact with animals
- Environmental degradation with changing weather pattern.

The trends of these diseases amounts to a crisis for today and a challenge for the future. The theme of the World Health Day (7th April) of 1997, 'Emerging Infectious Diseases—Global Alert: Global Response' is of great importance.

EMERGING INFECTIOUS DISEASES

These are grouped into three groups:

Diseases due to New Agents

Human Monkeypox

This was first reported from Zaire, Africa during 1970, caused by a virus, belonging to orthopox-virus group, monkeys being the reservoirs. It differs from smallpox in that it is milder and is associated with localized lymphadenopathy, indicating percutaneous route of entry.

New Types of Diarrheal Diseases—Three Types

1. Infantile diarrhea, caused by Rota virus, discovered in 1973. It is so called because it looks like a wheel with spokes.
2. Diarrhea caused by *Campylobacter jejuni*, identified in 1977. It is transmitted through contaminated water.
3. Diarrhea caused by *Cryptosporidium parvum*, discovered in 1976, a protozoan parasite, resulting in acute or chronic diarrhea. It lives in the intestine of reptiles, birds and mammals.

Legionnaires' Disease or Legionellosis

This is caused by *Legionella pneumophila*, discovered in 1977. It lives in moist soil, lakes, streams, cooling towers, etc. Clinically, it mimics pneumonia.

Ebola Hemorrhagic Fever

It is a deadly hemorrhagic fever, caused by Ebola virus, discovered in 1977. The first epidemic broke-out in Zaire (Africa) in 1976, then in Sudan in 1979. Subsequent epidemics occurred in Cote d' Ivoire in 1994 and 1995, Liberia in 1995 and again in Zaire 1995, in Kikvit in 1995 and in 1996 at Mayibout, Gabon.

Ebola virus is a RNA virus, belonging to *Filovirdiae* group, reservoirs being the animals such as chimpanzees, monkeys and squirrels, transmitted by droplets clinically characterized by fever, headache, malaise, myalgia, vomiting, bloody diarrhea, progressing to liver and kidney failure, shock and death. Mortality is 70 to 90 percent. Thus is a frightening disease.

AIDS

Acquired Immunodeficiency Syndrome (AIDS) is caused by Human Immunodeficiency Virus (HIV) identified in 1983, pathologically characterized by progressive paralysis of the immune system, predisposing the individual to opportunistic infections. It is cent-percent fatal. It is currently a pandemic disease.

It is mainly transmitted by sexual route but is also transmitted parenterally and vertically. Today about 50 million people including children are living with this virus and is on the increase. Annual death rate is about 3 million. Prevention is the only intervention. Thus, AIDS also constitutes a frightening disease. It is one of the most serious diseases.

Hanta Virus Pulmonary Syndrome

This is caused by Hanta virus, first recognized in 1993 in United States. This is characterized by respiratory failure, having a case fatality of 50 percent. This virus is carried by rodents (mice). Other Hanta viruses when affect human beings result in hemorrhagic fever with renal syndrome.

Creutzfeldt-Jakob Disease (Spastic Pseudoparalysis)

This is the human form of bovine spongiform encephalopathy of cattle (BSE), also called 'Mad Cow Disease', caused by BSE-agent, prion, a protein capable of becoming pathogenic, transmitted by exposure to diseased cattle or by consuming their meat.

The BSE agent was identified during 1986. Cases increased among cattle until 1989. The first case of CJD was reported from UK in 1994. Subsequently similar cases were reported from France, Germany, Oman Sultanate and Falkland Islands.

Pathologically, the disease CJD and BSE is characterized by sponge like holes in the brain. Clinically CJD is characterized by mental deterioration, slurring of the speech, difficulty in walking (i.e. spastic pseudoparalysis), progressive paralysis and death. CFR is about 80 percent.

Hepatitis E

This is caused by Hepatitis E virus, discovered during 1988, transmitted enterically (feco-oral route). It is enterically transmitted non-A, non-B hepatitis.

Severe Acute Respiratory Syndrome

A viral disease. Explained under epidemiology.

Hepatitis C

This is caused by Hepatitis C virus, discovered during 1989, transmitted parenterally. It is parenterally transmitted Non-A, Non-B hepatitis. This results in liver cancer.

Diseases due to New Variants of Known Pathogens

- 0157.HF strain of *E. coli* was first identified during 1982. It has resulted in many outbreaks of diarrheal disease, characterized by hemorrhagic colitis; hemolytic uremic syndrome and deaths due to renal failure. This strain has been linked to undercooked hamburger beef and unpasteurized milk.
- *Exanthem subitum*: This disease is caused by human herpes virus 6 (HHV-6), characterized by rashes.
- *Cholera*: This disease caused by the new variant 0139, first reported in Bengal, during 1992 and later spread to other parts of India, China, Thailand and other countries of SE Asia.
- *Avian (Bird) flu*: This is caused by H5 N1 type A influenza virus, originated from China, Hong Kong during 1996-97. The viruses are carried by ducks, poultry and often pigs. It is transmitted among birds through bird-feeds, cages, unsanitary poultry, and inhalation of the material contaminated with virus.

Exchange of genetic material between those viruses in pigs produces new strain, leading to epidemics among human population of inhalation of the virus. Each epidemic is caused by a different strain.

However, there is no indication of spread of bird flu from one person to the other but possibility can not be ruled out.

Diseases Caused by an Infectious Agents but Resulting in Noncommunicable Diseases

- *Human T-lymphotrophic virus-1 (HTLV-1)*, identified in 1982, results in T-cell lymphoma (Leukemia) (Lymphocytic leukemia).
- *Human T-lymphotrophic virus-2 (HTV-2)*, identified in 1982, results in hairy cell leukemia.
- *Chlamydia (1982)* resulting in coronary artery disease.
- *Hepatitis-C (1989)* virus, parenterally transmitted Non-A, Non-B hepatitis, results in liver cancer.
- *Human herpes virus 8 (1995)* results in Kaposi's sarcoma.

RE-EMERGING INFECTIOUS DISEASES

Malaria, kala-azar, dengue fever, plague, tuberculosis, gonorrhea, typhoid and dysentry.

Malaria

Malaria has come back with greater force not only due to the resistance by the parasites to the drugs but also due to the resistance by the vectors to insecticides. So, it is called 'resurgence' (or Roll-back) of malaria. It is also due to administrative and operational failures in the national program.

Kala-azar (Visceral Leishmaniasis)

It was brought under control during the middle of 20th century due to DDT spraying carried out to control malaria. The vectors, sandflies, of kala-azar were also controlled. During 1977, the incidence of kala-azar increased and reached its peak, 1,00,000 cases. Then slowly declined to about 20,000 during 1986. Again increased slowly to 70,000 in 1992.

The factors predisposing for re-emergence of kala-azar are deforestration, industrialization, urbanization, poor living conditions, livestocks (cattle) in the houses, etc.

Dengue Fever

The re-emergence of this disease is due to factors predisposing for the breeding of *Aedes aegypti* near human habitations and development of resistance to insecticides, uncontrolled population growth, urbanization without appropriate water management, jet travel, etc.

During the pandemic of 1998, about 1.2 million cases of DF and DHF were reported. It is estimated that every year about 5,00,000 cases of DF occur with about 12,000 deaths, more among children, all over the world.

In India, currently DF is an endemic disease often resulting in epidemics. The epidemic which occurred in Delhi, in 1966, affected about 25,000 people with about 400 deaths. This was mainly due to collection of water in the air coolers, which was not changed, predisposing for breeding of *Aedes aegypti* mosquito. The fatality is due to dengue, hemorrhagic fever and dengue shock syndrome.

Plague

During 1960s plague was totally under control because of DDT spraying, under National Malaria Eradication Program, which simultaneously controlled rat-fleas also, which are the vectors of plague.

During August 1994, plague reappeared in Maharashtra followed by an epidemic in Surat of Gujarat State. In the following weeks, plague occurred in Delhi, Punjab, Rajasthan and Kolkata. About 4700 cases were reported including 53 deaths. Epidemic died during October 1994.

Predisposing Factors for the Epidemic

Before the Onset of Epidemic

Earth quake occurred in Maharashtra, during September 1993. Unrecovered dead bodies became good food for rats. This resulted in increased population of rats, predisposing for epidemic of plague in 1994.

Floods occurred in Gujarat in August 1994. The free food was supplied to the affected people. The left over and spilled food resulted in increased population of rats.

During the Epidemic

Migration of the people to Surat city due to industrialization, resulted in eruption of slums and collection of garbage, carcasses which are the breeding places for the rats. Added to that there was an artificial scarcity of antibiotics, created by the people buying them in panic.

- *Tuberculosis:* Re-emergence of TB is due to various factors such as failure in the National TB Control Program and emergence of HIV. Tuberculosis being the commonest opportunistic infection of AIDS and HIV infection being on the increase, TB has re-emerged.
- *Gonorrhea:* The re-emergence of this disease is due to the development of resistance to antibiotics such as penicillin in most of the countries.
- *Typhoid:* The re-emergence of this disease is again due to the development of resistance by *Salmonellae* to all the routinely used drugs.

- *Dysentery:* Development of resistance by *Shigella dysenteriae* has resulted in outbreaks of diarrheal disease in Central and South Africa. This epidemic strain has resulted in about 15 percent deaths among the infected persons.

CONTROL OF EMERGING AND RE-EMERGING DISEASES

- Strengthening of the disease surveillance system for early recognition of the epidemics and their control measures
- Encouraging research initiatives for treatment regimens and improved diagnostics
- Encouraging research for new methods of control measures
- Establishment of drug resistance surveillance mechanisms
- Upgradation of International Health Regulations (The revised IHR has entered into force from 15th June 2007).

BIBLIOGRAPHY

1. ICMR Bulletin. Emerging Infectious Diseases in South East Asia. Research Priorities, ICMR, New Delhi 2004; 34:5-6.
2. WHO Emerging Infectious Diseases – Global Response, Global Alert. Backgrounder World Health Day; Geneva 7th April 1997.
3. WHO. The World Health Report 1996.

CHAPTER 45

Disaster Management

DEFINITION

Disaster is defined as an event or a calamity resulting in desperate things such as human casualties (injuries and deaths), destruction, loss of properties, disruption of normal activities occurring in a scale sufficient to require assistance from outside the affected area.

IMPACT

- Human sufferings (injuries and deaths). Survivors are at risk of developing infectious diseases due to epidemics like acute gastroenteritis, measles, hepatitis A, malaria, etc. There is widespread panic in the community.
- Death of animals, destruction of standing crops and damage to the properties.
- Roads, rails, bridges, electrical installations, telecommunications, buildings and other properties are damaged.
- Disruption of all the routine activities of the community.
- Acute shortage of food, clothes, shelter, etc. resulting in living problems.

The disasters, either natural or man-made, slow or sudden, have been occurring now and then in different parts of the world. Therefore, WHO in 1990 has given the call to member countries to meet disasters and in that connection the theme of World Health Day on 7th April 1991 was 'Should Disaster Strike Be Prepared.' The methyl isocyanide gas leak in Bhopal in 1984 was perhaps the greatest man made disaster in the history, next to Tsunami waves affecting Indonesia in 2004.

Disasters are not confined to a particular part of the world. They can occur anywhere and at any time. In India, Bhopal gas tragedy in Madhya Pradesh occurred in 1984, Cyclones in Andhra Pradesh occurred in 1977, Air Crash in Bangalore in 1990, Earthquake in Maharashtra (Koyna in 1967) and in Latur in 1994. Tsunami waves in Tamil Nadu in 2004 deserve special mention. Disasters following heavy rains and floods have been occurring almost every year in India. One more recent disaster was the attack by the terrorists (human bombs) in twin buildings of World Trade Center in New York in 2003, when about 6,000 people lost their lives and thousands were injured. Therefore, understanding about disasters and being prepared before it strikes requires to be looked into from its managerial dimensions.

CLASSIFICATION OF DISASTERS

1. Natural disasters.
2. Man-made disasters.

Natural Disasters

Natural Phenomena Beneath the Earth's Surface (Tectonic)

a. Earthquake.
b. Tsunamis.
c. Volcanic eruptions.

Earthquakes: These are due to interactions at the edge of great plates of the earth, which make up the surface of the world. Usually they occur in well defined bolts. However, no country is immune to this. The high level of mortality in earthquake is due to collapse of the buildings. Consequently, the tragedy will be more when earthquake occurs at night.

Tsunamis: These are due to earthquakes under the sea. This results in displacement of large volume of water causing waves of low amplitude but of long wavelengths, resulting in floods on the coastal lands. Thus, damage and loss of life can occur at great distances from the point of origin of the wave. The tsunami set up in Lisbon earthquake in 1755 caused great tides as far as in Barbadoss and floods in Norway and Germany. Recent disaster of tsunami set up in Indonesia in 2004, affected coastal areas of Tamil Nadu in India.

Volcanoes: There will be mud-slides and glowing clouds. 23,000 deaths occurred following mud-slides in Columbia in 1985 and 30,000 deaths following glowing clouds at Saint Pierre in Martinique. There will be injuries, burns and suffocation. Volcanic soils are highly fertile. So, often they are densely populated, e.g. Merapi Volcano in Central Jawa.

Natural Phenomena at the Earth's Surface (Topological)

a. Landslides.
b. Avalanches.

Landslides and avalanches: An avalanche is a mass of snow which is set in motion by its own weight through a violet disturbance of its equilibrium. Such avalanches are common in all mountaineous area, where slopes are sufficiently steep and the precipitation is in the form of snow. There are two kinds of avalanches—the surface avalanch in which only the top covering of the snow slips and the ground avalanch in which the whole mass is carried away.

Principal types of avalanches:

- *Powder snow avalanche*: This usually occurs in winter season, after a fresh fall of snow. It becomes detached following a strong wind or the blast of another avalanche. It can flatten quite a large tract of forest.
- *Fresh wet snow avalanche*: This moves a little slower than a powder snow avalanche. Consequences are same but in addition it has a crushing effect because of its weight. On coming to a halt it hardens immediately like a plaster.
- *Wet snow avalanche*: It is mainly a spring time avalanche. It flows slowly but its force is considerable. It flattens and destroys everything. 1 cu.mtr of powder snow weighs about 1 kg while the same volume of wet snow weighs several hundred kilograms.
- *Snow slab avalanche*: In this type, the upper layer of snow is compressed and is separated from the underlying snow by a layer of air. It is difficult to recognize.
- *Sea/River avalanche*: It is caused by movement of glacier.

Natural Phenomena above the Earth's Surface

a. *Meteorological (Hydrological) phenomena*
   i. Windstorms (Cyclone, typhoon, hurricane)
   ii. Tornadoes
   iii. Hailstorms (or Snow storms)
   iv. Sea-surges
   v. Floods
   vi. Droughts.

   Windstorms: These may be cyclone, typhoon, hurricane.
   - *Cyclone*: This begins as low pressure area in equatorial latitude. Severe winds occur in a circular band. The speed is highest in the center and lowest in the periphery. The speed will be about 60 km/hour. The threat of cyclones is only in coastal areas. This is associated with heavy rains causing danger to the life.
   - *Cyclone storm surge:* This occurs when the winds at high speed acts directly on the sea-water resulting in the movement of a mass of water at the same speed of cyclone, striking the coast and moves in the land in the form of floods and will only be stopped by high inland. The associated rainfall results in casualties. Once the effect comes down water level begins to retreat. It is associated with the rainfall.

   Floods: These are the most common of all natural disasters and cause greater deaths than any other type of disaster. Reasons are overflow of rivers, heavy rainfall, melting of snow, breaking of dams and glacial lakes, cyclonic storm-surge and tsunami.

   Tornadoes: A tornado is like a cyclone, a vortex of air, but on a much smaller scale. The velocity of air raising in the center may be very high and is responsible for damage. Big objects may be vaccumed from the ground. While crossing an urban area, it may totally destroy the building.

   Secondary disasters: These are the ones, which follow primary disasters, e.g. firestorm, breach of dams or tidal waves following earthquakes or Tsunami.
b. *Biological phenomena*
   i. Epidemics of diseases
   ii. Locust swarms (group of insects/bees)

Man-made Disasters

- *Caused by Warfare*
  - Conventional
  - Nuclear
  - Biological
  - Chemical
- *Caused by accidents*
  - Vehicular—Air crafts, train, ship, four wheelers, two wheelers.
  - Drowning
  - Collapse of the building
  - Explosions
  - Fires
  - Biological
  - Chemicals including poisoning

DISASTER MANAGEMENT CYCLE

The components of a disaster management cycle is as follows: Disaster impact, response, rehabilitation, reconstruction, mitigation and preparedness **(Flow chart 45.1)**.

Disaster Impact

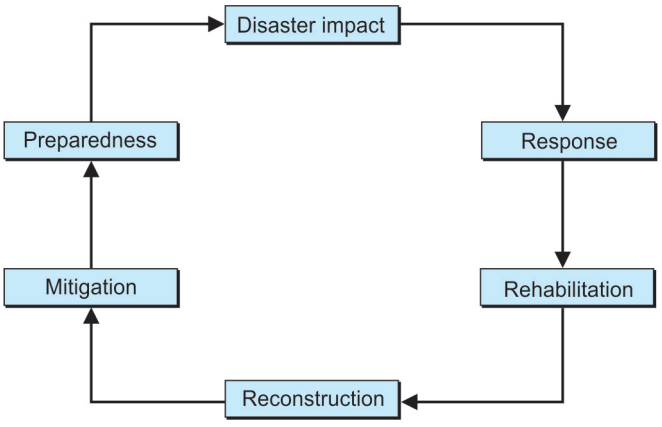
The period of impact may be few minutes in case of earthquakes, hours in cyclones and days in floods.

The greatest need is the emergency care, to be given in the first few hours. Since the casualties occur in mass, the management is carried out in the following steps:

- *Search, rescue and first-aid:* It is the uninjured survivors who come to immediate help. These survivors are organized. They come to rescue and provide first aid.
- *Field care:* Food to be provided at the place of disaster. People are sheltered in tents, schools and community halls. Health resource persons (doctors, nurses, etc.) and other volunteers, police, home guards are deployed to the place. An enquiry center to be established to respond to patients, friends, relatives and family members. Dead victims to be identified and adequate mortuary space provided.
- *Triage:* Since the health manpower resources are in shortage compared to casualties, the injured survivors are classified depending upon the severity of injuries and chances of survival with medical supervision. This is called as 'Triage-approach'. Before that the people trapped under debris, following earthquake and collapse of the buildings, are tracked (sometimes with the help of trained dogs) and rescued by cutting through the fallen buildings with spades, gas-cutters, bulldozers, etc. People marooned in floods are rescued with boats.

  The triage approach system consists of color coding of the victims, in priorities, carried out at the site.

Flow chart 45.1 Disaster management cycle



Priority I: Red color—this group consists of critically ill patients, who need immediate medical/surgical treatment within 6 hours.

Priority II: Yellow color—this group consists of moderately ill (or moderately risk cases) requiring resuscitation within 24 hours.

Priority III: Green color—this group consists of ambulatory patients of minimum risk cases.

Priority IV: Black color—this group consists of dead or moribund patients.

Arrangements should be made for the transportation of the priority groups to the nearest health facility.

- *Tagging*: The patients are identified with the tags which provide the information such as name, age, contact address, and the treatment given.
- *Care of the dead*: The dead body is removed from the site of disaster, shifted to mortuary, identified and bereaved family members are received.

  If the dead bodies contaminate the water sources as in floods, the risk of water-borne epidemic is more.

Response

This is carried out under the following phases:

- *Relief phase:* This starts when help or assistance is obtained from outside. Measures are taken to prevent the occurrence of epidemics. Arrangements are made to provide food, clothes, shelter and drugs.

  The factors which influence the outbreak of diseases during disasters are overcrowding and poor sanitation of temporary shelters, displacement of the population, lack of protected water supply, contamination of water sources, damage to sewerage system, disruption of the routine health programs (because of diversion of the health workers towards relief work), displacement of domestic and wild animals, (predisposing for zoonoses).
- Mass immunization against cholera, typhoid have not been proved effective. On the other hand, it may lead to false sense of security. However, vaccinations are recommended for health care providers. Tetanus toxoid injection is given only for the required patients.
- Since malnutrition is likely to occur, specially among vulnerable groups like mothers, children and sick people following disasters, measures are taken to strengthen the food supplies.

Rehabilitation

This should be started from the time of onset of disaster to see that the normal conditions of life are restored (to predisaster condition) as early as possible. For that, the following services are restructured and reorganized. This

consists of improving the environmental health measures following the medical and first-aid care of the affected people. The services are as follows:

- *Water supply:* The important and the best way of providing water supply is by chlorination with a residual chlorine concentration of 0.7 ppm. Survey is made to find out the source of water and the following protective measures are undertaken.
  - Access of people and animals is restricted by a fence
  - Excreta to be disposed away from the water source
  - Wells, if any, are protected from contamination.
- *Food supply:*
  - Food hygienic measures are implemented to prevent food borne outbreaks
  - Food handlers should maintain a high standard of personal hygiene
  - People should wash their hands before eating food and after using toilet.
- *Improvement of sanitation:* With special emphasis to dispose the human excreta by construction of temporary trench latrines, separate for men and women. Washing, cleaning and bathing facilities also to be provided.
- *Control of vectors:* Since the flood water provide an opportunity for breeding of the vectors, resulting in the epidemics of vector borne diseases, specially in the endemic areas, like malaria, and dengue fever, measures are taken to control the vectors.
- *Care of survivors:* Efforts are made to reintegrate the survivors of the disaster into the society with the help of NGOs, department of social welfare, etc. Orphaned children should also be taken care off.

Mitigation

This involves measures to lessen the likely effects of emergencies. These include, depending upon the disaster, protection of vulnerable population and structures. For example, improving the structural qualities of schools, houses and such other buildings so that medical casualties can be minimized. Similarly, ensuring the safety of health facilities and public health services including water supply and sewerage system reduces the cost of rehabilitation and reconstruction. This mitigation compliments the disaster preparedness and disaster response activities.

Preparedness

This consists of strengthening the capacity of a country to manage efficiently all types of emergencies, so that the resources should be able to provide assistance to the victims and bring back the life to normal.

The preparedness should start from the community people because many times the external agency may not arrive for days to the affected area, specially if transportation and communications are affected.

Health workers, social workers, and members of NGOs, etc. are all trained.

Preparedness should be in the form of money, man-power and materials.

Disaster preparedness is a continuous, on-going multi-sectoral activity.

It also consists of the following measures:

- Evaluation, from past experiences about the risk, the area has
- Location of disaster prone areas
- Adoption of a standard operating procedure
- Organization of communication, information and warning systems
- Ensuring co-ordination and response mechanisms
- Development of public education program
- Co-ordination with news-media
- National and international relations
- Organization of disaster simulation exercises that test response mechanisms
- Keeping stock of foods, drugs and other essential commodities.

The preparedness should be active and energetic when it is forecasted before it really strikes, a few hours before in case of cyclones and a week before in case of floods.

Indian meteorological department (IMD) plays a key role in forewarning the disaster of cyclone-storms by detection and tracing. It has five centers in Kolkata, Bhubaneswar, Vishakapatnam, Chennai and Mumbai. Satellite imagery facilities and cyclone warning radars are provided to various cyclone warning centers. In addition, there are 31 special observation posts set up along the east coast of India. Insat Disaster Warning System (DWS) receivers have been installed in the coastal areas of Tamil Nadu and Andhra Pradesh. The Snow and Avalanche Study Establishment (SASE) in Manali has been issuing warning to the people about avalanches 24-48 hours in advance.

The International Agencies, which provide humanitarian assistance to the disaster strike areas are United Nations agencies. These are:

- Office for the Co-ordination of Humanitarian Affairs (OCHA)
- World Health Organization (WHO)
- UNICEF
- World Food Program (WFP)
- Food and Agriculture Organization (FAO)

The Inter-governmental organizations are:

- European community Humanitarian Office (ECHO)

- Organization of American States (OAS)
- Center of Co-ordination for Prevention of Natural Disasters in Central America
- Carribean Disaster Emergency Response Agency.

Some Non-Governmental Organizations (NGOs) are:

- Co-operative American Relief Everywhere (CARE)
- International committee of Red Cross
- International Council of Voluntary Agencies (ICVA)
- International Federation of Red Cross and Red Crescent Societies (IFRC), etc.

BIBLIOGRAPHY

1. Gupta A. Information Technology and Natural Disaster Management in India. National Centre for disaster Management; Indian Institute of Public Administration, New Delhi 1991.
2. Park K. Park's Textbook of Preventive and Social Medicine 18th edn 2005.
3. WHO 'Should Disaster Strike, Be Prepared.' World Health Day. Emergency Preparedness and Response 7th Apr 1991.

CHAPTER 46

Integrated Disease Surveillance Project: 2004–2009

It is called 'Integrated' because:
There is incorporation of:
- Public sector
- Private sector (Private practitioners; Private hospitals; Private labs; NGOs, etc.)
- Community participation.

There is incorporation of:
- Communicable diseases
- Noncommunicable diseases.

There is incorporation of:
- Rural health system
- Urban health system.

There is incorporation of medical colleges (both Pvt. and Govt.)

There is incorporation of various International Health Agencies also.

All are incorporated in order to improve the disease surveillance.

SURVEILLANCE

Surveillance is defined as an ongoing, systematic, collection, compilation, analysis, interpretation and dissemination of the health data for early detection and prediction of epidemics for planning and implementation of prevention and control measures, specially on a set of high priority diseases and risk factors of noncommunicable diseases and also for evaluation of control measures. It also helps in optimizing the allocation of resources.

Surveillance also facilitates the study of disease patterns in the country and identifies new emerging diseases.

Thus, surveillance has been identified as 'backbone' of any health delivery system/Public Health Program.

Project

Disease surveillance activity has been undertaken as a 'project' work by the Government of India and it is not a national program. Integrated disease surveillance project (IDSP) was initiated during 1998 incorporating various International Health Agencies such as WHO, CDC, NIH, USAID, DFID and others.

Thus, IDSP is a decentralized, state based, surveillance program in the country.

Objectives

- To establish a decentralized surveillance system in the country.
- To detect early warning signals of impending outbreak.
- To initiate control measures early, by allocating the health resources more efficiently.
- To study the disease pattern and to identify new emerging diseases.
- To involve all stakeholders (public and private sector) in surveillance.
- To involve paramedical personnel in surveillance system.

Thus, disease surveillance is an effective tool for early identification and effective control of epidemics.

Not all the outbreaks are predicted or prevented. However, the risk/scale of the outbreak can be minimized if it occurs.

Types of Surveillance in Integrated Disease Surveillance Project (Table 46.1)

There are three parallel system of surveillance:

1. *Syndromic surveillance:* It is the diagnosis made by the paramedical worker/community member based on the clinical pattern (Suspect case).
2. *Presumptive surveillance:* It is the diagnosis made by the Medical officer of PHC based on the history and clinical examination (Probable case).
3. *Laboratory surveillance:* It is the diagnosis confirmed by the appropriate laboratory test (Confirmed case).

In other words, case classification is of three types, namely suspect case, probable case and confirmed case.

Table 46.1 Diseases and conditions covered under IDSP

Sl.No.	Category	Disease and condition
1.	Regular surveillance	
	• Vector borne disease	• Malaria
	• Water borne disease	• Acute diarrheal disease (Cholera)
		• Typhoid
	Respiratory disease	*Tuberculosis*
	• Vaccine preventable diseases	• Measles; Poliomyelitis (under-eradication)
	• Other conditions	• Road traffic accidents
	• Other international commitments	• Plague
	• Unusual clinical syndrome	• Meningoencephalitis; respiratory distress, hemorrhagic fevers, other undiagnosed conditions
2.	Sentinel surveillance	
	• STIs/Blood borne diseases	• HIV/HBV, HCV
	• Other conditions	• Water quality
		• Out door air quality (Urban areas)
3.	Regular periodic survey Noncommunicable risk factors	• Anthropometry, physical activity, blood-pressure, tobacco, nutrition, blindness and any other unusual health conditions of emergency
4.	Public health emergency	• Any other unusual condition may be included during public health emergencies

The administrative structure consists of "National Surveillance Committee" and the chairman is the Secretary of Health Department. At the State level, the chairperson of the State Surveillance Committee is State Secretary Health and at the district level is the District Magistrate or District Collector. Structure framework, of IDSP for rural and urban areas is as shown in **Figure 46.1.**

Surveillance Actions

- Feedback and sharing information by the stakeholders such as Medical Officers of Primary Health Centers/ Community Health Centers, District Hospital, Pvt. Practitioners, etc.
- Response to the surveillance information, should be in the form of guidelines, report, etc.
- Level of response is specified in the form of trigger. For example:
  - Trigger level 1: Suspected/Limited outbreak—Local response by MO,
  - Trigger level 2: Epidemic—Local or regional response (i.e. District level response by DHO),
  - Trigger level 3: Established outbreak—State level response, depends upon:
    - In nonendemic area—occurrence of even one suspected epidemic prone disease should initiate trigger response.
    - In endemic area—change in the pattern of disease or
    - Evidence of clustering of cases is considered as a trigger point.

Warning Signs of an Impending Outbreak

- Clustering of cases or death in time and/or space
- Unusual increase in cases or deaths
- Even a single case of measles, AFP, cholera, plague, DF or JE
- Acute febrile illness of unknown etiology
- Occurrence of two or more epidemiologically linked cases of meningitis, measles
- Unusual isolate
- Shifting in age distribution of cases
- High vector density
- Natural disasters.

Epidemic Response

There is nothing but the epidemiological investigation of an epidemic. This includes the following:

- Definition of outbreak
- Confirmation of the outbreak

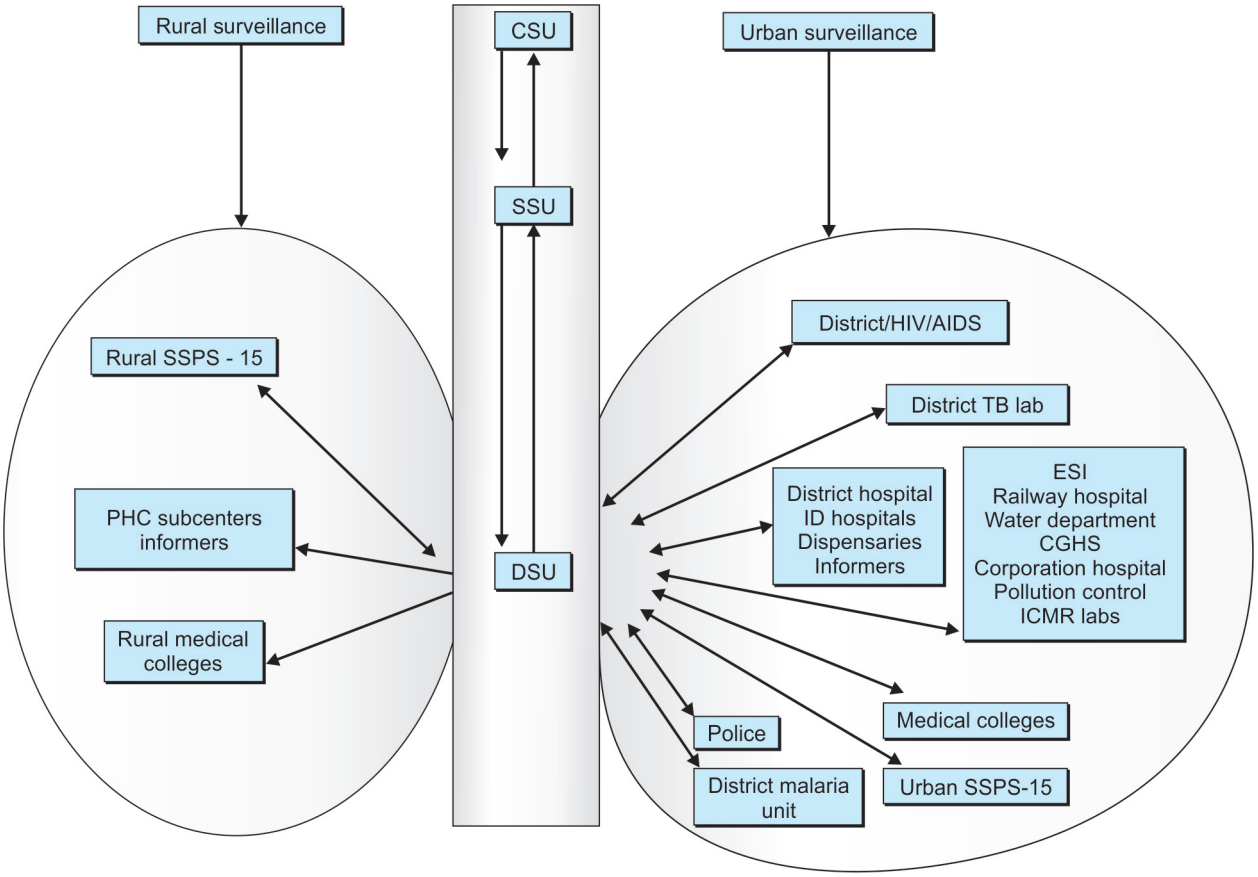


Fig. 46.1 Structural framework of integrated disease surveillance project
Abbreviations: CSU: Central surveillance unit; SSU: State surveillance unit; DSU: District surveillance unit; SSPS: Selected sentinel private sites

- To assess the magnitude of the problem (in terms of morbidity and mortality)
- To study the distribution of the outbreak with reference to time, place and person.
- To identify the source of infection and mode of spread
- To implement control measures.

Intensifying the Information, Education and Communication Activities by the Following Measures

- Organization of workshops
- Review meetings
- Role of media
- Role play
- Interpersonal communication.

Laboratory network of communicable diseases and noncommunicable risk factors would be established.

Monitoring and Evaluation

Number of performance indicators are identified for monitoring and evaluation and would be used in Baseline sample surveys, midterm evaluation, endline evaluation ensuring laboratory quality and cost-effective analysis.

BIBLIOGRAPHY

1. Govt. of India. Integrated Disease Surveillance Project 2004-09. Ministry of Health and Family Welfare, New Delhi 2004.
2. NICD. Surveillance of Epidemic Prone Diseases, New Delhi 1998.

CHAPTER 47

Bioterrorism

Biological warfare has been existing since ancient times. Outbreaks of plague, smallpox, cholera, influenza has played a major role in decimating human populations. Such catastrophes were described as 'Evil spirits', wrath of God, deserving retribution to evil ways.

In due course of time, it was realized that they were due to infection agents. That tempted the conquerors to use such infectious agents as military weapons to cause social paralysis. There are accounts of using diverse noxious substances like feces, dead horses, gas, etc. as weapons but were not successful.

HISTORICAL BACKGROUND

Biological warfare seems to have been existing since 600 BC when Roman Generals poisoned water used by the enemy, by dumping rotting animal carcasses. In Scythia (400 BC) arrows were used dipped in blood, manure or decomposing bodies and targeted at water supply of the enemy. Hanibal in 190 BC hurled venomous snakes in Roman ships. The tartars of Ukrain (1346) catapulted bodies of plague victims into the city of Kaffa. Blankets infested with smallpox were distributed to American Indians during the French and Indian War which raged between 1954 through 1967. The Japanese (1932) experimented on Chinese by using Anthrax, Cholera and Shigellosis. Members of religious cult (1984) in Dalas, Oregon, contaminated salads in restaurants with *Salmonella typhimurium* in an attempt to influence the results of elections. In 1995, the Japanese Cult-Ann Shimrikyo, released nerve gas in a Tokyo sub-way. In the recent past Anthrax contaminated letters were posted to politicians. Terrorists (NCB – personnel, i.e. nuclear, chemical and biological weapon personnel) attacked World Trade Center in New York on Sept 11, 2001.

With the advancement in techniques, genetic manipulations, delivery systems, the threat of biological warfare is more eminent today, not only aiming at human enemies but also towards live stocks and crops to produce economic loss.

Biological weapons (BW) are also clubbed with nuclear weapons (N) and chemical weapons (C) in the acronym NBC. Biological weapons: are defined as microorganisms that infect and grow in target hosts to produce a clinical disease. Such microbes can be natural, wild type strains or genetically engineered organisms. They produce their effects in humans, livestock and crops.

Biological weapons (BW) are aptly called as 'Poor man's atomic bomb', as their production cost is low. It has been estimated the convention weapon cost ($ 2000) as compared to nuclear ($ 800), chemical ($ 600) and BW ($ 1) respectively to produce 50 percent casualty.

An ideal BW is the one, which:

- Can be produced in large quantities
- Can infect large number of individuals
- Can be stable when stored
- Retains the virulence after aerosol dissemination.

EVOLUTION OF CHEMICAL AND BIOLOGICAL WEAPONS

Phase I: Gaseous chemicals like chlorine and phosgene were used in World War I.

Phase II: Use of nerve agents—tabum, a cholinesterase inhibitors and marks beginning of anthrax and plague in World War II.

Phase III: Herbicides were used causing crops destruction.

Phase IV: In recent time, biotechnological and genetic engineering revolutions are in progress.

Merits

- Low cost—'Poor man's atomic bomb'.
- Large quantities can be produced in short time with small facilities.
- Nondetection by routine security system (biosensor), access to a wide range of agents and their dispersal can be made silently.
- Very toxic, hence small quantities will kill large number of persons.
- Destroys the enemy leaving his infrastructure intact as booty for the winter.

Demerits

- Difficulty of protecting workers during production, transportation and delivery.
- Difficulty in maintaining quality control, contamination during growth and harvesting.
- Effective delivery system.
- May be destroyed after delivery.
- May disperse in unexpected ways aided by the wind.
- Need specific conditions for storage; hence difficult to maintain in weapons.
- Difficult to control once released.

Top Biological Weapons

Bacillus anthracis

It is a gram-positive organism, affecting sheep and cattle. Humans get the disease either by inhalation of spores, when it is called Woolsorter's disease (Pulmonary anthrax) or by cutaneous infection. Man to man transmission does not occur. Pulmonary anthrax is characterized by an incubation period of one day to eight weeks, flu like symptoms, abrupt onset of respiratory distress, cyanosis, shock, septicemia and death.

Treatment is by ciprofloxacin, 400–800 mg, given IV twice a day.

Vaccination is given by 6 subcutaneous doses at 0, 2 and 4 weeks, followed by 6, 12 and 18 months.

Chemoprophylaxis is either by ciprofloxacin or doxycycline. Bacteriae are extremely stable and can be stored as powder, used as aerosol sprays.

Yersinia pestis

Results in plague, which is a zoonotic disease, disease of rodents, mainly rats. It is transmitted from rats to rats and rats to humans accidentally by the bite of infected rat-fleas.

There are three forms of plague—bubonic, pneumonic and septicemic, of which last two forms are serious.

Useful antibiotics are streptomycin, chloramphenicol and doxycycline.

A formalin killed vaccine is available.

The bacilli is used as an aerosol spraying biological weapon. It looses its infectivity quickly in aerosol preparation.

Smallpox Virus

It is also called as variola virus. Smallpox has been declared eradicated by WHO in 1980. Since then vaccination has been discontinued. Virtually everyone is now susceptible and therefore feared as the greatest threat.

Virus is highly infectious. Genetic recombination may enhance the virulence. The disease is characterized by high fever, followed by cutaneous eruptions in the stages of macules, papules, vesicles and pustules, which on drying leave behind permanent pockmarks.

Case fatality rate being 40 percent.

Effective chemotherapy is not available. Vaccine now exists only in selected WHO laboratories.

Clostridium botulinum

These bacilli are gram-negative, anerobic and spore forming. The bacilli release an endotoxin, which is a powerful neurotoxin, resulting in a condition called Botulism, characterized by the paralysis of parasympathetic system, the features being ptosis, dysphagia, dysarthria, diplopia and constipation.

Lethal dose of the toxin is 1–2 ng, which is absorbed from the intestine.

Polyvalent antitoxin can neutralize the toxin. Immunization is by 3 doses of toxoid at 2 months interval.

Contamination of food, water or aerosol are methods of BW.

Vibrio cholerae

These bacteriae cause gastroenteritis, characterized by sudden onset of severe diarrhea, dehydration, acidosis, renal failure, shock and death, by contamination of water and food.

Ebola Virus

It is a highly contagious virus. These viruses target small capillaries, causing leak of blood and serum, 2 to 3 days after infection. Conjunctival hemorrhage and multiorgan failure ensues.

These patients are treated by pressor agents, antiviral agents, fresh plasma and clotting factors. Incubation period and death is rapid. No vaccine is available.

Mycotoxin

This is the toxic product of fungi such as aspergillus, penicillium, fusarium, which when contaminate grain and agriculture products, results in disease. It is usually delivered by air as 'Yellow rain.'

Newer Trends

Products of microbes that can kill or incapacitate targeted hosts, e.g. hormones, neuropeptides and cytokines, called as 'designer substances' to target a particular organ or a type of enemy.

Russia seems to have a new type of genetically modified anthrax to elude the vaccine used by America.

Rumors are that Israelis are working to prepare 'Ethnic bomb.'

Parasite BW are under trial to affect cash crops and cause huge economic loss.

Delivery of Biological Weapon

- Scud missiles
- Motor vehicles with a spray
- Handpump sprayers
- By an individual
- Book or letter
- Guns
- Remote control devices
- Robotic delivery.

Combating Biological Weapons Incident/At Risk Group

The first responders are physicians, infectious disease specialists, epidemiologists, hospital and public health administrators and laboratory experts.

Steps to be Taken

- *Detection:* A microbiologic confirmation is needed.
- *Case definition:* To be formulated by health care personnel.
- *Notification:* To proper civilian and military authorities.
- Differentiation between natural and terrorist warfare:
  - Natural: Gradual rise in cases.
  - Terrorist: Sudden rise in cases, in hours or days.
- *Investigation:* A quick identification of the source and consequence of the outbreak.
- *Medical intervention:* Diagnosis, isolation and treatment.
- *Prophylaxis:* Immunization of health care professionals and contacts—actively or passively.
- *Public awareness:* It needs to be created to ensure that the incident does not turn into public hysteria.

Future Suggestions (Prevention and Control Measures)

- To create awareness among the public and doctors.
- To stock pile drugs and vaccine.
- Allocation of separate funds.
- *Preparedness:* This is not a cause for panic—It is a cause for serious, deliberate long-term concern.
- International collaboration is required as BW do not respect 'boundaries, culture, language or territory', hence solution has to be global.
- Microbiologists are the main focal point of action, because the BW are the products of their specialty.

Finally

Biological warfare is a reality. We have a large pool of microbiological technology. We have to put these resources into use. There is an urgency to develop out the bioterrorism capabilities of human, agricultural and veterinary bioterrorism. Hence we should have a clear vision, political will, careful planning and organization by integrating local, state and central capabilities and to remember that we can deal with bioterrorism and not overreact to it.

BIBLIOGRAPHY

1. Malur PR. Bioterrorism. Karnataka Medical Journal 2002;73(1).
2. Pal D, Chattopadhyay UK. Bioterrorism. J Ind Med Assoc 2002;100:37-40.
3. Raghunath. Biological Warfore: Bioterrorism. National Med J, India 2001;14:194-6.
4. Simon DJ. Biological Terrorism. JAMA 1997.p.278.

CHAPTER 48

Global Warming

Today, global health is being affected very much and the prime cause is human activities only such as industrialization, urbanization, deforestration, vehicular traffic, burning of fossil fuel (coal and petroleum products found underground), nuclear explosions, use of chemical fertilizers, etc. supplemented by natural disasters. All these have resulted in climate change, which in turn has affected the most fundamental determinants of health—air, food and water.

The climate change has been a constant and menacing problem and it is on the increase due to increased population growth.

During 2007, we consumed more than 30 billion barrels of oil per day. In addition we used 03 billion tones of coal. Burning of these fuels has resulted in causing air pollution by increasing the concentrations of carbon dioxide, nitrous oxide, methane, chlorofluorocarbons and depletion of ozone layer in the earth's atmosphere.

Normally, these gasses (CO_2, CH_4, N_2O, chlorofluorocarbons, etc.) trap sufficient heat, coming from the Sun, to sustain life on earth. These prevent the heat from being radiated out. Thus, they act like the glass of a green-house. Therefore, they are called 'Green House Gases' (GHGs). Without Green House Effect, life would not have been existed on earth. The earth's over all surface temperature is about 15°C and it is being maintained by the carbon cycle and the ecological system (i.e. excess temperature is cooled by ice caps). Accumulation of these GHGs in the atmosphere result in trapping more heat and rise of the surface temperature of the earth. This effect is called 'Global Warming', by which our life/health is put into danger.

HISTORY OF GLOBAL WARMING

1824 - A French mathematician, JB Joseph Fourier discovered that the temperature of Earth was slowly increasing. He called it 'Green House Effect'.

1850 - An instrument became available to record the surface temperature of Earth (Before that, there was proxy thermometer).

1880s - Scientists associated the relation between the human activities and the rise of CO_2 level in the atmosphere.

1995 - Scientists formed an association Inter-governmental Panel on Climate Change (IPCC). The IPCC concluded that global warming has been due to building of green house gasses in the atmosphere.

From the last 8000 years, Earth's surface temperature is raised by 1°C only. As on today, it is 15°C. From the last 100 years, the surface temperature has raised by ½°C and at this rate of global warming, it is estimated that within another 50 years (by 2050), the temperature would rise by 2.5°C and by the end of this century, by another 2.5°C. A rise in temperature of 2°C could trigger irreversible and catastrophic state of global warming. The Earth which was like an icebox has started burning. All because of human activities only.

HAZARDS OF GLOBAL WARMING (FIG. 48.1)

- Acid rain
- Shift in hydrological cycle

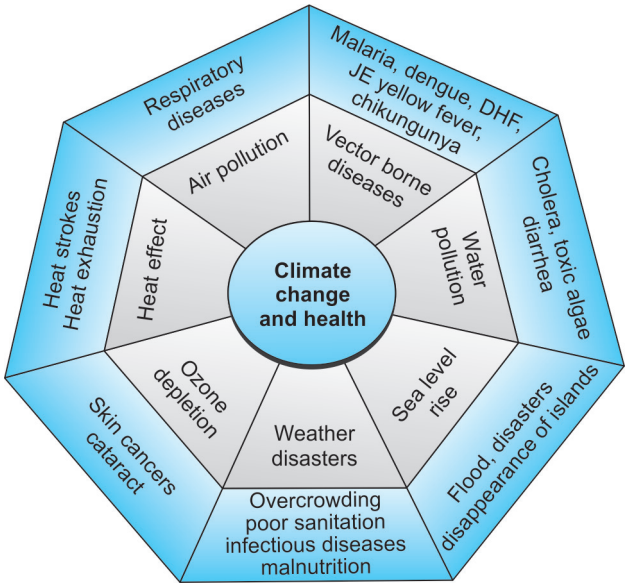


Fig. 48.1 Possible health impacts due to climate change

- Effect on glaciers
- Air pollution
- Disturbances of ecological system
- Ozone depletion.

1. *Acid rain:* The SO_2 and NO_2 coming from the industries combine with oxygen and moisture of the air and form dilute mixture of sulphuric acid, nitric acid (and carbonic acid) in the clouds. When the acid rain falls on earth, it results in the following effects:
   - Destruction of food crops
   - Deforestation (Dense forests become scrub jungles)
   - Desertification
   - Erosion of soil
   - Acidification of water bodies
   - Destruction of acquatic life.
2. *Shift in hydrological cycle:* This results in the following effects:
   - Reduction in the quality and availability of drinking water
   - Reduction in the productivity of arable land
   - Favoring of draughts and famines
   - Increased incidence of malnutrition.
3. *Effect on glaciers:*
   - Melting of polar icecaps
   - Retreat of glaciers
   - Rise of sea levels (resulting in frequent floods and disappearance of islands)
   - Inundation of coastal areas and threatening the life of coastal people
   - Degradation of surface water quality
   - Favoring water borne epidemics.
4. *Hazards of air pollution:*
   - Respiratory diseases (allergic, infectious and carcinogenic)
   - Decreased vital capacity of lungs
   - Animals (cattle) become weak (Animal yield becomes less)
   - Destruction of historical monuments
   - Heat waves, heat stress
   - Smog formation in valleys.
5. *Effects of ecological disturbance:*
   - Increased frequency of natural disasters (like rainstorms, hurricanes, floods, cyclones, etc.)
   - Alteration of vector ecology favoring their propagation and transmission of vector borne diseases (like malaria, filariasis, dengue fever, JE, etc.)
   - Destruction of coral reefs (The great barrier reef of Australia, which took lakhs of years for its construction will be lost in another 50 to 100 years affecting the life of more than 1500 species of acquatic life which depend on these coral reefs).
   - Economic loss.
6. *Ozone depletion:* Normally ozone layer acts as a barrier to the harmful effects of UV rays. Depletion of zone allows harmful rays from the Sun resulting in increased incidence of skin cancer and cataracts.

Global health is thus affected mainly by global warming supplemented by natural disasters, terrorism, increased population growth, displacement and migration of people. It is difficult to reverse over human time scales. This has jeopardized the hopes of achieving Millennium Development Goals.

WHO IS THE WORST POLLUTER?

Developed countries are the worst polluters (US, Russia and Japan in that order). Fifty five percent carbon emission is produced by 15 percent of the population. This is likely to double in another 150 years. This leads to an effect called, 'Runaway Green House' effect. This is found in the planet Venus, where the surface temperature is 860°F (480°C) and CO_2 concentration is 97 percent, Nitrogen is hardly 3 percent and clouds are of sulphuric acid, making the planet hottest, next to sun in the solar family.

Thus, the effects of climate change originate mainly from the industrialized countries but the health risks are concentrated in the poorest developing nations that have contributed least to the problem, including India. The health impacts will be disproportionately greater in the vulnerable groups of population in the developing and under developed countries. The population that are hit hardest are the very young, the malnourished, the elderly, medically infirm and socially disadvantaged group. The countries with high levels of poverty, malnutrition, weak health infrastructures and poor political unrest will be least able to cope-up.

Without effective action to mitigate and adopt to climate change, the burden of climate sensitive diseases like malnutrition, diarrheal disease, malaria and dengue fever will be greater and that will be more difficult and costly to control.

Thus, keeping in view the overwhelming evidence that climate change presents growing threat to public health/ global health, WHO's selection of the theme for World Health Day - 2008, 'Protecting Health from Climate Change', is both timely and relevant.

There is sound evidence that global warming is now unequivocal. The effects on global climate system could be abrupt or irreversible, sparing no country, causing more frequent and more intense heat waves, rain storms, tropical cyclones and tidal surges in sea level this very century. Food and water shortage will put the health security of millions of people at stake. These will threaten human health security and cost lives.

It is predicted by Intergovernmental Panel on Climate Change (IPCC) that 150 to 250 million people in Africa will suffer water shortage (crisis), while the residents of mega cities of Asia will be at great risk of river and coastal flooding.

Subsequent generations face an uncertain future. Our beautiful planet is in crisis and danger. Human species may become extinct. We are conducting dangerous experiment on our mother Earth. We need to mobilize all our intellectual forces to ward off climate change and to achieve our continued existence on this planet. We have to work towards a carbon neutral world and bring Net Zero Carbon Emission. Tipping point to disaster is fast approaching. It is the time to act now.

KYOTO PROTOCOL

United Nations (UN) Secretary called the climate changes as, 'the biggest challenge of 21st century'. In this connection of challenge for worldwide cooling of earth, on 16th February 1997, Kyoto protocol was introduced, based on the principles set out in UN Framework Convention in Climate Change (UNFCC), as an international agreement setting targets for industrialized countries to cut down their green house gas emission to at least 5.2 percent below that of 1990 levels by 2010 and those countries who are not able to meet the challenges, will have to pay penalty.

It was supported by 141 nations but it was boycotted by USA, the worst polluter. However, 34 industrialized countries signed the Kyoto protocol.

Kyoto protocol allows trading of emission, i.e. if a committed country fails to reach the target, it can do it by buying the Clean Development Mechanism (CDM) from low emission nations. Protocol was adopted in Kyoto, Japan, in 1997. It entered into force in 2005. The first commitment period was from 2005 to 2012. Most of the nations have failed to fulfil the targets. The second commitment period is from 2012 to 2016. Copenhagen summit was held from Dec 7 to Dec 18, 2009. It was to ensure that rich nations significantly reduced their GHG emissions and provide finance and technology to poor nations.

ACTION NEEDS TO BE TAKEN NOW

It is a challenge to achieve the goal of Net Zero Carbon Emission. It is a challenge for each one of us. The challenge is daunting, perplexing, intense and wide. It calls for a preventive, public health approach. It is a shared international responsibility. We need to strengthen the existing public health system rather than inventing the new system. We must tackle the issue on all fronts. We have to 'Think Globally, Act Locally'. (World Health Day Theme - 1990).

One Planet One Family. We have to save our beautiful planet Earth.

CONTAINMENT MEASURES

- Encourage greeneries. They act as most effect carbon sinks.
- Opt for electric cars, which are emission free and eco friendly. Saves fuel.
- Tap the sun and use solar power plants.
- Encourage community biogas plants, which prevent the use of firewood.
- Beat the wind by wind mill to obtain power supply.
- Improve water harvesting system.
- Save the wet lands to recharge ground water. They help to preserve flora and fauna.
- Use solar lantern for rural home lighting.
- Mitigate disasters.
- Ban the plastic bags, which are not ecofriendly. Not only carbon emissions occur while they are manufactured but also noxious fumes are released while they are burnt or disposed off.
- Avoid leisurely car drives and walk as much as possible.
- Save the rivers from sewage and industrial waste.
- Save Himalayas.
- Avoid using papers and use E-mail so that trees can be saved.
- Use bicycle which is a zero pollution vehicle (Being a good exercise prevents obesity and improves health).

Thus, there should be intersectoral coordination among Government agencies, Intergovernmental and Non-Governmental Organizations (NGOs), professional groups and local communities to meet the global threat. Sooner the steps taken, greater will be the impact.

BIBLIOGRAPHY

1. Mathur JS. A Comprehensive Textbook of Community Medicine. 1st edn, 2008.
2. Raj Chengappa. Global Warming. What India Should Do. India today July 14, 2008.
3. WHO 60 Years. World Health Day. 'Protect Health from Climate Change' April 7, 2008.

CHAPTER 49

Integrated Management of Childhood Illness

Integrated management of childhood illness (IMCI) is a strategy developed by WHO and UNICEF in order to reduce morbidity and mortality among under five children, that bear the highest burden of deaths from common diseases, by providing quality care to such sick children.

The background is that more than ten million children die each year in developing countries before they reach their fifth birthday. Seven in ten of these deaths are due to acute respiratory infections (mostly pneumonia), diarrhea, measles, malaria and malnutrition and often a combination of these conditions. When the children develop overlapping of the features of more than one condition, then a single diagnosis may not be possible and the treatment also becomes complicated. So, many children are not properly assessed and treated at the first level health facilities and the parents are also poorly adviced.

Thus, IMCI is a fostering, holistic, integrated, cost-effective, approach to child health and development by management of such cases, specially in rural areas, where the services of staff and laboratory are minimum or even non existent and the drugs and equipment are also scarce.

Since majority of children in rural areas first approach the health worker, it is envisaged that if these workers are trained to identify and treat the above mentioned diseases, using a set of interventions, in an integrated approach, the under five mortality and morbidity could be reduced considerably. This IMCI strategy not only includes curative components but also preventive and promotive components.

- *Curative component* includes the integrated management of the five most important causes of childhood deaths—acute respiratory infections (mostly pneumonia), diarrhea, measles, malaria and malnutrition—and of common associated condition. This is the core intervention or focus of IMCI.
- *Preventive measures* include immunization, vitamin A and Iron and folic acid supplementation.
- *Promotive measures* include improved infant feeding including exclusive breastfeeding and child nutrition to promote growth and development.

OBJECTIVES

- To reduce under five mortality
- To reduce the frequency and severity of illness and disability
- To promote growth and development.

COMPONENTS

- Improvement in the case management skills of health care staff through IMCI guidelines
- Improvement in the health system required for the effective management of childhood illness
- Improvements in family and community practices.

The IMCI guidelines are designed for the integrated case management of sick children aged 1 week up to 5 years, using an evidence—based, syndromic approach that supports the rational, effective and affordable use of drugs and diagnostic tools.

The charts of the IMCI at the first level health facility are:

- Assess and classify the sick child age 2 months up to 5 years, for the clinical condition, nutritional status and immunization status.
- Treat the child.
- Counsel the mother to solve problems if any such as feeding and how to take care at home.

- Assess, classify and treat the sick young infant age 1 week up to 2 months.
- Follow-up care.

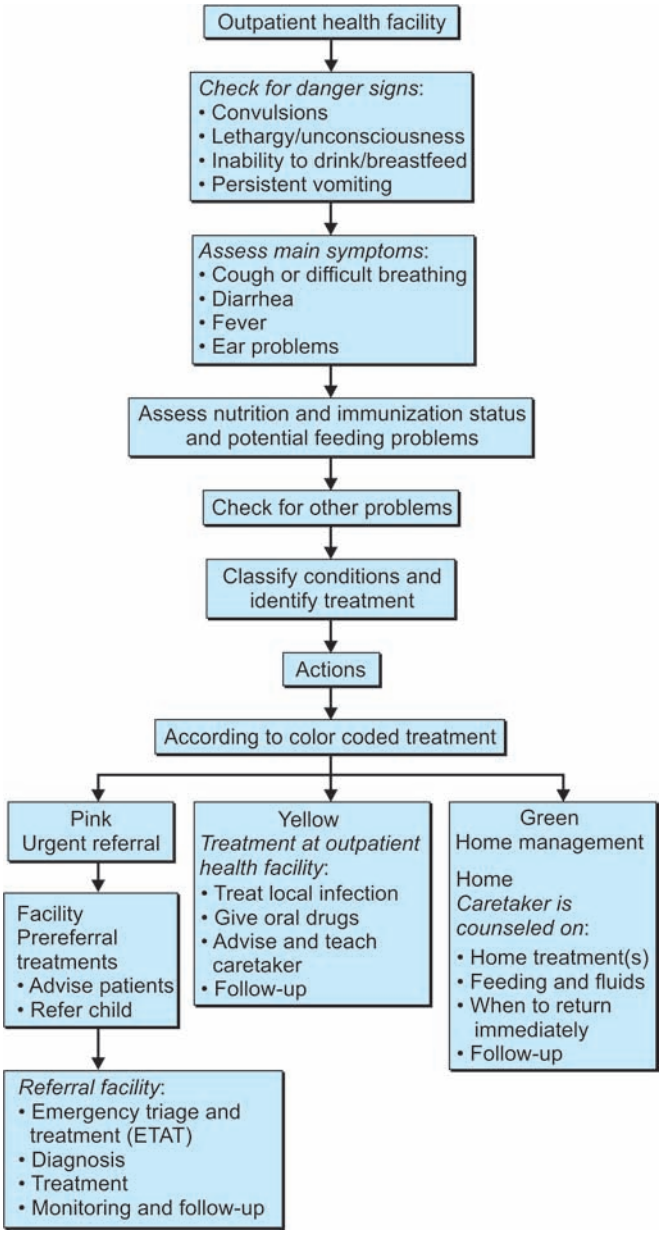
The above IMCI classifications are action oriented and allow the health care provider to determine if a child should be urgently referred to another health facility, if the child can be treated at the first level facility (e.g. with oral antibiotic, antimalarial, ORS, etc.), or if the child can be safely managed at home.

PRINCIPLES

- All sick children (1 week up to 5 years) must be examined in the outpatient health facility for 'General danger signs', which indicate the need for immediate referral or admission to a hospital.
- All sick children, aged 2 months up to 5 years must be routinely assessed for major symptoms such as cough or difficult breathing, diarrhea, fever, ear problems. And children aged 1 week up to 2 months for bacterial infections and diarrhea. They must also be routinely assessed for nutritional and immunization status, feeding problems and other potential problems.
- Only a limited number of carefully selected clinical signs are used, based on evidence of their sensitivity and specificity to detect disease.
- The combination of signs leading to child's classification(s) rather than a diagnosis calls for specific action based on whether the child should be urgently referred or requires specific treatment or may be safely managed at home. The classifications are color coded.

  'Pink' suggests urgent referral to hospital for admission, 'Yellow' indicates initiation of specific treatment at outpatient health facility, and 'Green' calls for home management **(Flow chart 49.1)**.
- IMCI focuses on major conditions which cause high mortality and are amenable to cost-effective interventions. However, management of trauma or other acute emergencies due to accidents or injuries and chronic problems are not included in IMCI strategy.
- IMCI policy ensures the availability and use of a limited number of essential drugs.
- Health workers do the counseling of caretakers/mothers about home management, feeding and when to return to a health facility.
- IMCI also provides a great opportunity for improving child health by interventions such as immunization, vitamin A supplementation and child nutrition including breastfeeding.

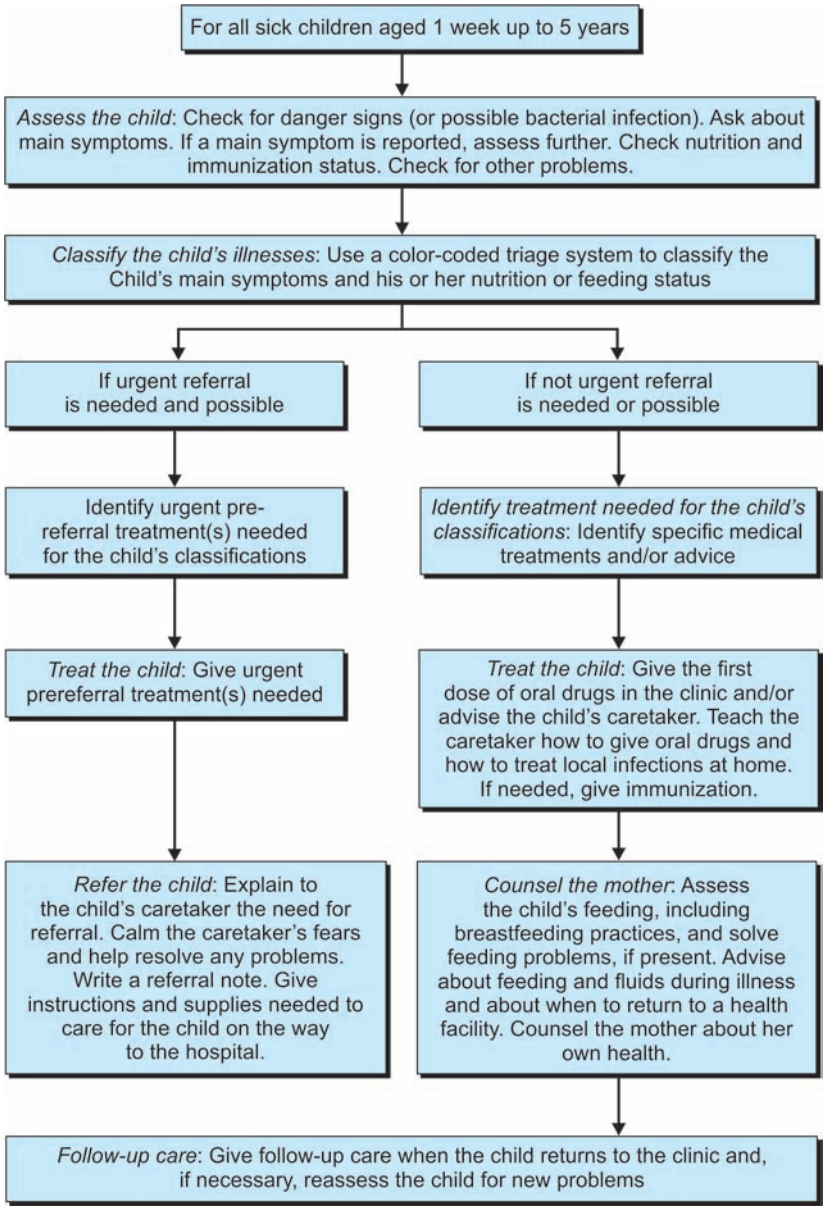
Flow chart 49.1 Integrated management of childhood illness (IMCI) case management process



The care management process is presented on two different sets of charts: one for children age 2 months up to 5 years and one for children age 1 week up to 2 months.

The Indian version of IMCI is IMNCI (Integrated Management of Neonatal and Childhood Illness).

Flow chart 49.2 Summary of the integrated case management process



The different Flow charts of IMCI guidelines for the management of childhood diseases are as follows:

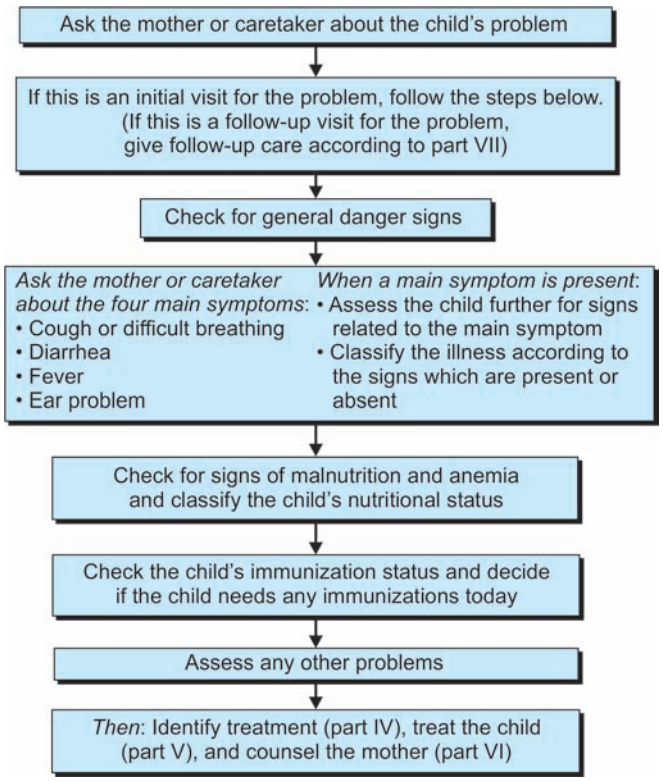
- Summary of the integrated case management process **(Flow chart 49.2)**.
- Select the appropriate case management chart.

The case management process for sick children is presented on 3 charts titled:

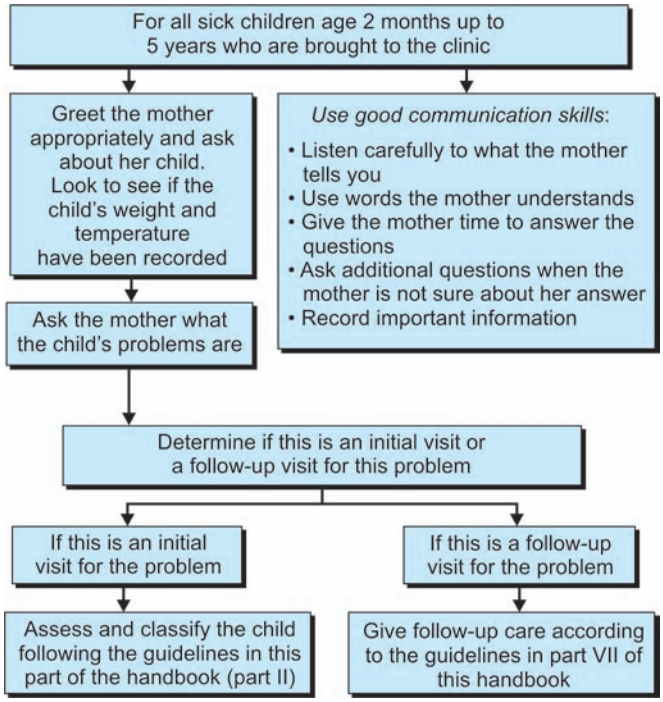
- Assess and classify the sick child **(Flow charts 49.3 to 49.14); (Tables 49.1 to 49.10)**
- Treat the child **(Flow chart 49.15)**
- Counsel the mother.

ASSESS AND CLASSIFY THE SICK CHILD

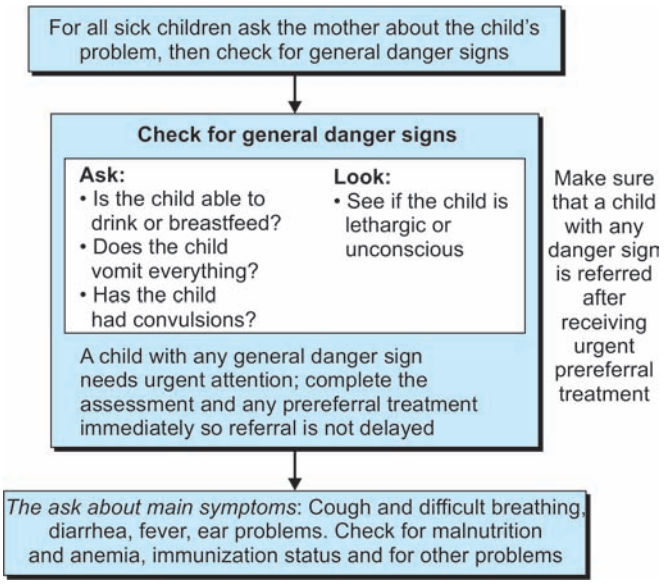
Flow chart 49.3 Summary to assess and classify



Flow chart 49.4 When a child is brought to the clinic



Flow chart 49.5 General danger signs



Flow chart 49.6 Cough or difficult breathing

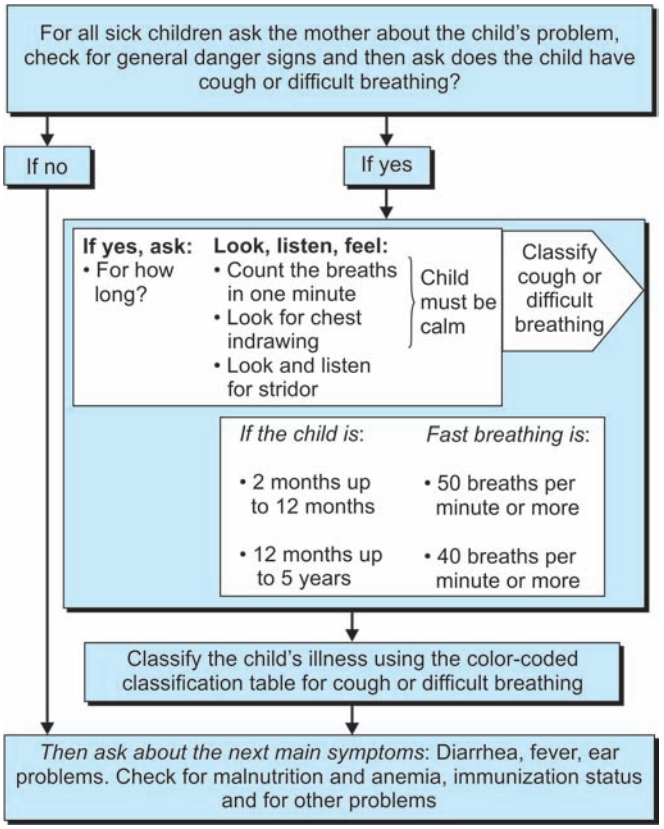
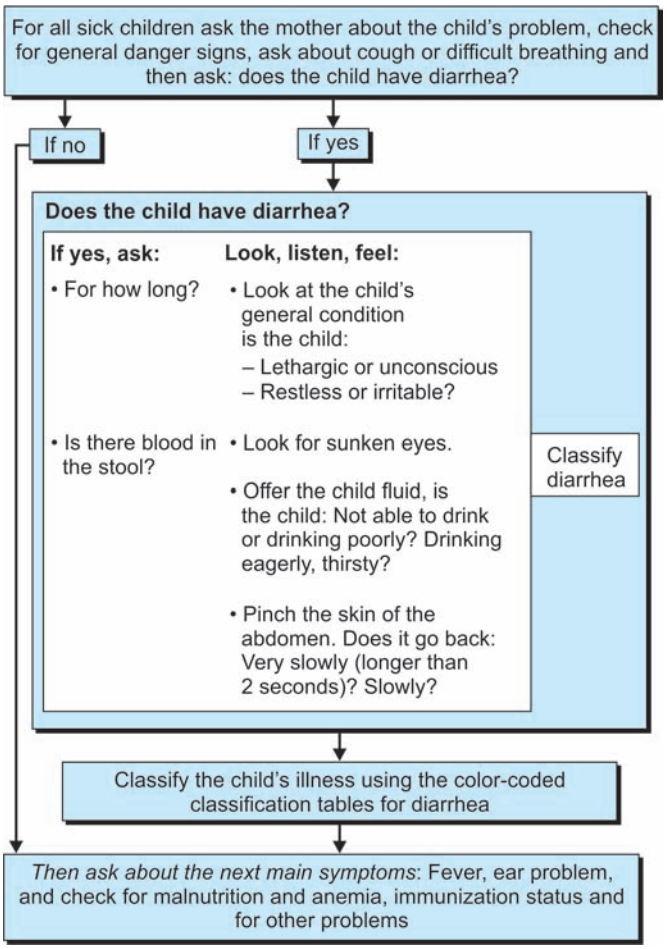


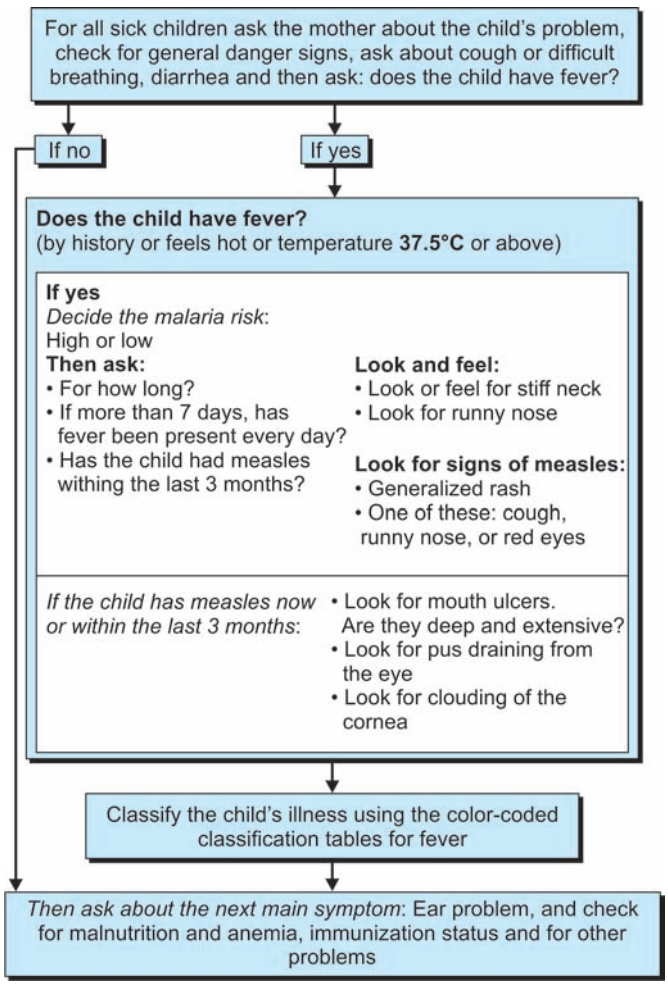
Table 49.1 Classification for cough or difficult breathing

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Any general danger sign or chest indrawing or stridor in calm child	Severe pneumonia or very severe disease	• Give first dose of an appropriate antibiotic • Refer urgently to hospital
• Fast breathing	Pneumonia	• Give an appropriate oral antibiotic for 5 days • Soothe the throat and relieve the cough with a safe remedy • Advise mother when to return immediately • Follow-up in 2 days
• No signs of pneumonia or very severe disease	No pneumonia: cough or cold	• If coughing more than 30 days, refer for assessment • Soothe the throat and relieve the cough with a safe remedy • Advise mother when to return imemdiately • Follow-up in 5 days if not improving

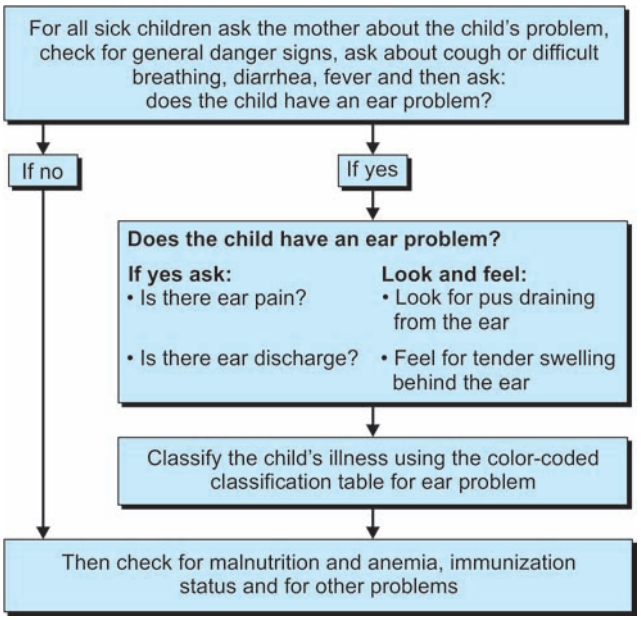
Flow chart 49.7 Diarrhea



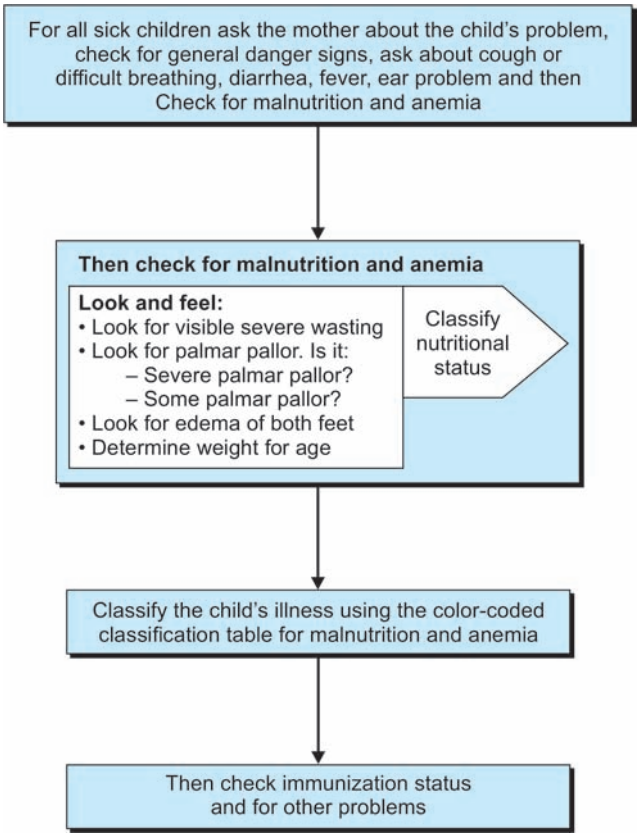
Flow chart 49.8 Fever



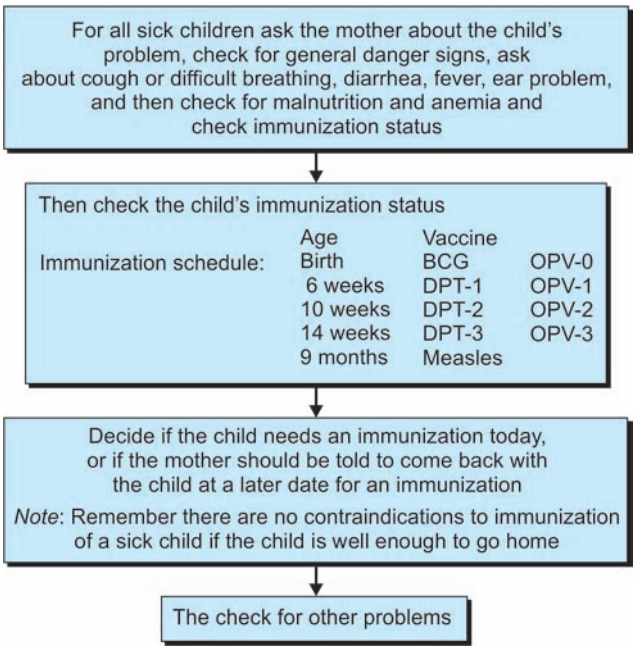
Flow chart 49.9 Ear problem



Flow chart 49.10 Malnutrition and anemia



Flow chart 49.11 Immunization status



Flow chart 49.12 Summary of assess and classify a sick infant age 1 week up to 2 months

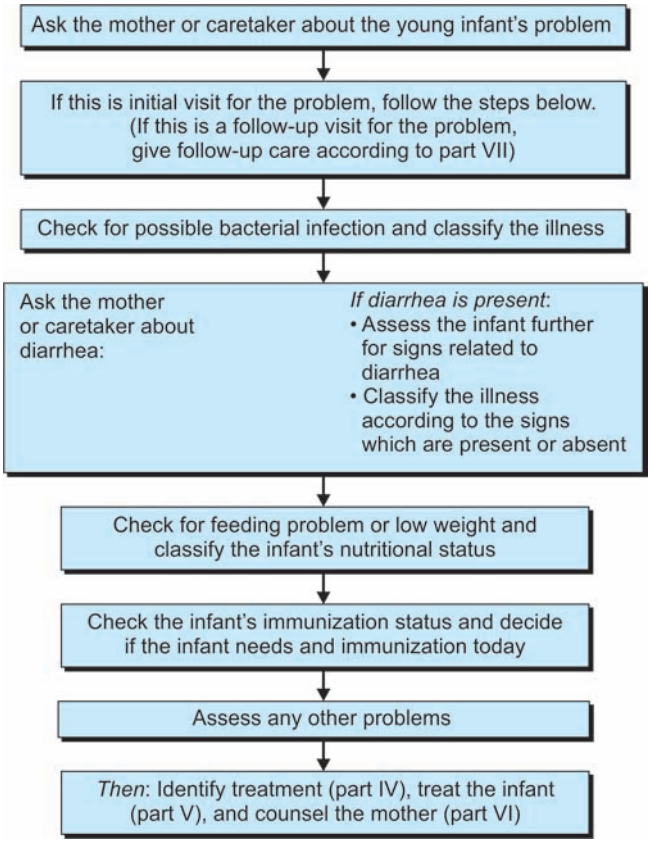


Table 49.2 Classification for dehydration

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
Two of the following signs: • Lethargic or unconscious • Sunken eyes • Not able to drink or drinking poorly • Skin pinch goes back very slowly	Severe dehydration	• If child has no other severe classification – Give fluid for severe dehydration (Plan C) or • *If child also has another severe classification:* – Refer urgently to hospital with mother giving frequent sips of ORS on the way. – Advise the mother to continue breastfeeding • If child is 2 years or older and there is cholera in your area, give antibiotic for cholera
Two of the following signs: • Restless, irritable • Sunken eyes • Drinks eagerly, thirsty • Skin pinch goes back slowly	Some dehydration	• Give fluid and food for some dehydration (Plan B) • *If child also has a severe classification:* – Refer urgently to hospital with mother giving frequent sips of ORS on the way. – Advise the mother to continue breastfeeding • Advise mother when to return immediately • Follow-up in 5 days if not improving
Not enough signs to classify as some or severe dehydration	No dehydration	• Give fluid and food to treat diarrhea at home (Plan A) • Advise mother when to return immediately • Follow-up in 5 days if not improving

Table 49.3 Classification for high malaria risk

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Any general danger sign • Stiff neck	Very severe febrile disease	• Give quinine for severe malaria (first dose) • Give first dose of an appropriate antibiotic • Treat the child to prevent low blood sugar • Give one dose of paracetamol in clinic for high fever (38.5°C or above) • Refer urgently to hospital
• Fever (by history or feels hot or temperature 37.5°C* or above)	Malaria	• If no cough with fast breathing, treat with oral antimalarial or If cough with fast breathing, treat with cotrimoxazole for 5 days • Give one dose of paracetamol in clinic for high fever (38.5°C or above) • Advise mother when to return immediately • Follow-up in 2 days if fever persists • If fever is present everyday for more than 7 days, Refer for assessment

*These temperatures are based on axillary temperature.

Table 49.4 Classification for low malaria risk and no travel to a high-risk area

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Any general danger sign • Stiff neck	Very severe febrile disease	• Give quinine for severe malaria (first dose) • Give first dose of an appropriate antibiotic • Treat the child to prevent low blood sugar • Give one dose of paracetamol in clinic for high fever (38.5°C or above) • Refer urgently to hospital • If no cough with fast breathing, treat with oral antimalarial or If cough with fast breathing, treat with cotrimoxazole for 5 days • Give one dose of paracetamol in clinic for high fever (38.5° C or above) • Advise mother when to return immediately • Follow-up in 2 days if fever persists • If fever is present everyday for more than 7 days, refer for assessment
• No runny nose • No measles • No other cause of fever	Malaria	
• Runny nose present or Measles present or Other cause of fever present	Fever—malaria unlikely	• Give one dose of paracetamol in clinic for high fever (38.5°C or above) • Advise mother when to return immediately • Follow-up in 2 days if fever persists • If fever is present everyday for more than 7 days, refer for assessment

Table 49.5 Classification for no malaria risk and no travel to a malaria risk area

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Any general danger sign • Stiff neck	Very severe febrile disease	• Give first dose of an appropriate antibiotic • Treat the child to prevent low blood sugar • Give one dose of paracetamol in clinic for high fever (38.5°C or above) • Refer urgently to hospital
• No general danger sign and • No stiff neck	Fever—malaria unlikely	• Give one dose of paracetamol in clinic for high fever (38.5°C or above) • Advise mother when to return immediately • Follow-up in 2 days if fever persists • If fever is present everyday for more than 7 days refer for assessment

Table 49.6 Classification for measles (If measles now or within the last 3 months)

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Any general danger sign • Clouding of cornea • Deep or extensive mouth ulcers	Severe complicated measles	• Give vitamin A • Give first dose of an appropriate antibiotic • If clouding of the cornea or pus draining from the eye, apply tetracycline eye ointment • Refer urgently to hospital
• Pus draining from the eye • Mouth ulcers	Measles with eye or mouth complications	• Give vitamin A • If pus draining from the eye, treat eye infection with tetracycline eye ointment • If mouth ulcers, treat with gentian violet • Follow-up in 2 days
• Measles now or within the last 3 months	Measles	• Give vitamin A

Table 49.7 Classification for ear problem

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Tender swelling behind the ear	Mastoiditis	• Give first dose of an appropriate antibiotic • Give first dose of paracetamol for pain • Refer urgently to hospital
• Pus is seen draining from the ear and discharge is reported for less than 14 days	Acute ear infection	• Give an oral antibiotic for 5 days • Give paracetamol for pain • Dry the ear by wicking • Follow-up in 5 days
• Ear pain • Pus is seen draining from the ear and discharge is reported for 14 days or more	Chronic ear infection	• Dry the ear by wicking • Follow-up in 5 days
• No ear pain and no pus seen draining from the ear	No ear infection	No additional treatment

Table 49.8 Classification for malnutrition and anemia

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Visible severe wasting • Severe palmar pallor • Edema of both feet	Severe malnutrition or severe anemia	• Give vitamin A • Refer urgently to hospital
• Some palmar pallor • Very low weight for age	Anemia or very low weight	• Assess the child's feeding and counsel the mother on feeding according to the food box on the counsel the mother chart – If feeding problem, follow-up in 5 days • If pallor: – Give iron – Give oral antimalarial if high malaria risk – Give mebendazole if child is 2 years or older and has not had a dose in the previous 6 months • Advise mother when to return immediately • If pallor, follow-up in 14 days • If very low weight for age, follow-up in 30 days
• Not very low weight for age and no other signs or malnutrition	No anemia and not very low weight	• If child is less than 2 years old, assess the child's feeding and counsel the mother on feeding according to the food box on the counsel the mother chart – If feeding problem, follow-up in 5 days • Advise mother when to return immediately

Table 49.9 Classification for possible bacterial infection

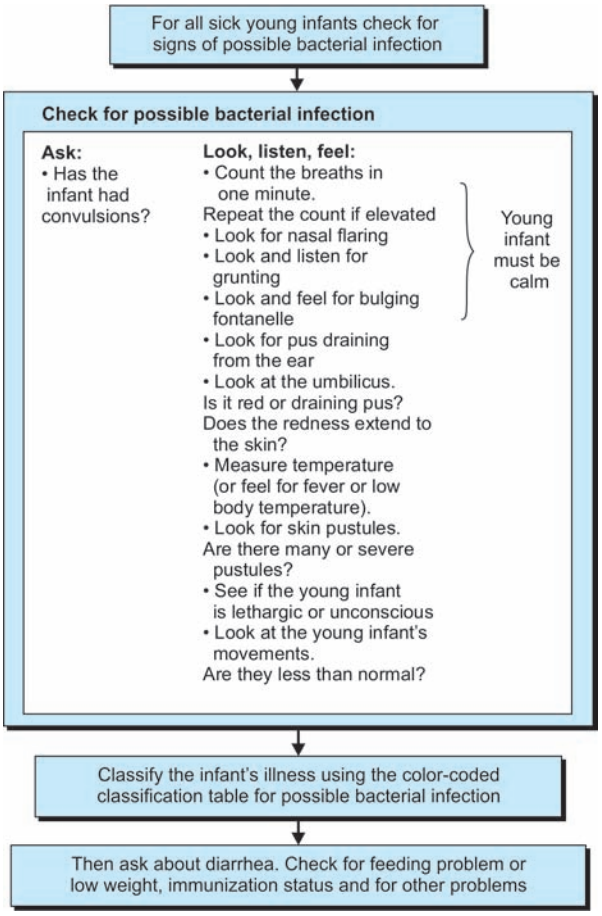
Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Convulsions • Fast breathing (60 breaths per minute or more) • Severe chest indrawing • Nasal flaring • Grunting • Bulging fontanelle • Pus draining from ear • Umbilical redness extending to the skin • Fever (37.5°C* or above or feels hot) or low body temperature (less than 35.5°C* or feels cold) • Many or severe skin pustules • Lethargic or unconscious • Less than normal movement	Possible serious bacterial infection	• Give first dose of intramuscular antibiotics • Treat to prevent low blood sugar • Advise mother how to keep the infant warm on the way to hospital • Refer urgently to hospital
• Red umbilicus or draining pus • Skin pustules	Local bacterial infection	• Give an appropriate oral antibiotic • Teach the mother to treat local infections at home • Advise mother to give home care for the young infant • Follow-up in 2 days

*These thresholds are based on axillary temperature. The thresholds for rectal temperature readings are approximately 0.5°C higher.

Table 49.10 Classification for feeding problem or low weight

Signs	Classify as	Identify treatment (Urgent prereferral treatments are in bold print)
• Not able to feed • No attachment at all • Not suckling at all	Not able to feed—possible serious bacterial infection	• Give first dose of intramuscular antibiotics • Treat to prevent low blood sugar • Advise the mother how to keep the young infant warm on the way to hospital • Refer urgently to hospital
• Not well attached to breast • Not suckling effectively • Less than 8 breastfeeds in 24 hours		• Advise the mother to breastfeed as often and for as long as the infant wants, day and night – If not well attached or not suckling effectively, teach correct positioning and attachment. – If breastfeeding less than 8 times in 24 hours, advise to increase frequency of feeding.
• Receives other foods or drinks • Low weight for age • Thrush (ulcers or white patches in mouth)	Feeding problem or low weight	• If receiving other foods or drinks, counsel mother about breastfeeding more, reducing other foods or drinks, and using a cup – If not breastfeeding at all: - Refer for breastfeeding counseling and possible relactation. - Advise about correctly prepared breast milk substitutes and using a cup • If thrush, teach the mother to treat thrush at home • Advise mother to give home care for the young infant • Follow-up any feeding problem or thrush in 2 days • Follow-up low weight for age in 14 days
• Not low weight for age and no other signs of inadequate feeding	No feeding problem	• Advise mother to give home care for the young infant • Praise the mother for feeding the infant well

Flow chart 49.13 How to check a young infant for possible bacterial infection?



IDENTIFICATION OF THE TREATMENT

Urgent Prereferral Treatment

- Giving the first dose of appropriate antibiotic
- Keeping the child warm
- Treatment to prevent low blood sugar with sugar water
- Frequent sips of ORS on the way to hospital.

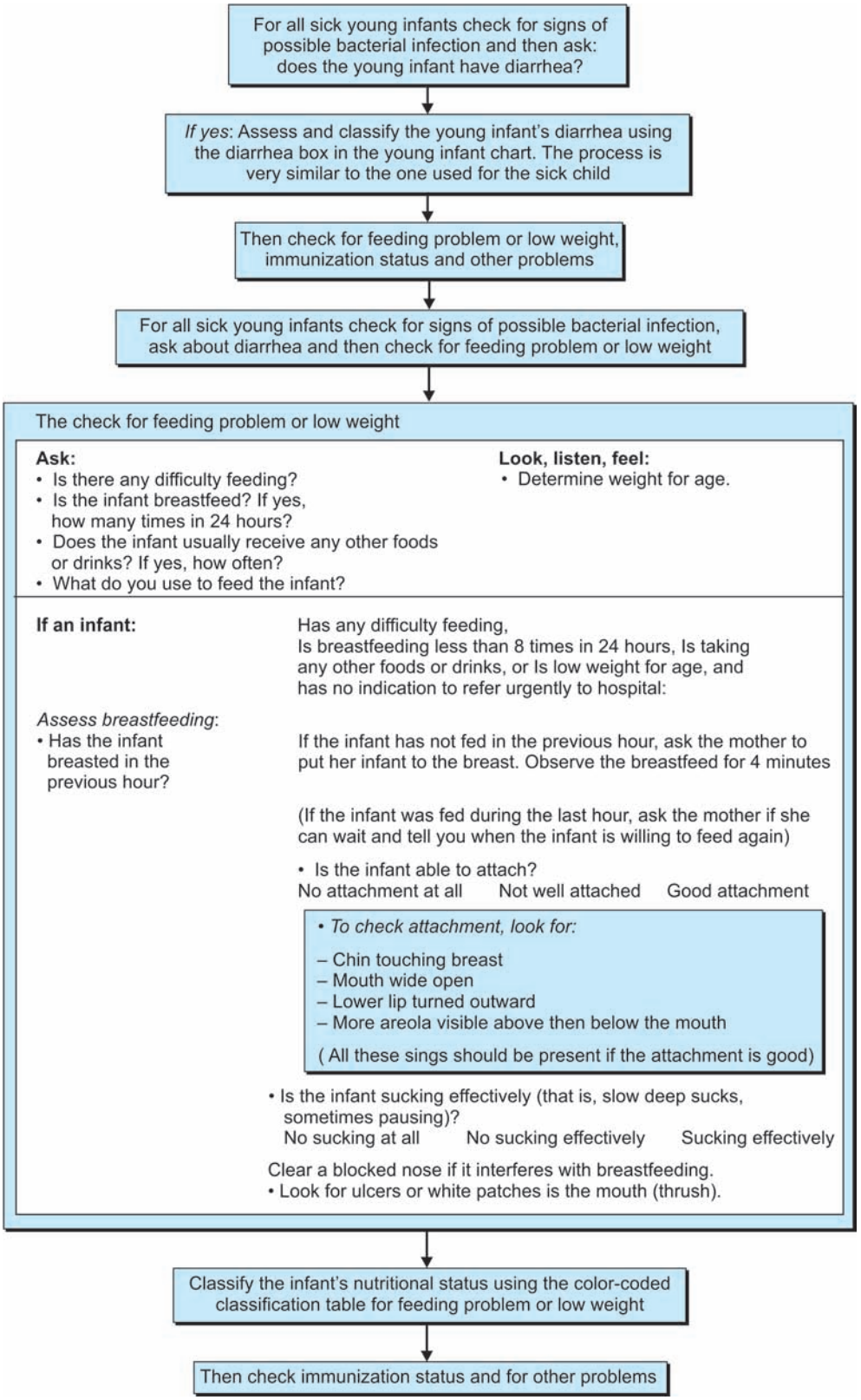
Overview of the treatment of the sick child or the sick young infant.

i. *Appropriate oral antibiotic*
For pneumonia, acute ear infection or very severe disease:
First line antibiotic: Cotrimoxazole
Second line antibiotic: Amoxycillin.
For malaria: Chloroquine and sulfadoxine - pyrimethamine are first and second line drugs respectively.
For high fever: Paracetamol
For measles or severe malnutrition: Vitamin A
For anemia: Iron syrup.
Note: Second line antibiotic is given only if the first line antibiotic is not available or if the illness does not respond to first line antibiotic.

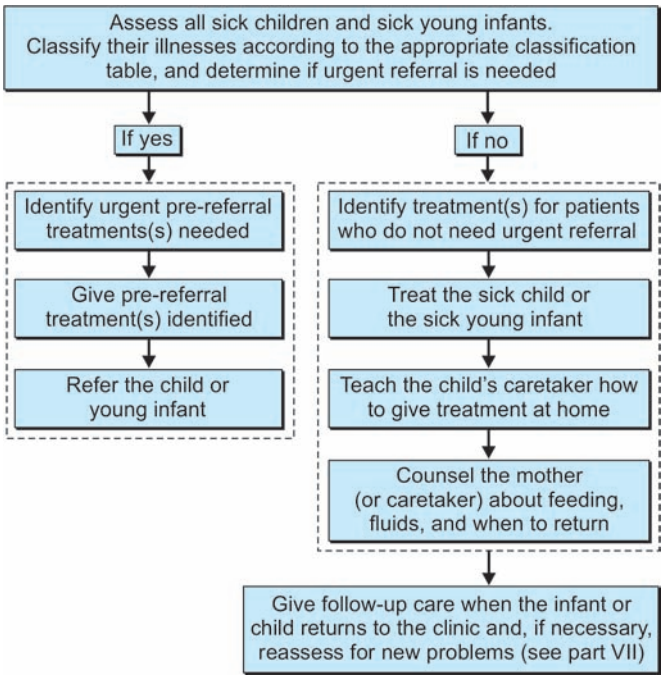
ii. *Urgent pre-referral treatment*: To be done as follows:
- Intramuscular antibiotic if the child cannot take oral antibiotic
- Quinine for severe malaria
- Breast milk or sugar water to prevent low blood sugar.

iii. *Treatment of local infections*
Such as umbilicus draining pus, skin pustules and thrush, are treated with gentian violet, in a child age 1 week up to 2 months. For a child age 2 months up to 5 years.

Flow chart 49.14 How to assess and classify a young infant for diarrhea?



Flow chart 49.15 Choose treatment priorities



Local infection	Treatment
Eye infection	Tetracycline eye ointment
Ear infection	Dry the ear by wicking with a soft cotton cloth or tissue paper
Mouth ulcers	Apply gentian violet
Dry cough	Apply smoothening agent to thorat

iv. Extra fluid for diarrhea and continued feeding.
v. Immunizations

vi. Follow-up care:

If the child has	Return for follow-up in
Pneumonia	2 days
Dysentery	
Malaria, if fever persists	
Fever-malaria unlikely if fever persists	
Measles with eye or mouth complications	
Persistent diarrhea	5 days
Acute ear infections	
Chronic ear infection	
Feeding problem	
Any other illness, if not improving	
Palor	14 days
Very low weight for age	30 dyas

COUNSEL THE MOTHER

- Using good communication skills
- About breastfeeding problems
- About feeding and fluids
- About when to return
- About her own health.

BIBLIOGRAPHY

1. Patwari, Neena Raina. IMCI A Robust Strategy. Ind J of Ped Vol 69, 2002.
2. WHO Handbook of Integrated Management of Childhood Illness.

ANNEXURE I

Sample Case Recording Forms

MANAGEMENT OF THE SICK YOUNG INFANT AGE 1 WEEK UP TO 2 MONTHS

Name: _____ Age: _____ Weight: _____ kg Temperature: _____ °C

ASK: What are the infant's problems? _____ Initial visit? _____ Follow-up Visit? _____

ASSESS (Circle all signs present) CLASSIFY

CHECK FOR POSSIBLE BACTERIAL INFECTION

- Has the infant had convulsions?
- Count the breaths in one minute. _____ breaths per minute
  Repeat if elevated _____ Fast breathing?
- Look for severe chest indrawing.
- Look for nasal flaring.
- Look and listen for grunting.
- Look and feel for bulging fontanelle.
- Look for pus draining from the ear.
- Look at umbilicus. Is it red or draining pus?
  Does the redness extend to the skin?
- Fever (temperature 37.5°C or feels hot) or low body temperature (below 35.5°C or feels cool).
- Look for skin pustules. Are there many or severe pustules?
- See if young infant is lethargic or unconscious.
- Look at young infant's movements. Less than normal?

DOES THE YOUNG INFANT HAVE DIARRHEA? Yes _____ No _____

- For how long? _____ Days
- Is there blood in the stools?
- Look at the young infant's general condition. Is the infant:
  Lethargic or unconscious?
  Restless or irritable?
- Look for sunken eyes.
- Pinch the skin of the abdomen. Does it go back:
  Very slowly (longer than 2 seconds)?
  Slowly?

THEN CHECK FOR FEEDING PROBLEM OR LOW WEIGHT

- Is there any difficulty feeding? Yes _____ No _____
- Is the infant breastfed? Yes _____ No _____
- If Yes, how many times in 24 hours? _____ times
- Does the infant usually receive any other foods or drinks? Yes _____ No _____
  If Yes, how often?
- What do you use to feed the child?
- Determine weight for age. Low _____ Not Low _____

If the infant has any difficulty feeding, is feeding less than 8 times in 24 hours, is taking any other food or drinks, or is low weight for age AND has no indications to refer urgently to hospital:

ASSESS BREASTFEEDING:

- Has the infant breastfed in the previous hour?

If infant has not fed in the previous hour, ask the mother to put her infant to the breast. Observe the breastfeed for 4 minutes.

- Is the infant able to attach? To check attachment, look for:
  — Chin touching breast Yes _____ No _____
  — Mouth wide open Yes _____ No _____
  — Lower lip turned outward Yes _____ No _____
  — More areola above than below the mouth Yes _____ No _____

no attachment at all *not well attached* *good attachment*

- Is the infant suckling effectively (that is, slow deep sucks, sometimes pausing)?

not suckling at all *not suckling effectively* *suckling effectively*

- Look for ulcers or white patches in the mouth (thrush).

CHECK THE YOUNG INFANT'S IMMUNIZATION STATUS Circle immunizations needed today.

Return for next immunization on:

BCG DPT1 DPT2

OPV 0 OPV 1 OPV 2

(Date)

ASSESS OTHER PROBLEMS:

ANNEXURE II

Management of the Sick Child Age 2 Months up to 5 Years

Name: _____ Age: _____ Weight: _____ kg Temperature: _____°C

ASK: What are the child's problems? _____ Initial visit? _____ Follow-up Visit? _____

ASSESS (Circle all signs present)	CLASSIFY
CHECK FOR GENERAL DANGER SIGNS NOT ABLE TO DRINK OR BREASTFEED LETHARGIC OR UNCONSCIOUS VOMITS EVERYTHING CONVULSIONS	General danger signs present? Yes ___ No ___ **Remember to use danger sign when selecting classifications**
DOES THE CHILD HAVE COUGH OR DIFFICULT BREATHING? Yes ___ No ___ • For how long? ____ Days • Count the breaths in one minute. _____ breaths per minute. Fast breathing? • Look for chest indrawing. • Look and listen for stridor.	
DOES THE CHILD HAVE DIARRHEA? Yes ___ No ___ • For how long? _____ Days • Is there blood in the stools? • Look at the child's general condition. Is the child: Lethargic or unconscious? Restless or irritable? • Look for sunken eyes. • Offer the child fluid. Is the child: Not able to drink or drinking poorly? Drinking eagerly, thirsty? • Pinch the skin of the abdomen. Does it go back: Very slowly (longer than 2 seconds)? Slowly?	
DOES THE CHILD HAVE FEVER? (by history/feels hot/temperature 37.5°C or above) Yes ___ No ___ Decide Malaria Risk: High Low • For how long? _____ Days • If more than 7 days, has fever been present every day? • Has child had measles within the last three months? • Look or feel for stiff neck. • Look for runny nose. Look for signs of MEASLES: • Generalized rash and • One of these: cough, runny nose, or red eyes.	
If the child has measles now or within the last 3 months: • Look for mouth ulcers. If Yes, are they deep and extensive? • Look for pus draining from the eye. • Look for clouding of the cornea.	
DOES THE CHILD HAVE AN EAR PROBLEM? Yes___ No___ • Is there ear pain? • Is there ear discharge? If Yes, for how long? ___ Days • Look for pus draining from the ear. • Feel for tender swelling behind the ear.	
THEN CHECK FOR MALNUTRITION AND ANEMIA • Look for visible severe wasting. • Look for palmar pallor. Severe palmar pallor? Some palmar pallor? • Look for oedema of both feet. • Determine weight for age. Very Low ___ Not Very Low ___	
CHECK THE CHILD'S IMMUNIZATION STATUS Circle immunizations needed today. BCG DPT1 DPT2 DPT3 OPV 0 OPV 1 OPV 2 OPV 3 Measles	Return for next immunization on: (Date)
ASSESS CHILD'S FEEDING if child has ANEMIA OR VERY LOW WEIGHT or is less than 2 years old • Do you breastfeed your child? Yes____ No ____ If Yes, how many times in 24 hours? ___ times. Do you breastfeed during the night? Yes___ No___ • Does the child take any other food or fluids? Yes___ No ___ If Yes, what food or fluids? _____ How many times per day? ___ times. What do you use to feed the child? _____ If very low weght for age: How large are servings? _____ Does the child receive how own serving? ___ Who feeds the child and how? _____ • During the illness, has the child's feeding changed? Yes ____ No ____ If Yes, how?	FEEDING PROBLEMS

ASSESS OTHER PROBLEMS:

CHAPTER 50

Telemedicine in Public Health

INTRODUCTION

People living in remote rural areas struggle to get timely and good quality speciality medical care. Because of this, the health status of rural Indians is still a cause for grave concern. One of the objectives of the National Rural Health Mission (NRHM) is to provide the rural population speciality health care services. Telemedicine has the potential to bridge this gap to provide speciality care to the rural areas.

Telemedicine is the use of electronic information to communicate technologies to provide and support health care when distance separates the participants. '*Tele*' (Greek) means 'distance' and '*mederi*' (Latin) means 'to heal.'

Telemedicine has been in use over four decades. It was all started with NASA's (National Aeronautics and Space Administration) efforts in 1960.

DEFINITION

World Health Organization 2002 defined tele-medicine as 'The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information, for diagnosis, treatment and prevention of disease and injuries, research and evaluation and for the continuing education of health care providers, all in the interest of advancing the health of individuals and their communities.'

Tele health is the use of electronic information and tele-communications technologies to support long distance clinical health care, patient and professional health related education and training, public health and health administration.

Telemedicine can be:

- *Asynchronous:* Provider to provider
- *Synchronous:* Provider to patient.

AIM OF TELEMEDICINE

The primary aim is to reach the unreached through:

- *Information management*
  - Patient information
  - Medical data (signs, symptoms, investigation reports, etc.)
  - Appointment scheduling
  - Archival and retrieval of patient records.
- *Low cost solution*
  - Using ordinary telephone line, satellite, etc.
- *Service to large population*
  - Through public health care delivery systems
- *Development of knowledge based system*
  - For decision support
  - For training and education.

Telemedicine focuses on discipline such as teleradiology, telepathology, teledermatology, telepsychiatry, etc. whereas telehealth focuses on disease management, monitoring and patient compliance.

A successful telemedicine set will have the following:

- Telemedicine Consultation Center (TCC) consisting of the patient, immediate health care provider, telemedicine technician and equipment for communicating the patient's medical information.

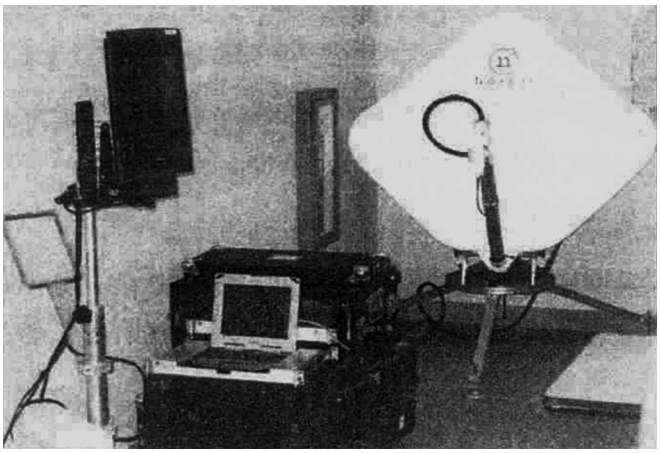


Fig. 50.1 A modern telemedicine system

- Telemedicine Specialty Center (TSC) consisting of specialist, telemedicine technician and the equipment to communicate with TCC. The specialist can interact with the patient present in the remote site.

The telemedicine system consists of an interface between hardware, software and a communication channel to connect the TCC and TSC to enable consultancy. The hardware consists of computer, printer, scanner and video conferencing equipment, whereas the software enables the acquisition of patient information (images, reports, films, etc). The communication channel will connect each other. The modern telemedicine system is shown in the **Figure 50.1**.

UTILITY OF TELEMEDICINE

- Easy access to remote areas
- Significantly reduces the time and costs of patient transportation
- Monitoring home care and ambulatory monitoring
- Improves communications between health providers separated by distance
- Critical care monitoring where it is not possible to transfer the patient
- Continuing medical education and clinical research
- A tool for public awareness
- A tool for disaster management
- Second opinion and complex interpretations
- It can bring expertise to the medical practice once established
- Telementored procedures—surgery using hand robots
- Disease surveillance and program tracking
- Provides opportunities for standardization and equity in provision of health care
- Improves rehabilitation services in remote areas.

Thus, telemedicine is not a substitute but a supplement for current health care system in a huge way. The hardware configuration is shown in the **Figures 50.2A and B**.

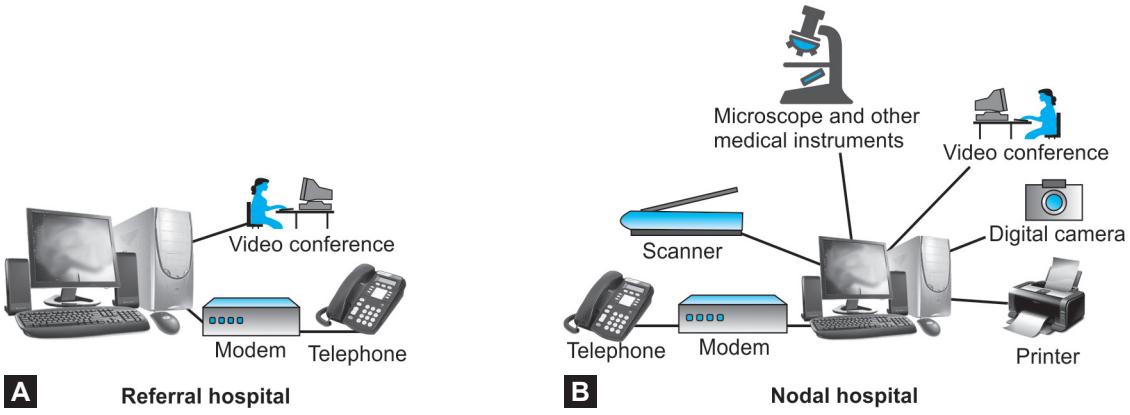
TYPES OF TECHNOLOGY

There are two types:

i. Store and forward
ii. Two-way interactive television

Store and Forward

This is used to transfer digital images from one location to another by a computer. This is typically used for non-emergent situations as in teleradiology, telepathology and teledermatology.



Figs 50.2A and B Hardware configuration

Two-way Interactive Television

This is used when 'face to face' consultation is necessary. The patient and often their provider (nurse or telemedicine coordinator) are at the originating site (at TCC). The specialist is at the referral site (TSC). The video conferencing equipment at both locations allow a 'real time' consultation to take place. Almost all specialties of medicine, such as internal medicine, psychiatry, cardiology, pediatrics, obstetrics and gynecology, have been found to be conducive to this type of consultation.

Infrastructures of Telemedicine Centers

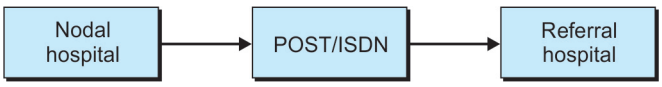
1. Primary telemedicine centers based in primary health centers.
2. Secondary telemedicine centers based in district and taluka hospitals.
3. Tertiary telemedicine centers based in apex hospitals (superspecialty hospitals).

Telecommunication Technologies

The term often used in the network of telecommunication is 'Bandwidth'. Bandwidth is the size of the electronic 'pipeline' through which information is carried over communication lines, measured in bits per second (bps). It determines how quickly the bits may be sent down the channels in a telecommunication medium. Bandwidth is proportional to the complexity of the data for a given level for system performance.

- *Integrated Services Digital Network (ISDN):* It is a dial-up digital connection. It can carry information at nearly five times the fastest rate achievable with plain old telephone service.
- *T-1:* It is the backbone of digital service provided to the end user. It transmits voice and data digitally at 1.554 megabits per second (Mbps). It can be used to carry analog and digital voice, data and video signals and can even be configured for ISDN service.
- *Plain Old Telephone Service (POTS):* POTS transmits data at the rate of up to 56 Kilobits per second (Kbps) and is the most widely available telecommunication technology in the world. It is suitable for audio-conferencing, store and forward communication, internet and low bandwidth videophone conferencing.
- *Internet:* Internet has a strong impact in delivering certain kinds of care to patients. With the increasing proliferation of e-health sites on the Web today many consumers are finding access to online patient scheduling, health education, review of lab work and even e-mail consultations.

Requirement specification



Nodal hospital, where a patient is getting treated, a doctor and a remote telemedicine console having audiovisual and data conferencing facilities exist.

Referral hospital, where an expert doctor provides service and a central telemedicine server exist.

Sequence of operation is shown in **Figure 50.3**.

Applications of telemedicine in public health is shown in **Figure 50.4**.

An epidemiological surveillance:

- It can give new insight into geographical distribution and gradients in disease prevalence and valuable insight into population health assessment.
- Identifies the population at risk based on risk factor profiles.
- Helps in delineating and differentiating the risk factors in the population.
- Helps in interventional planning, assessment of interventional strategies and their effectiveness.
- Can play a pivotal role in anticipating epidemics.
- It is an essential tool in real time monitoring of diseases, locally and globally.
- Geographic information system (GIS) provides the basic architecture and analytical tools to perform spatial temporal modeling of climate, environment and disease transmission in understanding the spread of vector borne diseases. Remote sensing techniques have been recently used in this regard.
- It facilitates aggregation and integration of disperate data from diverse sources so that it can guide the formulation of public health programs and policy decisions.

Interactive health communication and disease prevention:

- It provides an easy access of relaying information to those living in remote areas.
- It supports primary, secondary and tertiary health promotion and disease prevention agendas.
- It promotes the people in adopting healthy life-styles.
- The users are exposed to a broader choice base regarding prevention, diagnosis or management of a health condition.
- It can help in peer information exchange and emotional support.
- It promotes self-care and domiciliary care practices.
- It can be a very important tool for the evaluation and monitoring of health care services.

TELEMEDICINE IN INDIA

Computer literacy is developing very fast in India. Health care providers are now looking at telemedicine as their newly found *Avatar*. Theoretically, it is easier to set up a telecommunication infrastructure in rural areas than to place hundred of medical specialists in these places. The future of

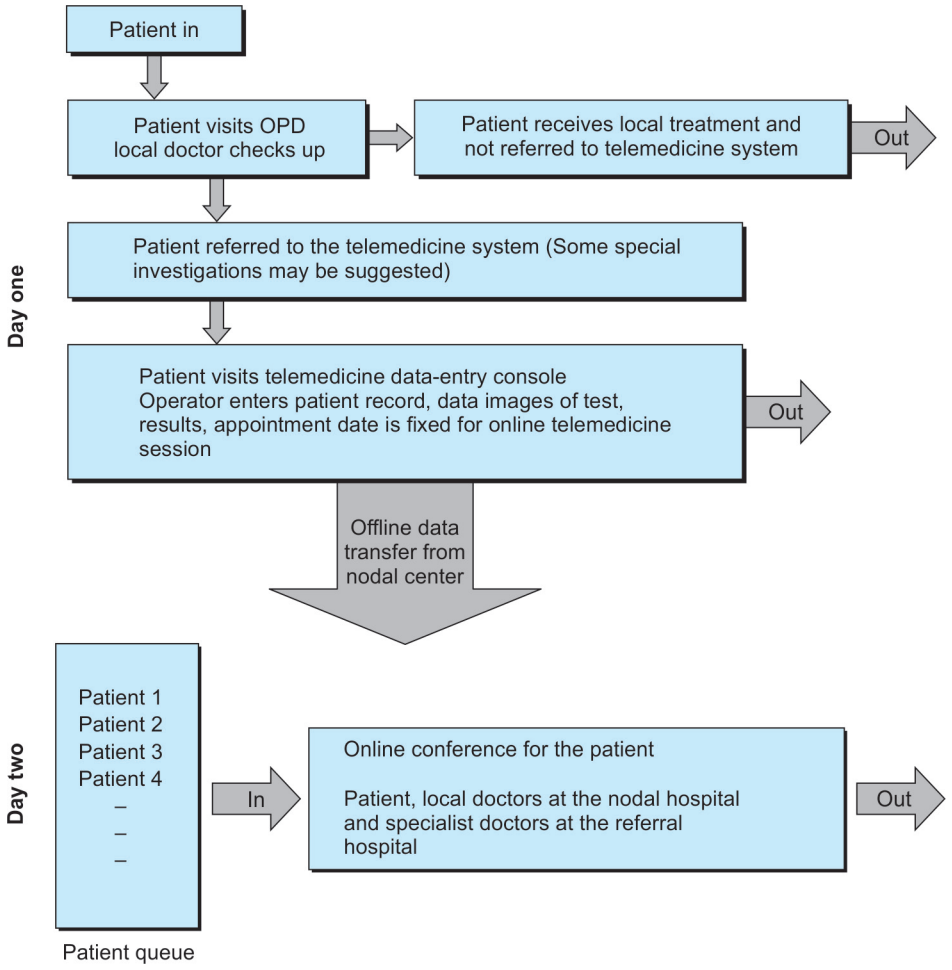


Fig. 50.3 Sequence of operation

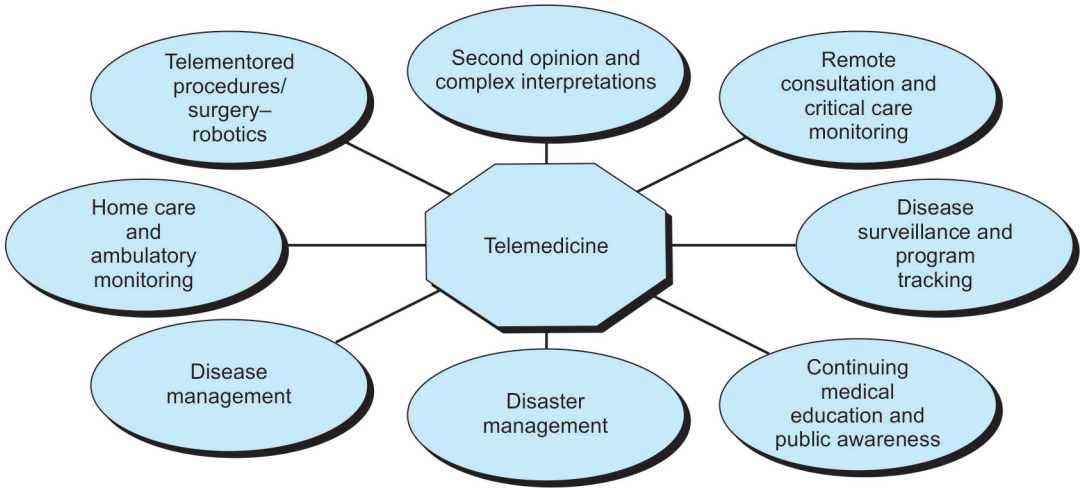


Fig. 50.4 Applications of telemedicine in public health

telecommunication lies in the satellite-based technology and fiber optic cables.

Advantages of Telemedicine in India

- Doctors are licensed to practice anywhere in India
- Maximum utilization of limited resources
- Saves travel, time and money
- Makes geography history! Distance meaningless
- Enormous continued medical education (CME) potential for general practitioners, urban trainee and teleconsultants.
- International grand rounds, web casting conferences.
- Motivation for computer literacy among doctors.
- Avoids unnecessary referrals to specialists.
- Useful in designing credits for recertification of doctors.

CURRENT EFFORTS IN INDIA

Telemedicine programs are actively supported by:

- Department of Information Technology (DIT)
- Indian Space Research Organization (ISRO)
- NEC Telemedicine Program for north-eastern states:
  - Apollo Hospitals
  - Asia Heart Foundation
  - State Government

} Corporate hospitals

The telemedicine software system developed by Center for Development of Advanced Computing (C-DAC) connects three primier medical institutes of the country viz. All India Institute of Medical sciences (AIIMS), New Delhi, Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow and Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh. Now, it is being connected to include medical centers in Rohtak, Shimla and Cuttack.

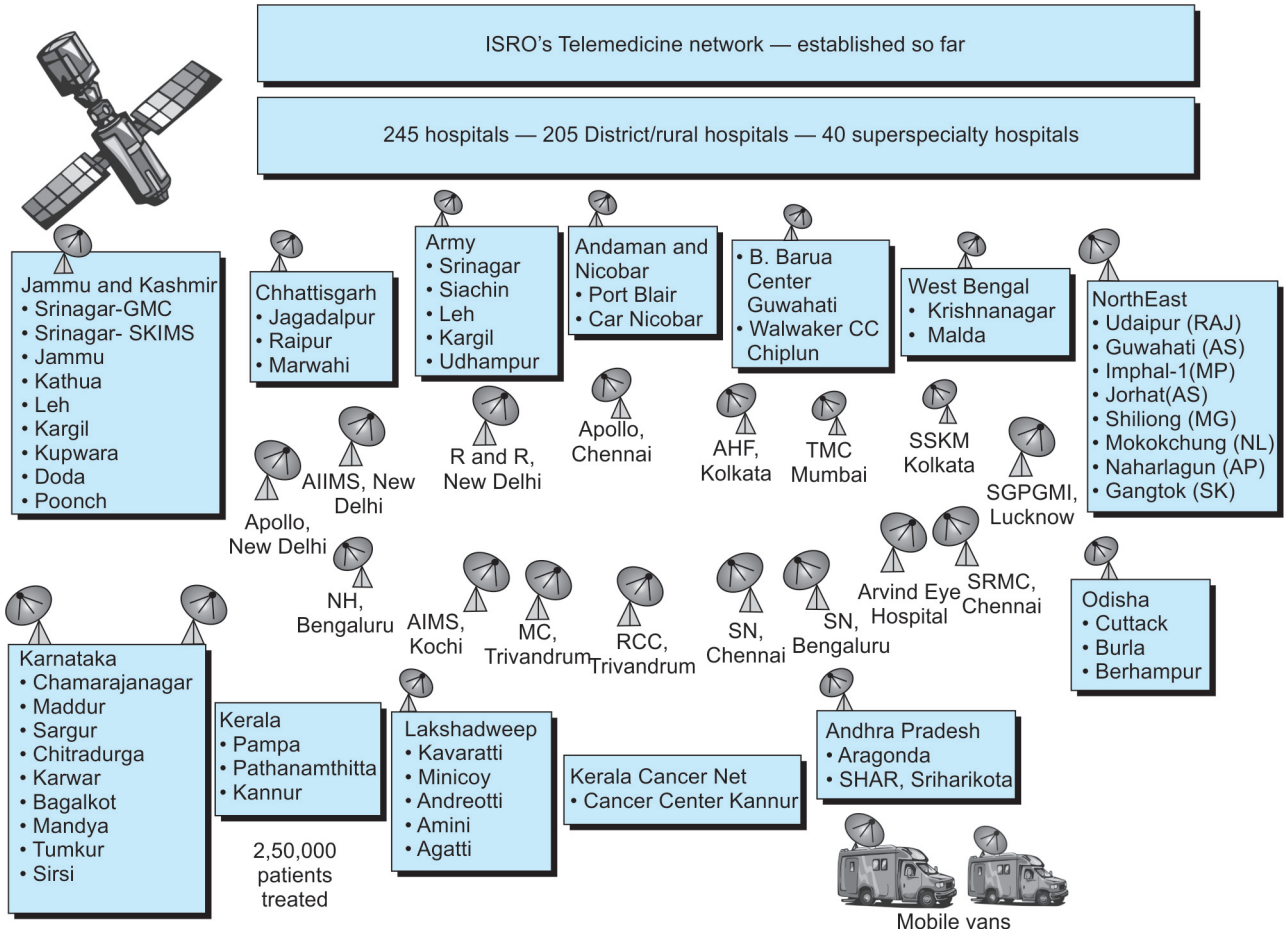


Fig. 50.5 Telemedicine programs—actively supported by ISRO

Telemedicine system has been installed in School of Tropical Medicine, Kolkata and in two district hospitals namely Siliguri District Hospital and Bankura Sammilani Hospital in West Benal. Second telemedicine project has been implemented at two Referral centers and at four nodal centers, in West Bengal.

In the past three years, ISRO's telemedicine network has expanded to connect 45 remote, rural hospitals and 15 superspeciality hospitals **(Fig. 50.5)**.

Rabindranath Tagore International Institute of Cardiac Sciences, (RTIICS), Kolkata and Narayana Hrudayalaya (NH), Bengaluru are the main telemedicine linking hub for seven states, offering services free of charge.

In Karnataka, in the past two years, the pilot project on telemedicine has provided more than 10,000 teleconsultations. This would serve as a model for the launching of 'HEALTHSAT' in future.

TEN Commandments for Success of Telemedicine

1. The responsibility must lie upon health care professionals
2. Intelligent systems must continue to be developed
3. All health care information must be digital
4. The flow of medical information must be user friendly
5. It must be mobile
6. The right medical information must be made available to the right decision maker at the right time in the right place
7. Patient integrity must be preserved without jeopardizing the access to information
8. We must take advantage of information technology as a tool for educating our patient
9. And as a tool for continuing medical education
10. We must think globally as we work locally.

Can telemedicine bridge the gap?

Yes

- It is a new vehicle for the delivery of health care.
- It makes the national health care services more accessible, available and equitable.
- It may turnout to be the cheapest as well as the fastest, way to bridge rural-urban health divide.
- The efficacy shown by ISRO's network is a proof.

Challenges

- Doctors are not fully convinced and familiar with e-medicine
- Lack of confidence among the patients about the outcome of e-medicine
- Initial investment is too high
- In India, nearly 40 percent of population live below poverty line and the basic amenities like transportation, electricity, safe drinking water, primary health care services are lacking.
- Only 65.38 percent of India's population is literate with only 2 percent being well-versed in English.
- For correct diagnosis and pacing of data, it requires advanced biological sensors and more bandwidth support
- There is no proper governing body to form guidelines
- There is no initiation taken by Government
- Technophobia by the handlers
- Poor data communication infrastructure
- Needs training of staff
- Involves medico-legal concerns
- Malpractices can occur in telemedicine
- Information may be lost due to a software glitch or hardware meltdown.

BIBLIOGRAPHY

1. Aparajitha Dasgupta and Soumya Deb : Telemedicine—A New Horizon in Public Health in India. IJCM 2008;33(1):3-7.
2. Technology and Managed Care: Is telemedicine the right tool for rural communities? J Postgrad Med 2005;51:275-8.
3. Telemedicine Society of India. www.tsi.org

CHAPTER 51

Tobacco and Health

HISTORY

The word tobacco is thought to be derived from the Arabic word '*Tabaq*', meaning 'euphoria producing herb'. It is also said that it is derived from Carib word 'tabaco', the name of the pipe in which tobacco was smoked. It is also possible to have been derived from the island of Tabago in the Carribbean. Some refer to have been originated from Tabasco state in Mexico.

The word 'Cigare' is derived from the Mayan word 'Sikar', which means to smoke. According to yet another theory the word tobacco is derived from Spanish word 'tobaca' which is a 'Y' shaped instrument used by early American Indians to inhale snuff.

Cultivation of tobacco plant probably dates back to 8000 years. The plant belongs to the family Solanaceae, grown chiefly in Turkey, Russia and India. Modern documented evidence of tobacco use has been available since the end of 15th century.

The crew members of Christopher Columbus in 1492 were the first Europeans to witness the curious habit of smoking tobacco. In 1493, Raman Pane who accompanied Columbus on this second voyage, was the first person to introduce tobacco seeds in Europe. Smoking became popular during 1500s. The queen of France, Catherine de Medici, who was suffering from migraine, was cured by Jean Nicot, who was a French ambassador to Portugal, made the queen to use powdered tobacco. Thus the tobacco plant got its generic name Nicotiana.

PREVALENCE OF SMOKING

Since tobacco is consumed more in the form of smoking than chewing, WHO has collected data only on smoking. It is predicted that about 1.9 billion people will be smoking by 2025 worldwide, 20 percent of them being teenagers. Roughly about 1 lakh children are taking up addiction everyday and 50 percent of them live in Asia. Rate of smoking has declined in the developed world. However, the tobacco consumption is rising by 3.4 percent per year since 2002 in developing world.

PUBLIC HEALTH IMPORTANCE

Tobacco use is a serious public health challenge globally. It has assumed the dimension of an epidemic resulting in enormous disability, disease and death. It is estimated that 5.4 million preventable deaths occur globally every year attributable to tobacco smoking, 70 percent of which being in developing countries and more than 6,00,000 people die annually from second hand smoke. Thus tobacco kills over 2200 people every day. At this rate it is expected to double by 2020. In addition to damage to personal health, tobacco use results in severe societal costs like reduced productivity, health care burden, environmental damage and poverty of the families.

Thus, consumption of tobacco is a social problem, an economic problem and a health problem. It is a social problem

because it is consumed with or without betel nuts, *pan* and lime. Also tobacco smoking is acquired as a habit in the company of friends and also observing the parents smoking. Often the habit develops because of inquisitiveness of experiencing smoking by teenagers. Later, they develop dependency and pointed as stigma.

It is an economic problem because money has to be spent not only for the purchase of tobacco products but also for the treatment of the consequences arising out of consuming tobacco, leading to poverty.

It is a health problem because tobacco, specially in the form of smoking causes damage to nearly every organ in the body, from head to toe. It causes many diseases and reduces the health of the smokers, resulting in decreased life span and premature deaths. Deaths caused by smoking is more than all the deaths from HIV, injuries, suicides, murders, etc. Smokers have 20 to 25 times higher risk of developing lung cancer, 2 to 3 times higher risk of having a heart attack and 3 times higher risk of sudden death. Thus, tobacco use is a serious public health challenge globally.

TYPES OF TOBACCO

Tobacco products are chiefly grouped into two groups—smoking forms and nonsmoking forms.

- *Smoking forms:* There are available as cigarettes, *beedis*, cigars and *hookah*.
- *Smokeless forms:* These are chewable tobacco, snuff, *gutka*, panmasala, *mawa*, *khaini*, dipping tobacco, *shisha* tobacco, tobacco water, tobacco paste and dissolvable tobacco (marketed as titbits).

Some of the forms are explained.

Cigarettes

This is manufactured out of cured and finely cut tobacco leaves often combined with other additives, then stuffed into a paper wrapped cylinder, 8 to 10 cms length and about 8 mm diameter. It is burnt on one side and smoke is inhaled in the mouth from the other end.

Beedis

These are hand made. About 0.5 gm of dried tobacco flakes are wrapped in a tobacco leaf and rolled in the form of an elongated cones, base being about 5 mm diameter and secured with colored thread. *Beedi* industry is a home based industry in an unorganized sector. They are widely used in India, Bangladesh, Thailand and Indonesia.

Hookah

There is burning of tobacco mixed with molasses and the resulting smoke passes through water before being inhaled. It is prevalent in some parts of India and Pakistan.

Dissolvable Tobacco

This consists of finely processed tobacco and developed in such a way that when placed in the mouth, dissolves on the tongue. It is marketed as 'Tit bits' or 'Tit tac'. Camel tobacco is the major purveyor of dissolvable tobacco.

Gutka

This is a preparation of crushed betelnuts, tobacco and sweet or savory flavorings. It is consumed like chewing tobacco.

COMPOSITION OF SMOKE

Cigarettes contain nearly 4000 chemical compounds out of which nearly 100 are toxic. Important ones are carbon monoxide, nicotine, chemical carcinogens and radioactive carcinogens.

Carbon monoxide reduces the oxygen concentration in the red cells.

Radioactive carcinogens are lead 210 and polonium 210.

Chemical carcinogens are plenty. Some of the potent ones are—polynuclear aromatic hydrocarbons (PAH), acrolein and nitrosamines. These bind with DNA of the cells and cause cancer cells.

Nicotine increases the level of dopamine in the brain, a neurotransmitter that is responsible for feelings of pressure and well-being. The acute effects of nicotine wear off within few minutes. So people will continue dosing themselves frequently by smoking throughout the day. Ultimately it results in physical and psychological dependency. So smokers continue to smoke not only to maintain pleasurable effects of nicotine but also to prevent withdrawal symptoms.

The other components of the cigarettes are shown in the **Figure 51.1**.

Health Hazards of Tobacco

This is studied under two headings:

1. Occupational health hazards of tobacco industry.
2. Health hazards due to smoking.

(*Note:* Data is not available for the hazards of smokeless forms of tobacco).

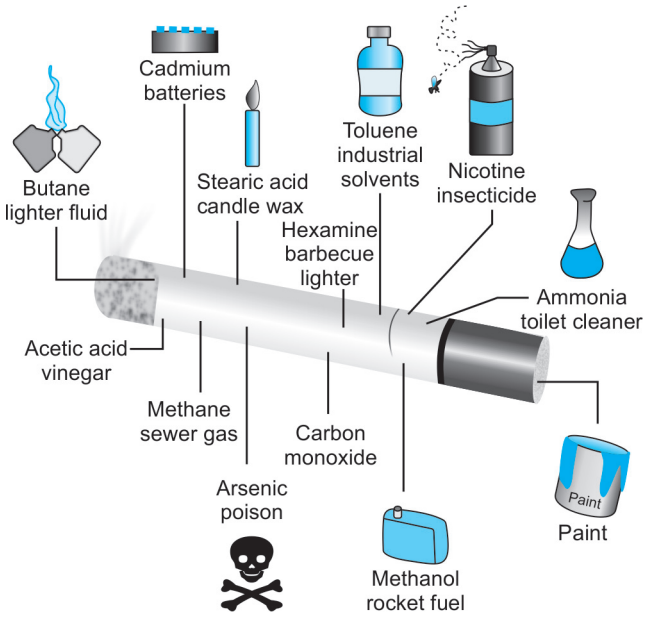


Fig. 51.1 Components of the cigarette

Occupational Health Hazards of Tobacco Industry

Tobacco being the important commercial crop, it provides employment to about 36 million people. The important groups of people affected are tobacco cultivators and *beedi* workers.

Health impact on tobacco cultivators are grouped as:

- *Irritant injuries (43%):* These are irritant contact dermatitis and allergic contact dermatitis, characterized by bullae and microvesicles respectively due to contact with chemicals, dirt, etc.
- *Intoxication injuries (12%):* This is called 'green tobacco sickness' (GTS), which is mild nicotine poisoning caused by the dermal absorption of nicotine from the surface of the wet tobacco plants.

  They will have GTS at least once a year, characterized by nausea, headache, dizziness, severe weakness, abdominal cramps, chills, perspiration, salivation, difficulty in breathing often accompanied by fluctuations in blood pressure and heart rate.
- *Musculoskeletal injuries (40%):* This occurs among the worker during 'topping' season while cutting the tobacco flowers from the tips of the plants and also during 'priming' season, while picking up the tobacco leaves. These injuries and pains occur due to various positions adopted for long periods during those seasons.
- *Chemical injuries (50%):* This is due to exposure to chemicals, pesticides, inadequate protective wears, etc.

Health Impact on Beedi Workers

These are due to inspirable dust of tobacco resulting in chronic bronchitis, bronchial asthma, and tuberculosis. They also get skin diseases, numbness of fingers due to *beedi* rolling. *Beedis* stored in the house, spoil the food resulting in nausea, vomiting.

Health Hazards due to Tobacco Smoking

These are grouped into immediate and delayed effects:

- *Immediate effects:* Fresh smokers get the feeling of relaxation, sharpness, calmness and alertness. Unpleasant experience will be nausea, cough, dizziness, rapid heart beat. Generally these vanish over time. Once the smoker develops dependency on nicotine, he/she will become a chronic smoker.
- *Delayed effects:* Smoking habit is often acquired during teenage because of influence of the friends company, due to observation of parental smoking and often due to inquisitiveness of experiencing smoking. Kids of smoking parents are three times more likely to develop the habit of smoking later in the life.

Smoking harms nearly every organ of the body in general and respiratory and cardiovascular systems in particular. Smoking results in many diseases, disabilities, reduces the lifespan of the individual leading to premature death. The effects of smoking depends upon the frequency of smoking, duration of smoking and also upon the concentration of the tar content in the cigarettes and *beedis*.

Second hand smoke is a mixture of smoke from the burning end of cigarette/beedi and the smoke exhaled from the lungs of the smoker. It lingers in the air for hours and is therefore inhaled involuntarily. So passive second hand smokers are also equally at a great risk of hazards.

While inhaling, the cigarettes burn at 700°C at the tip and around 60°C in the core. The heat breaks down the tobacco to produce various toxins.

On cardiovascular system: Nicotine results in hardening of vessels, increased viscosity of blood, arteriosclerosis, narrowing of arteries, atherosclerosis, resulting in high blood pressure, aneurysm of abdominal aorta, renal failure, thromboangitis obliterans leading to gangrene in the extremities, sudden blockage of coronary artery leads to myocardial infarction and cerebral thrombosis leads to stroke and paralysis. A recent thought is that the cigarette smoke changes the shape of the heart. Smoking also makes a strong and permanent binding of carbon monoxide with hemoglobin of red cells resulting in loss of function of red cells. Smokers have twice the risk of getting heart attack than nonsmokers.

On respiratory system: Carbon monoxide, cyanide, polynuclear aromatic hydrocarbons and acrolein present in the smoke cause alveolar damage in the lungs resulting in reduction of pulmonary capacity leading on to chronic bronchitis, emphysema, chronic obstructive pulmonary disease (COPD) and even bronchogenic carcinoma. Smoking also predisposes the lungs for tuberculosis by structural damage of the alveoli.

On reproductive system among men: Smoking reduces the blood supply to penis leading to erectile dysfunction and impotency among 50 percent of smokers.

On reproductive system among women: Nicotine interferes with the synthesis of estrogen, thus with ovulation and folliculogenesis. Smoking also interferes with embryo transport, endometrial receptivity and uterine blood flow leading to preterm delivery, stillbirth, low birth weight, sudden infant death syndrome (SIDS) and even infertility. Postmenopausal women develop lower bone density and increased risk for hip fracture.

On ophthalmic system: Smoking causes macular degeneration leading to blindness. It also leads to early cataract development.

In oral cavity: Smoking stains teeth and gums, increases the risk of periodontal diseases and bad breath (halitosis) and teeth to fall out. The acid taste due to smoking often results in aphthous ulcers and even leukoplakia.

On genitourinary system: Smoking causes damage to the kidney and even results in cancer of the kidney and bladder.

On face: Smoking reduces vitamin A level resulting in decreased blood supply to the skin of the face giving a pale and wrinkled appearance of the face.

Smoking and cancer: Chronic smoking causes many types of cancers including cancer of nose, throat, oral, tongue, pharynx, larynx, bronchus, esophagus stomach, pancreas, kidneys, bladder, bone marrow (acute myeloid leukemia) and even cervix among women.
Note: Smokeless tobacco is not a safe alternative to smoking cigarettes. Chewing tobacco can also cause oral cancer, leukoplakia and periodontal diseases.

Summary of tobacco related diseases are shown in the **Flow chart 51.1**.

HEALTH BENEFITS OF SMOKING

These are very few when compared to hazards. Since the health hazards outweigh than the benefits, the benefits are ignored. These are:

- *On digestive system:* Smoking decreases appetite and also reduces the risk of ulcerative colitis.
- *On cardiovascular system:* Occurrence of Kaposi's sarcoma is reduced among the smokers without HIV infection.
- *On central nervous system:* Smoking is a protective factor for Parkinson's disease due to nicotine as a dopamine stimulant.
- *On reproductive system among women:* Smoking reduces the risk of uterine fibroids and endometriosis.

Quitting Smoking

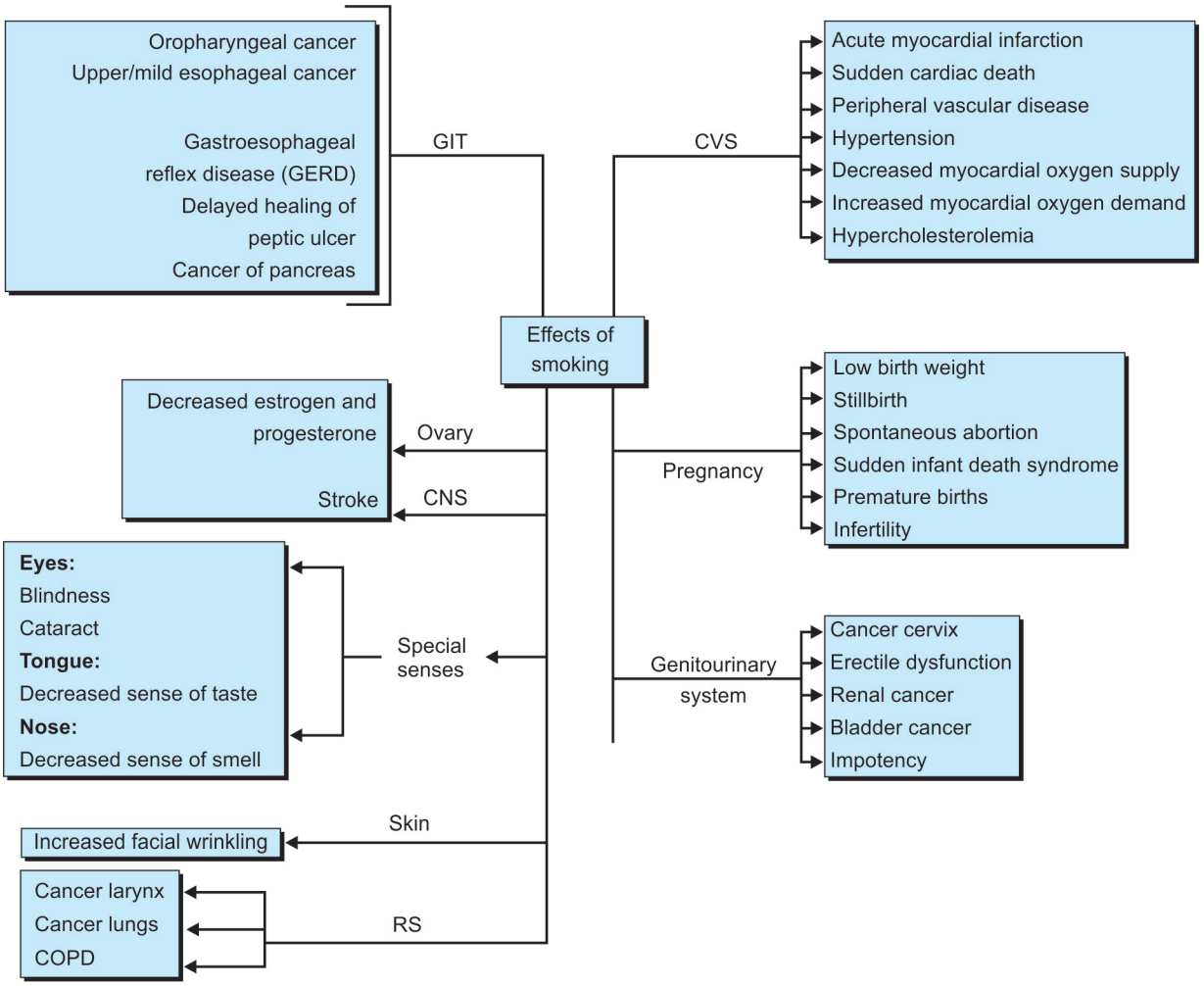
There is no single quit method of smoking that guarantees success.

- Nicotine replacement treatment (NRT) in the form of chewing gum or nasal spray.
- Zyban (Bupropian) drug helps in cessation of smoking.
- Champix (Varenicline) mimics the effect of nicotine in the body and reduces urge to smoke and also reduces withdrawal symptoms.
- Behavior modification programs.
- Alternative therapies like acupuncture and hypnosis.
- Will power.

Prevention and Control of Health Hazards of Smoking

1. *Primordial prevention*
   - Health education of school children and the population at large about the hazards of tobacco smoking and tobacco chewing.
   - Smokers are motivated to quit smoking by the following measures:
     - Strong determination
     - Regular exercises
     - Daily routine to be changed to avoid triggering for smoking or chewing tobacco
     - Chewing gum when craving for smoking occurs.
     - Avoid company of smokers
     - Avoid coffee, tea, alcohol and such other beverages, which often stimulate smoking
     - Remove ash tray, lighters which tempt for smoking
     - Seek support of family members, well-wishers, etc.
2. *Specific protection:*
   - Avoiding smoking, itself is a specific protective measure.
   - The specific protective measures for beedi workers are:
     - Wearing masks, to avoid inhalation of tobacco dust
     - *Beedi* rolling to be done in well ventilated rooms
     - Wearing gloves to protect hands
     - Wearing goggles to prevent absorption through eyes.
3. *Early diagnosis and prompt treatment:* This is done by periodical screening of chronic smokers and the beedi workers for the hazards of tobacco and encouraged them

Flow chart 51.1 Summary of tobacco related diseases



not only to take the treatment correctly and completely but also to quit smoking.

4. *Disability limitation:* This consists of giving intensive treatment, when smokers or beedi workers come with advanced disease.
5. *Rehabilitation:* This consists of rehabilitating those who have become handicapped due to surgical procedures like amputation of legs, blindness, etc. physically, mentally, socially and vocationally.

Legislative Measures

Government of India passed an Act titled 'Cigarettes and Other Tobacco Products Act' (COTPA) in 2003. The provision are:

- Prohibition of smoking in public places.
- Prohibition of direct and indirect advertisement of cigarettes and other tobacco products like film heroes holding/smoking cigarettes or burning cigarettes, etc.
- Prohibition of sale of cigarettes and other tobacco products to persons below 18 years.
- Mandatory depiction of statutory warning including pictorial warning on tobacco packs.
- English or regional language to be used for health warnings on tobacco packs.
- Ingredients to be declared on tobacco product packages.

NATIONAL TOBACCO CONTROL PROGRAM (NTCP)

Discussed under National Programs.

BIBLIOGRAPHY

1. CDC Facts Sheet. Health Effects of Cigarettes Smoking—Smoking and Tobacco use.

CHAPTER 52

Public Health Acts

These are intended to improve the health status of the citizens of the country. These have been grouped as follows:

I. Related to quality of professional education and services.
   1. The Indian Medical Council Act, 1956 (Professional conduct and ethics) and Regulations, 2002
   2. The Indian Nursing Council Act, 1947
   3. The Dentists Act, 1948
   4. The Pharmacy Act, 1948
   5. The Rehabilitation Council of India Act, 1992
   6. The Indian Medicine Central Council Act, 1970
   7. The Homeopathy Central Council Act, 1973
   8. The Consumer Protection Act (CPA), 1986.

II. Related to census, births and deaths.
   1. The Census Act, 1948.
   2. The Registration of Births and Deaths Act, 1969.

III. Related to Control of Epidemics (to prevent public health problems)
   1. The Epidemic Diseases Act, 1897.
   2. The Transplantation of Human Organs Act, 1994.
   3. The Prevention of Food Adulteration Act, 1954.
   4. The International Health Regulations.

IV. Related to tobacco and drugs control.
   1. The Cigarettes and Other Tobacco Products Act, 2003.
   2. The Narcotics and Psychotrophic Substances Act, 1985.
   3. The Drugs and Cosmetics Act, 1940.
   4. The Drugs and Magic Remedies (Objectionable Advertisements) Act, 1955.
   5. The Drugs (Control) Act, 1948.

V. Related to maternal health and women empowerment.
   1. The Medical Termination of Pregnancy Act, 1971 (MTP, Act).
   2. The Maternity Benefit Act, 1961.
   3. The Family Court Act, 1984.
   4. The Dowry Prohibition Act, 1961.
   5. The Immoral Traffic (Prevention) Act, 1956.
   6. The Prenatal Diagnostic Techniques (Regulation and prevention of misuse) Act, 1994.
   7. The Hindu Succession Act, 1956.
   8. The Indecent Representation of Women (Prohibition) Act, 1986.
   9. The Commission of Sati (Prevention) Act, 1987.

VI. Related to child protection and health.
   1. Prenatal Diagnostic Techniques (Prohibition of sex selection) Act, 1994.
   2. The Infant Milk Substitutes, Feeding Bottles and Infant Foods (Regulation of production, supply and distribution) Act, 1992.
   3. The Juvenile Justice Act, 2000.
   4. The Child Labour (Prohibition and regulation) Act, 1986.
   5. The Child Marriage Restraint Act, 1929.

VII. Related to the welfare and rehabilitation of disadvantaged.
   1. The Persons with Disabilities (Equal opportunity, protection of rights and full participation) Act, 1995.
   2. The National Trust for Welfare of Persons with Autism, Cerebral Palsy, Mental Retardation and Multiple Disabilities Act, 1999.
   3. The Mental Health Act, 1987.

4. The Scheduled Castes and the Scheduled Tribes (Prevention of astrocities) Act, 1989.

VIII. Related to health, welfare and safety of industrial workers.
1. The Factories Act, 1948.
2. The Mines Act, 1952.
3. The Employees State Insurance Act, 1948.
4. The Workmen's Compensation Act, 1923.
5. The Minimum Wages Act, 1948.
6. The Contract Labour Act, 1970.
7. The Dangerous Machine Act, 1983.
8. The Plantation Labour Act, 1951.
9. The Minimum Wages Act, 1948.
10. The Bonded Labour System (Abolition) Act, 1976.
11. The Trade Union Act, 1926.
12. The Dock Workers Act, 1986.

IX. Related to environmental health.
1. The Environment (Protection) Act, 1986.
2. The Biomedical Waste (Management and handling) Rules 1998.
3. The Municipal solid waste (Management and handling) Rules 2000.
4. The Hazardous Waste (Management and handling) Rules, 1989.
5. The Public Liability Insurance Act, 1991.
6. The National Environment Tribunal Act, 1995.
7. The Air (Prevention and control of pollution) Act, 1974.
8. The Water (Prevention and control of pollution) Act, 1974.
9. The Atomic Energy Act, 1962.
10. The Insecticides Act, 1988.
11. The Motor Vehicles Act, 1988.
12. The Wild Life (Protection) Act, 1942.

X. Related to promotion of voluntary work.
1. The Red Cross Society (Allocation of property) Act, 1936.
2. The Societies Registration Act, 1860.

THE CONSUMER PROTECTION ACT, 1986

Parliament of India has provided this Act, to the purchaser (the consumers, i.e. patients) a forum for speedy redressal of their grievances against providers of services, including doctors in a quick, efficacious and economic way. Thus, doctors are also under the same obligation to compensate the patient for any deficiency in the quality of their services.

Consumers with complaints can approach the Commissions at the District, State and Central level. There is no court-fee and the consumers do not have to go through lawyers but can plead their own cases. The decision will be given within 3 to 6 months, unlike civil courts.

Under this Act, a complaint means any written allegation made by complainant in regard to one or more of the following:

- He has suffered a loss or damage as a result of any unfair trade practice adapted by any trader
- The goods or service mentioned in the complaint suffer from one or more defects
- A trader has charged for the goods a price in excess of what is fixed by the law or displayed on the packet of goods.

Under this act 'negligence' means a breach of duty of care by the Doctor.

Doctors in charitable clinics providing free services or working in Government hospitals are exempted from this Act. Doctors with independent practice or working in private hospitals/nursing homes or paid by insurance firm for treatment of a client, are liable for any negligence under this Act.

This Act recognizes six rights of the consumers, namely right to safety, right to be informed, right to choose, right to be heard, right to seek redressal and right to consumer education.

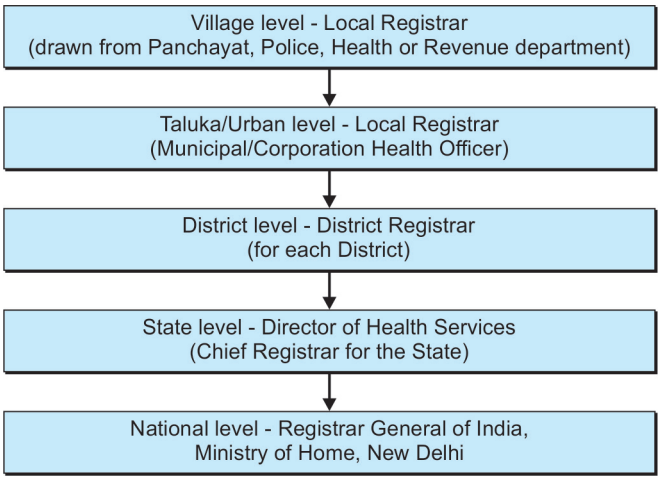
If the compensation asked for is less than 5 lakhs, the complaint can be filed in the District Forum; if the compensation is between 5 and 10 lakhs, the complaint can be filed in the State Forum and more than 10 lakhs, in the National Commission, Delhi. The Imprisonment may vary from 1 month to 3 years with fine not less than ₹20,000.

REGISTRATION OF BIRTHS AND DEATHS ACT, 1969

Births and Deaths are the vital events in the country. Knowledge about these events are essential to understand the various indicators, demography, health and civil needs, thereby the Government can plan and implement health activities, family welfare programs, etc. which in turn will be useful for socioeconomic development of the country.

To achieve this objective and to have an uniform registration in the country, the registration of Births and Deaths Bill was introduced in 1967 and was placed on the State Book in 1969 as the Registration of Births and Deaths Act 1969 to collect and compile vital statistics. The Act came into force from 20.08.1970. Accordingly the Births and Deaths have to be registerd compulsorily within 14 days and 07 days of the incident respectively. If registered after the date of expiry but within 30 days of its occurrence, shall be registered only by written permission from the prescribed authority, i.e. Registrar on payment of the prescribed fee. Beyond one year, it can be registered by First Class Magistrate on payment of prescribed

Flow chart 52.1 The channel of collection and sending information



fee. Registrars are authorized to collect and register births and deaths occurring within his/her administrative area and forward the data of vital events to higher officer periodically. The channel of collection and sending information is as follows **(Flow chart 52.1)**.

His office will be in contact with the Regional Office of WHO. On the basis of the data received from all states of the country, Registrar General of India will bring out an annual report titled, 'Vital Statistics of India'.

The local Registrar in rural areas will collect the information of vital events from the *chowkidars*, head of the family, panchayats, medical officer, persons in charge of burning *ghats* or buriyal grounds. In urban areas, this data is collected from hospitals and nursing homes. Local registrar will also collect the information frm persons in charge of police stations, hostels and *dharmashalas*.

Limitations in Registration

- Wide scattering of villages
- Illiteracy and ignorance about registration among the people
- Lack of proper maintenance of records
- Negligence by village *chowkidars*
- Deaths among those, who do not possess any property are often not registered
- False registration can take place
- Public health department has no powers to deal with the deafulters. Even if defaulters are prosecuted, punishment is nominal
- Lack of medical personnel in interior areas.

Recommendations for the Improvement

- Law should be properly framed
- Those doing derelication of duty must be penalized
- The existing system should be reorganized and strengthened.

BIBLIOGRAPHY

1. Government of India. The Gazette of India; Consumer Protection Act, New Delhi 1986.
2. Kishore J. National Health Programs of India. 5th edn, 2005.

Annexure

SOME STALWARTS AND THEIR CONTRIBUTION TO COMMUNITY MEDICINE

Stalwart	Contribution
1. Fracastorius (1483-1565)	• Theory of 'Contagion' and its transmission before discovery of microbes
2. Thomas Sydenham (1624-1689)	• Differential diagnosis of scarlet fever, malaria, dysentry, cholera
	• Initiated science of clinical methods
3. Bernado Ramazzini (1633-1714)	• Father of occupational medicine
	• Systematic study of occupational diseases
4. Percivall Pott (1713-1788)	• Discovered that soot causes scrotal cancer
5. Edward Jenner (1796)	• Smallpox vaccine
6. Edwin Chadwick (1800-1890)	• A report of 'Sanitary conditions of laboring population'
7. Pattenkofer (1819-1901)	• Multifactorial etiology of disease
8. Louis Pasteur (1822-1895)	• Demonstration of bacteria in air
	• Antirabic treatment
9. Lister (1827-1912)	• Antiseptic properties of carbolic acid
10. John Snow (1848)	• Investigation of epidemic of cholera in London
11. Robert Koch (1843-1910)	• Demonstration that anthrax is caused by a bacillus
	• Koch's postulates
12. Hansen (1873)	• Discovery of lepra bacilli
13. Manson (1878)	• Filariasis, the first disease to be proved to be transmitted by a vector (mosquito)
14. Kitasato (1889)	• Isolated *Clostridium tetani*
	• Extracted tetanus toxin and anti-toxin
15. Ronald Ross (1898)	• Mechanism of transmission of malaria through female anopheles mosquito
16. Alexander Flemming (1881-1955)	• Discovery of penicillin
17. Calmette and Guerin (1906)	• BCG Vaccine
18. von Pirquet (1907)	• Mantaux test for detection of delayed hypersensitivity
19. Semple (1911)	• Prepared BPL Vaccine
20. Lord Dawson (1920)	• The concept of health center
21. Paul Muller (1939)	• Discovery of in insecticidal property of DDT
22. Norman Gregg (1941)	• Teratogenic properties of rubella virus
23. Salk (1955)	• Killed vaccine against poliomyelitis
24. Sabin (1957)	• Live vaccine against poliomyelitis
25. Witkor and Kaprowski (1964)	• Tissue culture vaccine against rabies
26. Germanier and Furer (1975)	• Live, oral typhoid vaccine

EDWARD JENNER (1749–1823)

Edward Jenner was born on May 17, 1749 in Berkeley, England. At that time, smallpox used to cause terrible epidemics.

At the age of 14, Edward Jenner became an apprentice to Dr Lundlow, a surgeon in Sodbury. He was impressed by a maid servant who sought his advice for a skin eruption, which she insisted could not be smallpox, under any circumstances. When questioned as to how she could be so sure of this, the young woman explained that she had contracted cowpox, a disease of bovine animals and thus was protected against smallpox. For twenty years, Jenner carefully recorded every account he received on this topic. Meanwhile he became a leading physician. He was the first to describe the signs of mitral stenosis.

On May 14, 1776, Sarah Nelmes, a wet nurse, consulted Edward Jenner because of cowpox. Using scrapings obtained from her lesions, he inoculated them into an eight-year-old boy, James Phillips. Two months later, he repeated the same procedure in the same child, but this time using a smallpox preparation, as a challenge.

The child did not develop any evidence of disease smallpox. Edward Jenner had won his gamble. He repeated the experiment on other children, with the same success. Results of his work were published in 1798 and he quickly acquired international fame. As all great scientists, Jenner also had to confront his adversaries. He foresaw the possible eradication of smallpox, which was achieved about one hundred fifty years later. Jenner spent rest of his life vaccinating the poor. He died on January 26, 1823 and left a decisive heritage to medicine and to all humanity.

SIR EDWIN CHADWICK (1800–1890)

He was a lawyer in England. His reports on poor law reform and health of labor classes initiated the 'sanitary era of public hygiene'. His report on 'the sanitary conditions of the laboring population' in 1842, in England, focused the attention of the people and government on the urgent need to improve public health. He was convinced that the diseases like cholera and typhoid were the outcome of poor standard of living conditions. His suggestions were simple, i.e. to rectify the defects of water supply and disposal of excreta. He also recommended the government to have a department concerned with the public health. The outcome of his recommendations was the passing of the 'Public Health Act of 1848'.

Thus, Chadwick's idea was that man's environment determined his health and this is undoubtedly true.

LOUIS PASTEUR (1822–1895)

He was born at Dole (JURA). His father was a soldier of Napoleon. As a youth, he was a fisherman. He became a science graduate, at Paris in 1847.

He is memorable for his work on:

- Molecular dissymmetry (1848)
- Fermentation of lactic acid (1857)
- Concept of aerobism and anaerobism (1863)
- Prophylactic disinfections of wine and milk (1865) by partial heating (pasteurization)
- Studies on anthrax and chicken cholera (1877)
- Discovery of rabies vaccine (1885).

The institute where he was working was named after him as Pasteur Institute. He retired as the Director of that institute in Paris.

His contribution to medical science has been commemorated by Pasteur Institutes all over the world.

Louis Pasteur died in 1895. After his death, a mausoleum was built in the Pasteur Institute.

JOSEPH LISTER (1827–1912)

He was born on April 5, 1827, in Upton, Essex, England. His father, Joseph Jackson Lister, was the first to design special lenses for an achromatic microscope.

Completed medical graduation, in 1852, in London and became professor of surgery in 1860. Noticing the staggering mortality in surgical wards due to tetanus and gas gangrene, Lister took this up as his life's mission to overcome this. He came to conclusion that those victims had injuries exposed to the air with broken skin, while the ones who survived the surgery had their skin intact on the site of the wound. After making an exhaustive study, came to conclusion that 'microbes' were the real culprits behind these fatal diseases. Thus he became the hunter of microbes and concluded that the destruction of these microbes could be carried out effectively by means of a chemical reagent. One day he came across a report saying that extensive application of phenol (carbolic acid) at the sewage works resulted the disappearance of odor due to putrefaction. This information was an eye opener on him.

The day August 12, 1865 is a red letter day in the history of modern surgery. He applied carbolic acid on the wound of a leg of a boy who had sustained fracture of the bone and carefully set the bone and put bandage after soaking the lint heavily with concentrated phenol. History was created when the boy rapidly recovered. Thus Lister carried out a surgical revolution.

In 1867, he published papers on successful antiseptic surgery, i.e. destruction of microbes by application of chemical reagent during surgery, it was known as Listerism.

In 1878, Pasteur suggested a modified version, i.e. 'Aseptic Surgery', wherein the instruments used for surgery were thoroughly sterilized before surgery.

Lister was appointed as queen Victoria's personnel surgeon. He was the first doctor to receive the rare Honor of title 'Baron Lister' he died on Feb 10, 1912 at Walmer, England.

Lister is called as the father of antiseptic surgery.

ROBERT KOCH (1843–1910)

Born is Clausthal, Hannover, he took his medical degree at Gottingen in 1866. As a district physician at Wallstein, he began his studies with anthrax bacillus. His bacteriological results were violently opposed by Paul Bert but completely confirmed by Pasteur.

In November 1877, Koch published his staining methods.

In 1882, he discovered *Tubercle bacillus* and published his postulates (Koch's postulates) meanwhile he and his assistants perfected the idea of steam sterilization.

In 1883, he visited Egypt and India and discovered cholera Vibrio and its transmission through water and food. Incidentally he found the organisms of Egyptian ophthalmia in 1883, which is named after him as Koch's week's bacillus, for which he received a donation of 1,00,000 marks from Prussian state.

In 1885, he was appointed as Professor of hygiene and bacteriology at the University of Berlin.

In 1891, he became the Director of the Institute for Infectious Diseases. In 1893, he wrote an important paper on water-borne epidemics, showing how they may be prevented by proper filtration.

In 1896, he investigated Rinderpest in South Africa.

In 1897, he produced new tuberculin.

In 1898, he investigated malarial fever in Italy.

In 1902, he studied Rhodesian Red Water Fever, horse sickness, trypanosomiasis and in the same year established methods of controlling typhoid.

In 1905, Robert Koch received Nobel Prize.

In 1906, he introduced 'Atoxyl' for the treatment of sleeping sickness. He died of heart failure on May 27, 1910 at the age of seventy-seven.

RONALD ROSS (1857–1932)

He was born on May 15, 1857, at Almora in India. He had his education at London. After graduating in medicine, he returned to India in 1879.

First he tried music. Later he shifted to literature and wrote novels. He was discouraged when they were not published. Later he joined Indian Medical Service. He saw Indians dying of cholera, small pox, malaria and plague. Yet, he had not an eye for microbes. After literature, he chose mathematics as his past time. With failure again he resolved to take microbe hunting as his main mission.

He went to London, studied bacteriology and returned to India in 1892 with a vow to combat malaria. He was discouraged because he could find nothing in the blood smear of malarias. So he went back to London to give up medicine. But this time Dr Patrick Manson, who was greatly obsessed with mosquitoes showed him development of Laveran's plasmodium parasites in the smear.

Ross returned to India in 1895 and carried out his research study at Secunderabad. In 1897, he discovered the development of the malarial parasites as oocyst on the stomach wall of the infected female Anopheline mosquito. Later he also tracked down the malarial parasites from the blood of infected birds through anopheles mosquito.

In 1902, Ross received the Nobel Prize. He returned to England, became the Director of Ross Institute and Hospital, founded in his honor. He died on September 16, 1932.

CALENDAR OF IMPORTANT DATES AND EVENTS

Month	Date	Event
January	1	New Year Day
	30	Anti-Leprosy Day
February	1	Deaf and Dumb Day
	4	World Cancer Day
	28	National Science Day
March	1	World Science Day
	8	International Women's Day
	9	Anganwadi Worker's Day
	10	World Kidney Day
	15	World Consumer Rights Day
	16	World Immunization Day/ Measles Day; World Glaucoma Day
	22	World Water Day
	24	World Tuberculosis Day
April	7	World Health Day
	17	Hemophilia Day
	25	World Malaria Day
	30	Child Labor Day
May	1	World Labor Day (May Day)
	12	Red Cross Day
	13	Mother's Day
	15	International Day of the Family
	17	World Hypertension Day
	31	World No Tobacco Day
June	5	World Environment Day
	14	World Blood Donors' Day
	26	International Day of Drug Abuse and Illicit Trafficking

Month	Date	Event
July	1	Doctor's Day (India)
	8	World Zoonotic Day
	11	World Population Day
August	1	World Breastfeeding Day
	1-7	World Breastfeeding Week
	15	Independence Day (India)
	20	World Mosquito Day
September	1-7	National Nutrition Week
	5	Teachers' Day
	8	International Literacy Day
	10	World Suicide Prevention Day
	20	International Peace Day
	21	Alzheimer's Day
	28	World Rabies Day; World Heart Day
October	1	Blood Donation Day; World Elders Day
	3	World Habitat Day
	8	World Sight Day
	10	World Mental Health Day (Second Thursday)
	11	National No Tobacco Day
	13	Anti-Natural Disaster Day
	14	World Standards Day
	16	World Food Day
	29	World Stroke Day
November	2	Red Cross Flag Day
	9	Legal Service Day
	11	National Filaria Day
	14	World Diabetes Day
	16	World Day of Remembrance for Road Traffic Victims
	18	World Epilepsy Day
	19	World Chronic Obstructive Pulmonary Disease Day; National Integration Day
	24	NCC Day
	25	International Day for the Elimination of Violence against Women
December	1	World AIDS Day; International Pollution Prevention Day
	2	National Pollution Prevention Day
	3	World Disabled Day
	8	National Day for the Mentally Retarded
	10	World Human Rights Day
	11	UNICEF Day

LIST OF WORLD BREASTFEEDING WEEK THEMES SINCE 1992

1992	–	Baby Friendly Hospital Initiative.
1993	–	Mother Friendly Work Place.
1994	–	Infantfeeding Act; Making the Act Work.
1995	–	Breastfeeding; Empowering Women.
1996	–	Breastfeeding; A Community Responsibility.
1997	–	Breastfeeding; Nature's Way.
1998	–	Breastfeeding; The Best Investment.
1999	–	Breastfeeding; Education for Life.
2000	–	Breastfeeding; It Is Your Right.
2001	–	Breastfeeding; In The 'Information Age'.
2002	–	Breastfeeding; Healthy Mothers And Healthy Babies.
2003	–	Breastfeeding In A Globalized World For Peace And Justice.
2004	–	Exclusive Breastfeeding; The Gold Standard; Safe, Sound, Sustainable.
2005	–	Breastfeeding and Family Foods—Loving and Healthy.
2006	–	Infant Milk Food (IMF) Act; Making it Known to People.
2007	–	Breastfeeding: The 1st hour: Save one million babies.
2008	–	Breastfeeding: Mother support; Going for the Gold.
2009	–	Breastfeeding: A Vital Emergency Response; Are you Ready?
2010	–	Breastfeeding: Just 10 Steps! The Baby Friendly Way!!
2011	–	Talk to me! Breastfeeding a 3D experience.
2012	–	Taking Stock of Policies and Programs.
2013	–	Breastfeeding support: Close to Mothers.

LIST OF WORLD HEALTH DAY THEMES

1950	–	Know Your Own Health Services.
1951	–	Health for Your Child and the World's Children.
1952	–	Healthy Surroundings Make Healthy People.
1953	–	Health is Wealth.
1954	–	The Nurse, Pioneer of Health.
1955	–	Clean Water Means Better Health.
1956	–	Destroy Disease Carrying Insects.
1957	–	Food for Health.
1958	–	Ten Years of Health Progress.
1959	–	Mental Illness and Mental Health in the World Today.
1960	–	Malaria Eradication—A World Challenge.
1961	–	Accidents Need Not Happen.
1962	–	Preserve Sight—Prevent Blindness.
1963	–	Hunger, Disease of Millions.
1964	–	No Truce for Tuberculosis.
1965	–	Smallpox—Constant Alert.
1966	–	Man and His Cities.
1967	–	Partners in Health.
1968	–	Health in the World of Tomorrow.
1969	–	Health, Labor and Productivity.

1970	–	Early Detection of Cancer Saves Lives.
1971	–	A Full Life Despite Diabetes.
1972	–	Your Heart is your Health.
1973	–	Health Begins at Home.
1974	–	Better Food for a Healthier World.
1975	–	Smallpox—Point of no Return.
1976	–	Foresight Prevents Blindness.
1977	–	Immunize and Protect Your Child.
1978	–	Down with High Blood Pressure.
1979	–	A Healthy Child, a Sure Future.
1980	–	Smoking or Health ; Choice is Yours.
1981	–	Health For All by the Year 2000.
1982	–	Add Life to Years.
1983	–	Health For All by the Year 2000; The Count-down has Begun.
1984	–	Children's Health ; Tomorrow's Wealth.
1985	–	Healthy Youth ; Our Best Resource.
1986	–	Healthy Living ; Everyone a Winner.
1987	–	Immunizing Chance for Every Child.
1988	–	Health For All; All For Health.
1989	–	Let Us Talk Health.
1990	–	Think Globally Act Locally; Our Planet (One Earth One Family)
1991	–	Should Disaster Occur Be Prepared.
1992	–	Heart Beat; Rhythm of Life.
1993	–	Handle Life With Care ; Present Violence and Negligence.
1994	–	Oral Hygiene.
1995	–	World Free Polio By 2000 AD.
1996	–	Healthy City For Better Living.
1997	–	Emerging Infectious Diseases ; Global Alert and Global Response.
1998	–	Pregnancy is Precious; Let Us Make it Safe.
1999	–	Active Ageing Makes the Difference.
2000	–	Safe Blood Starts With Me; Blood Saves Lives.
2001	–	Mental Health; Stop Exclusion – Dare to Care.
2002	–	Move For Health; Prevention of Noncommunicable Diseases.
2003	–	Shape the Future of Life ; Healthy Environments for Children.
2004	–	Road Safety is No Accident.
2005	–	Make Every Mother and Child Count.
2006	–	Working Together For Better Health.
2007	–	Invest in Health; Build a Safer Future (International Health Security.
2008	–	Protect Health from Climate Change (60th Anniversary of WHO).
2009	–	Save Lives, Make Hospital Safe in Emergencies.
2010	–	Join the Global Movement to Make Cities Healthier.
2011	–	Combat Drug Resistance—No Action Today; No Cure Tomorrow.
2012	–	Ageing and Health: Good Health Adds Life to Years.
2013	–	High Blood Pressure

GOALS TO BE ACHIEVED BY 2000–2015

Year	Goal to be achieved
2003	• Enactment of legislation for regulating minimum standard in Clinical Establishment/Medical Institutions.
2005	• Eradication of Poliomyelitis and Yaws.
	• Elimination of Leprosy.
	• Establishment of an integrated system of surveillance, National Health Accounts and Health Statistics.
	• Increase State sector Health spending from 5.5 to 7% of the budget.
	• 1% of total health budget for Medical Research.
	• Decentralization of implementation of public health programs.
2007	• Achieve Zero level growth of HIV/AIDS.
2010	• Elimination of Kala-Azar. Reduction of Mortality by 50% on account of TB, Malaria and other Vector and Water borne diseases.
	• Reduction of Prevalence of Blindness to 0.5%
	• Reduction of IMR to 30/1000 LB and MMR to 100/lakh LB.
	• Increase utilization of public health facilities from current level of < 20 to > 75%.
	• Increase health expenditure by Government from the existing 0.9 to 2.0% GDP.
	• 2% of total health budget for Medical Research.
	• Increase share of central grants to constitute at least 25% of total health spending.
	• Further increase of State Sector health spending to 8%.
2015	• Elimination of Lymphatic Filariasis.

MILESTONES IN VACCINATION

1976	–	First vaccination by Edward Jenner against small-pox.
1985	–	Successful immunization by Sir Louis Pasteur against rabies.
1892	–	Cholera vaccine.
1913	–	Toxoid, Antitoxin immunization against diphtheria.
1921	–	BCG vaccine.

1923	–	Diphtheria toxoid.
1923	–	Pertussis vaccine.
1927	–	Tetanus toxoid.
1937	–	Influenza vaccine.
1937	–	Yellow fever vaccine.
1949	–	Mumps vaccine.
1954	–	Salk's polio vaccine.
1957	–	Sabin's oral polio vaccine.
1960	–	Measles vaccine.
1964	–	Purified Chick Embryo Cell-Culture Vaccine by Kondo Human Diploid Cell Vaccine by Wiktor.
1962	–	Rubella vaccine.
1968	–	Type C *Meningococcus* vaccine.
1970	–	Researchers in Israel proved that injection of a peptide from a virus can induce the production of antibodies that recognize the entire virus or disease.
1971	–	Type A *Meningococcus* vaccine.
1975	–	Live vaccine against typhoid developed by Germanier and Furer.
1980	–	First commercial vaccine for hepatitis B.
1982	–	First vaccine produced through genetic engineering (vaccines for diarrhea in pigs).
1982	–	First synthetic vaccine produced from diphtheria toxin.
1985	–	Purified Vero-cell Rabies Vaccine by Merieux Institute.

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