UNIVERSITY OF ILLINOIS
COLLEGE OF MEDICINE
AT CHICAGO

Online ICU Guidebook

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HOME

- Home
- ICU Basics
- Intensive Care Topics
- Vasopressors
- Mechanical Ventilation
- Procedures + Calcs
- Core ICU
- Core CCU

Welcome to the online ICU Guidebook.
The purpose of this website is to provide residents with quick online access to information that will help during your ICU/CCU rotations.

How to use this document:
ICU Basics: basic tips for surviving your rotation. ICU daily checklist.
Intensive Care Topics: common admissions and useful algorithms.
Vasopressors: a quick reference for use of common vasopressor agents.
Mechanical ventilation: a quick reference for ventilators.
Procedures + Calculators: a collection of procedure tips, videos, notes, and useful calculators.
CORE ICU Articles: Must read ICU articles.
CORE CCU Articles: Must read CCU articles.

Other important sites:
Online Housestaff Survival Guide
UIH Clinical Care Guidelines
New-Innovations
AMION [cards]

ICU Guidebook | Basics

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General

Welcome to your ICU Month(s). These are some general rules/guidelines to follow:
Three L's to NOT DO:

- Lie (especially parts of physical exam that you did not do)
- Be Lazy
- Be Late

These are the habits to ICU success:

- Be Organized
- Be Involved
- Be Efficient
- Be Thorough
- Take Initiative
- Take Ownership of Your patients

Daily routine / Patient care

Here is a checklist that should be followed for every ICU patient:
Daily Checklist
Every day each person should have the following addressed:

1. Code Status
2. Sedation (held in am, when stopping, etc.)
3. GI Prophylaxis (most important when intubated)
4. DVT Prophylaxis
5. Fluid, electrolytes, nutrition
6. Disposition

Other daily tasks to always keep in mind:

- Monitor I/O on EVERY PATIENT with 24h totals
- Know their IV access including dates central lines have been placed
- Duration of abx use
- Duration of steroid use for shock patients

For Mechanically Ventilated Patients, always know the following:

- Date Intubated
- Size of Tube
- Vent Settings (mode/rate/volume/pressure/PEEP/FiO2)
- Peak/Plateau Pressure

Progress Notes

Organ based is generally the most thorough. For CCU, include cardiac studies in your note and cardiac systems in you're A/P:

1. CAD
2. CHF
3. EP
4. HTN
5. Lipids

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ICU Topics
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Shock
- Shock algorithm
- Septic shock
- Cardiogenic shock
- Hypovolemic shock

Pulm
- Respiratory distress
- ARDS
- COPD
- Asthma

CV
- Hypertensive crisis
- Heart failure
- Hypothermia protocol

Neuro
- Seizures
- Brain Death

ID
- Antimicrobials in the ICU
- Vancomycin dosing

Other
- Sedation
- Acid-base review
- Decision Making Capacity
- Death Pronouncement

Endo
- DKA
- HHS

ICU Guidebook | Intensive Care Topics | Shock

When evaluating a patient with hypotension, always think of the following algorithm. Think of life-threatening causes and immediately rule them out. Here are some pointers:

- ECG to r/o AMI as a cause of cardiogenic shock
- CBC to r/o acute blood loss
- Infectious workup if sepsis is suspected

Quick Links

- Surviving sepsis Guidelines
- Antimicrobials
- Sepsis
- Cardiogenic Shock
- Hypovolemic Shock

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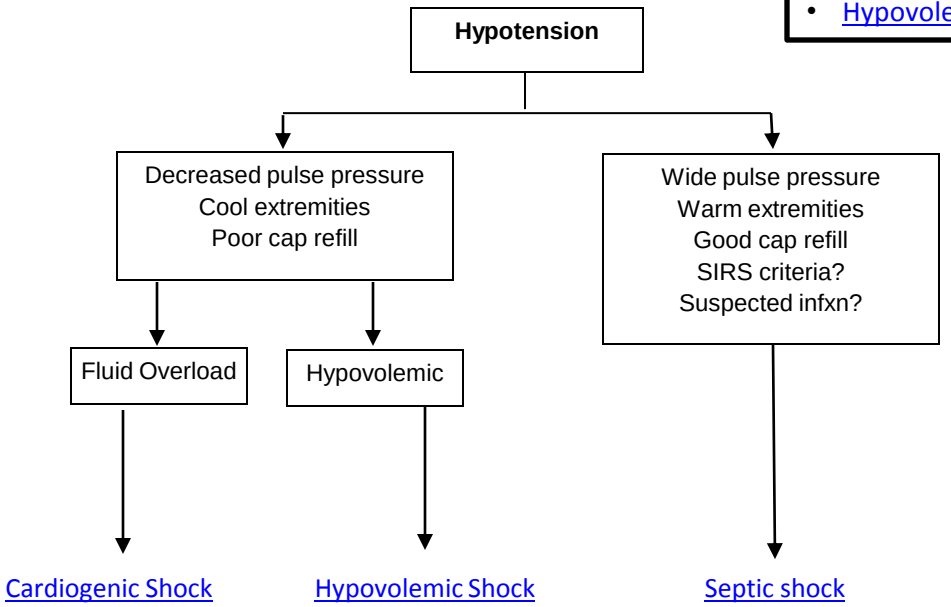

Types of Shock

Michael Johnson, PharmD
University of Illinois Chicago
November 2011

Shock Type	Cardiac Index / Pump Function	CVP/PCWP / Preload	SVR / Afterload	SvO_2 / Tissue Perfusion
Cardiogenic	↓↓	↑↔	↑	↓
Distributive ▪ SIRS ▪ Sepsis	↑ (Usually)	↓↔	↓↓	↑ (Transiently)
Hypovolemic	↓	↓↓	↑	↓
Others	Mixed (Sepsis with myocardial suppression), Obstructive			

MAP = CO X SVR
CO = Stroke Volume X HR
SV composed Afterload, Preload & Inotrope
Oxygen Delivery (DO_2) = CO X $Sa O_2$ X Hgb X 13.4

Adrenergic Receptors

Receptor	Cardiac Effect	Vascular Effect	Net
α_1	None	↑	↑ BP
α_2	Peripheral: Hypertension Central: Hypotension, bradycardia		
β_1, β_2	↑ HR, Ionotropic	↓	↑ CO
DOPA	Vasodilatation in renal, mesenteric, coronary, and intracerebral vascular beds		

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ICU Guidebook | Intensive Care Topics | Sepsis

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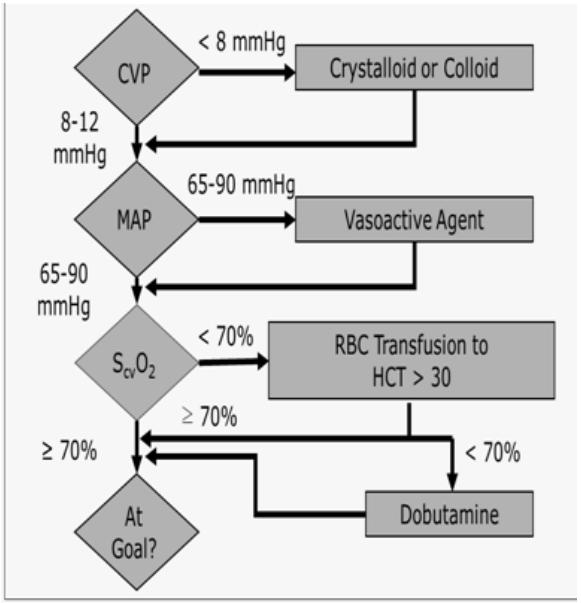
When evaluating a patient with hypotension, immediately try to assess whether you suspect sepsis, and where in the sepsis spectrum the patient falls. Does he meet SIRS criteria? Does he have a known or suspected source of infection?

Once you clarify this and you have ruled out other causes of shock, follow the algorithms below from the surviving sepsis campaign and initate EGDT. The original articles can be found in the CORE ICU folder.

Quick Links

- Surviving sepsis Guidelines
- Antimicrobials
- Sepsis calculator
- Shock
- Cardiogenic Shock
- Hypovolemic Shock

SIRS	Severe Sepsis	Septic Shock
1. T ≤ 36 or > 38 C 2. HR ≥ 90 bpm 3. RR ≥ 22 bpm or PaCO2< 32 mmHg 4. WBC ≥ 12,000 or ≤ 4,000 cells/mm^3 or > 10% bands	Sepsis *plus* Organ dysfunction • Hypotension • Hypoxia • Oliguria • Acidosis • Obtundation	Severe sepsis *with* Hypotension *Despite* Adequate fluid Resuscitation
Sepsis At least 2 SIRS criteria *plus* Infection	**Mortality: 25-30 %**	**Mortality: 40-70 %**



Rivers et al. *N Engl J Med.* 2001;345:1368-77.

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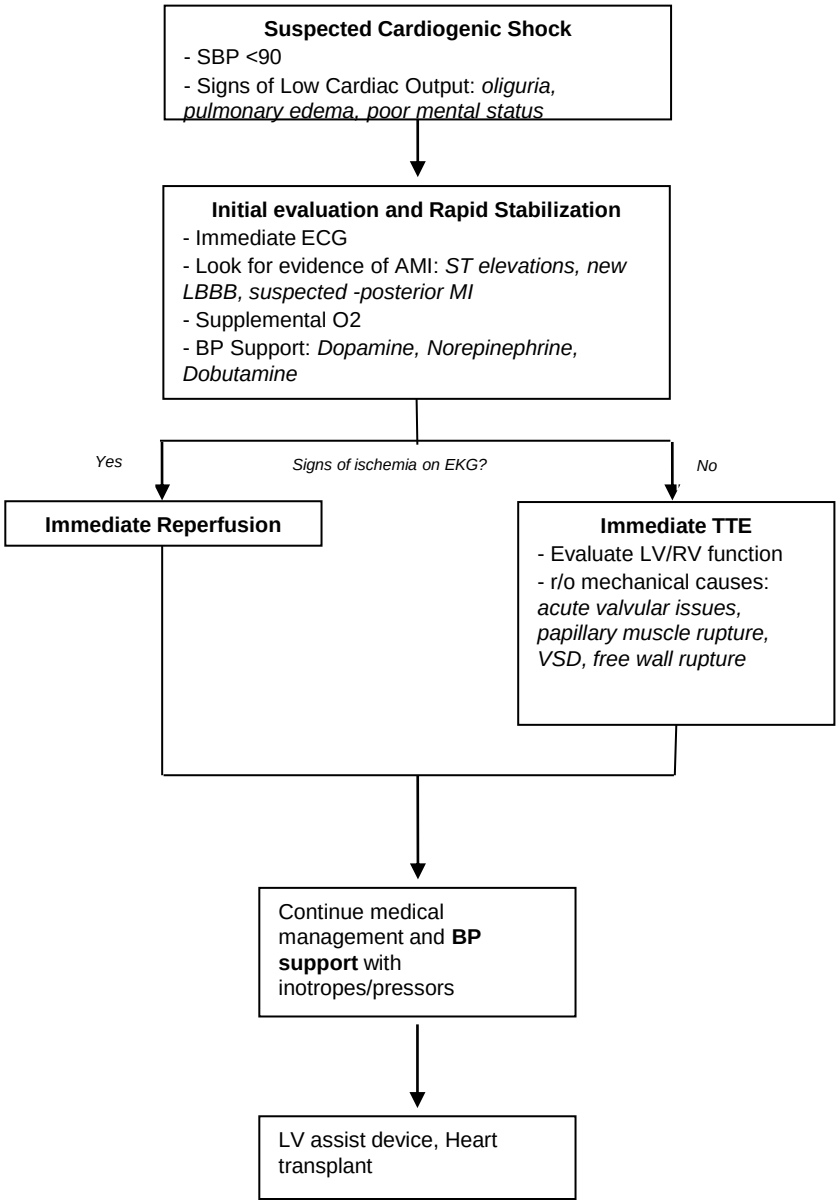

Quick Links

- Heart Failure
- ACS UIH Guidelines
- ADHF UIH Guidelines
- Shock
- Septic shock
- Hypovolemic Shock

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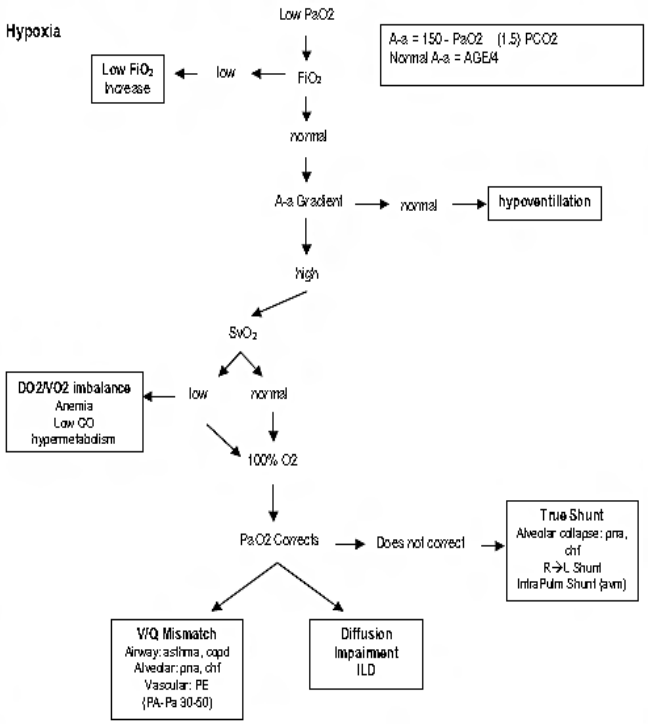

Concerning levels from an ABG & VS that may suggest future need for intubation:

** PaO2/FiO2 <300-200*
** Increased PaCO2 + tachypnea*
** RR >30-35*
** PaO2<50 on 50% or greater FiO2*
** PaCO2 >55 w/ nL lung fxn (I.e no COPD, fibrotic lung dz)*
** pH <7.3*

Quick Links

- ABG Calculator
- A-a gradient
- Wells criteria for PE
- Decision to Intubate
- Asthma
- COPD

Oxygen Delivery Devices/FiO2

Device	Capacity	Flow (L/min)	FiO2
Nasal Canula	50mL	1	0.21-0.24
*FiO2 decreases as minute ventilation increases		2	.24-.28
		3	.28-.34
		4	.34-.38
		5	.38-.42
		6	.42-.46
O2 Face Mask	150-250mL	5-10	.40-.60
Mask-Reservoir Bag	750-1250mL		
Partial Nonrebreather		5-7	.35-.75
Nonrebreather		5-10	.4-1

Tobin, ICU Book, pg 407

Contraindications for NIPPV/BiPAP/CPAP: severe encephalopathy, inability to cooperate/protect airway, high risk of aspiration, inability to clear secretions, upper airway obstxn, hemodynamic instability

Hypercapnea

- Respiratory Drive
  - Chemoreceptors
    - Met alkalosis
  - Primary neuro
    - Brainstem stroke
    - Tumor
    - Primary alveolar hypoventilation
  - Secondary neuro
    - Sedatives
    - CNS infection
    - Hypothyroidism
- NM system
  - Neuropathies
    - cervical cord injury
    - phrenic nerve injury
    - Guillan-Barre
    - ALS, polio
  - NMJ
    - myasthenia gravis
    - Lambert Eaton
  - Myopathies
    - Diaphragm injury
    - PM/DM
    - Musc. dystrophy
    - Hyperphosphatemia
- Vent. Apparatus
  - Chest Wall
    - obesity
    - kyphosis/scoliosis
  - Pleura
    - fibrosis,
    - effusion
  - lung parenchyma
    - emphysema
    - fibrosis
    - CHF,
    - PNA
  - Airways
    - asthma,
    - COPD
    - bronchiectasis,
    - CF
    - OS

ICU Guidebook | Intensive Care Topics | ARDS

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INCLUSION CRITERIA: Acute onset of
1. PaO2/FiO2 ≤ 300 (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

VENTILATOR SETUP AND ADJUSTMENT
1. Calculate predicted body weight (PBW)
Males = 50 + 2.3 [height (inches) - 60]
Females = 45.5 + 2.3 [height (inches) -60]
2. Select any ventilator mode
3. Set ventilator settings to achieve initial VT = 8 ml/kg PBW
4. Reduce VT by 1 ml/kg at intervals ≤ 2 hours until VT = 6ml/kg PBW.
5. Set initial rate to approximate baseline minute ventilation (not > 35 bpm).
6. Adjust VT and RR to achieve pH and plateau pressure goals below

OXYGENATION GOAL: PaO2 55-80 mmHg or SpO2 88-95%
Use a minimum PEEP of 5 cm H2O. Consider use of incremental FiO2/PEEP combinations such as shown below (not required) to achieve goal.

PLATEAU PRESSURE GOAL: ≤ 30 cm H2O
Check Pplat (0.5 second inspiratory pause), at least q 4h and after each change in PEEP or VT.
If Pplat > 30 cm H2O: decrease VT by 1ml/kg steps (minimum = 4 ml/kg).
If Pplat < 25 cm H2O and VT< 6 ml/kg, increase VT by 1 ml/kg until Pplat > 25 cm H2O or VT = 6 ml/kg.
If Pplat < 30 and breath stacking or dys-synchrony occurs: may increase VT in 1ml/kg increments to 7 or 8 ml/kg if Pplat remains < 30 cm H2O.

pH GOAL: 7.30-7.45
Acidosis Management: (pH < 7.30)
If pH 7.15-7.30: Increase RR until pH > 7.30 or PaCO2 < 25 (Maximum set RR = 35).
.
If pH < 7.15: Increase RR to 35.
If pH remains < 7.15, VT may be increased in 1 ml/kg steps until pH > 7.15 (Pplat target of 30 may be exceeded).
May give NaHCO3
Alkalosis Management: (pH > 7.45) Decrease vent rate if possible.

Quick Links

- ABG Calculator
- A-a gradient
- Wells criteria for PE
- ARDSnet protocol
- Asthma
- COPD

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

Adjustments:
- To improve oxygenation: increase FiO2, increase PEEP (although PEEP > 10 is rare) or increase inspiratory time
- To improve ventilation: increase tidal volume or inspiratory pressure, or increase rate (this may shorten inspiratory time and effect oxygenation, as well as influence auto-PEEP)
- Permissive hypercapnea: toleration of relatively high PaCO2 to avoid barotraumas / volutrauma
  - Vt = 4-6 ml/kg IBW (keep PaCO2 < 80 and pH > 7.15)
  - Relative contraindications: cerebrovascular dz, hemodynamic instability, renal failure, pulmonary HTN

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Your initial evaluation of COPD should include the following:

- History, Physical, Basic labs
- Chest XR
- Arterial blood gas analysis

Once your clinical impression of COPD is confirmed, you can initiate your treatment:

- Bronchodilator therapy
- Corticosteroids
- Supplemental O2 if needed
- Antimicrobials

In this section we will discuss COPD topics specific for the ICU.

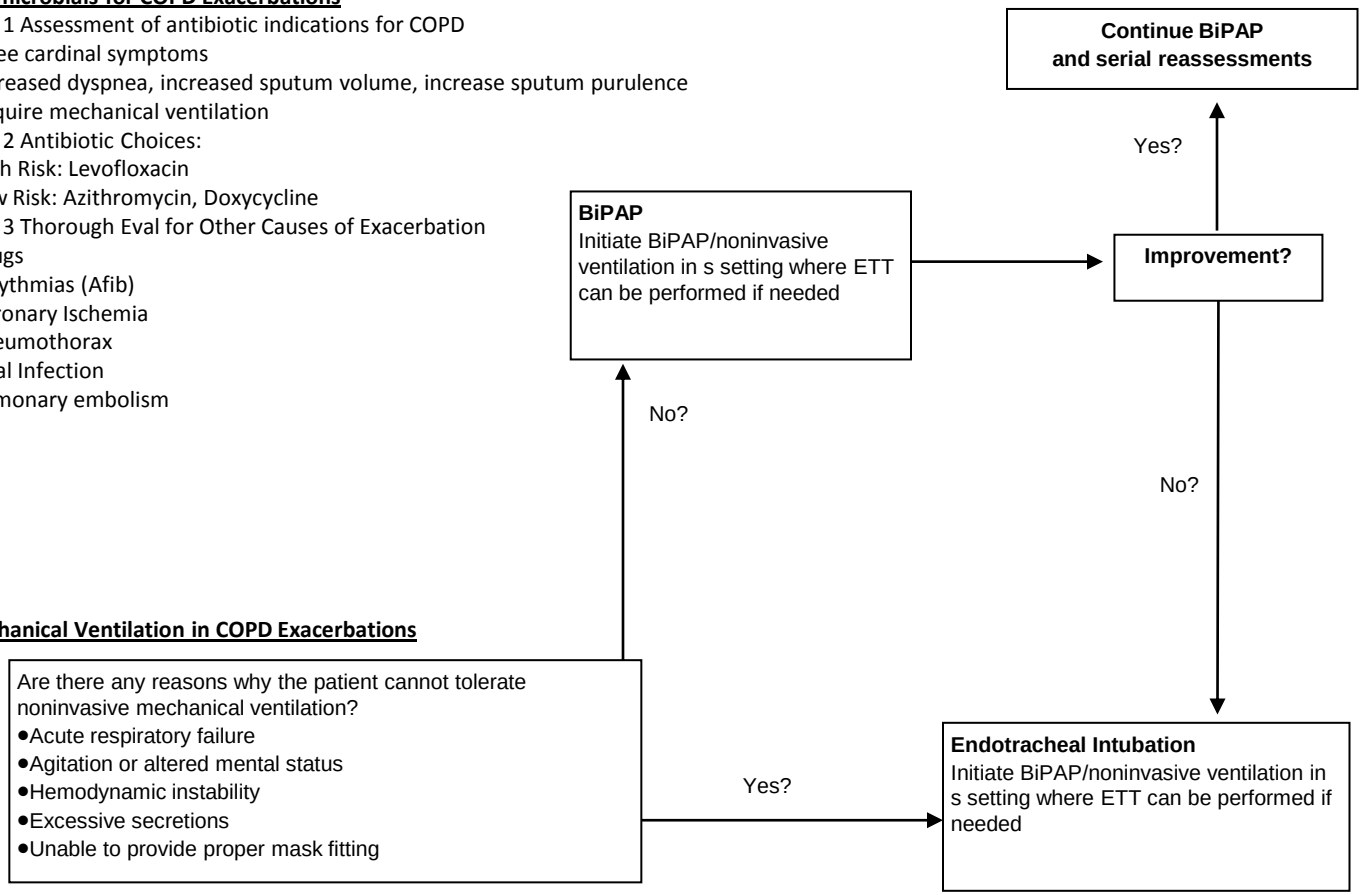
Quick Links

- ABG Calculator
- A-a gradient
- Wells criteria for PE
- Decision to Intubate
- Asthma
- COPD

Antimicrobials for COPD Exacerbations

Step 1 Assessment of antibiotic indications for COPD
•Three cardinal symptoms
• Increased dyspnea, increased sputum volume, increase sputum purulence
• Require mechanical ventilation
Step 2 Antibiotic Choices:
• High Risk: Levofloxacin
• Low Risk: Azithromycin, Doxycycline
Step 3 Thorough Eval for Other Causes of Exacerbation
• Drugs
• Arrythmias (Afib)
• Coronary Ischemia
• Pneumothorax
• Viral Infection
•Pulmonary embolism

Mechanical Ventilation in COPD Exacerbations



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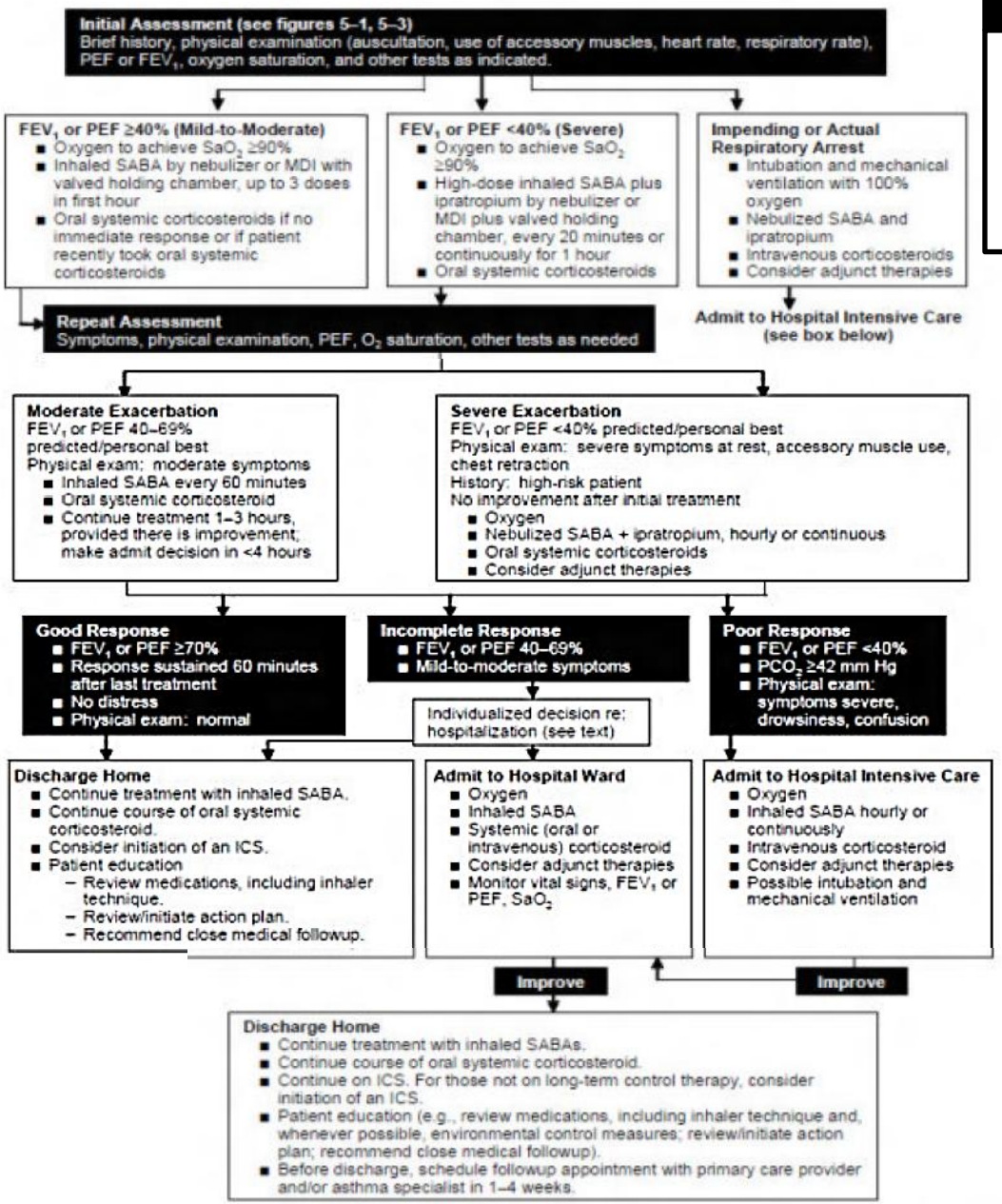


Quick Links

- ABG Calculator
- A-a gradient
- Wells criteria for PE
- Decision to Intubate
- COPD
- UIH Asthma Guidelines

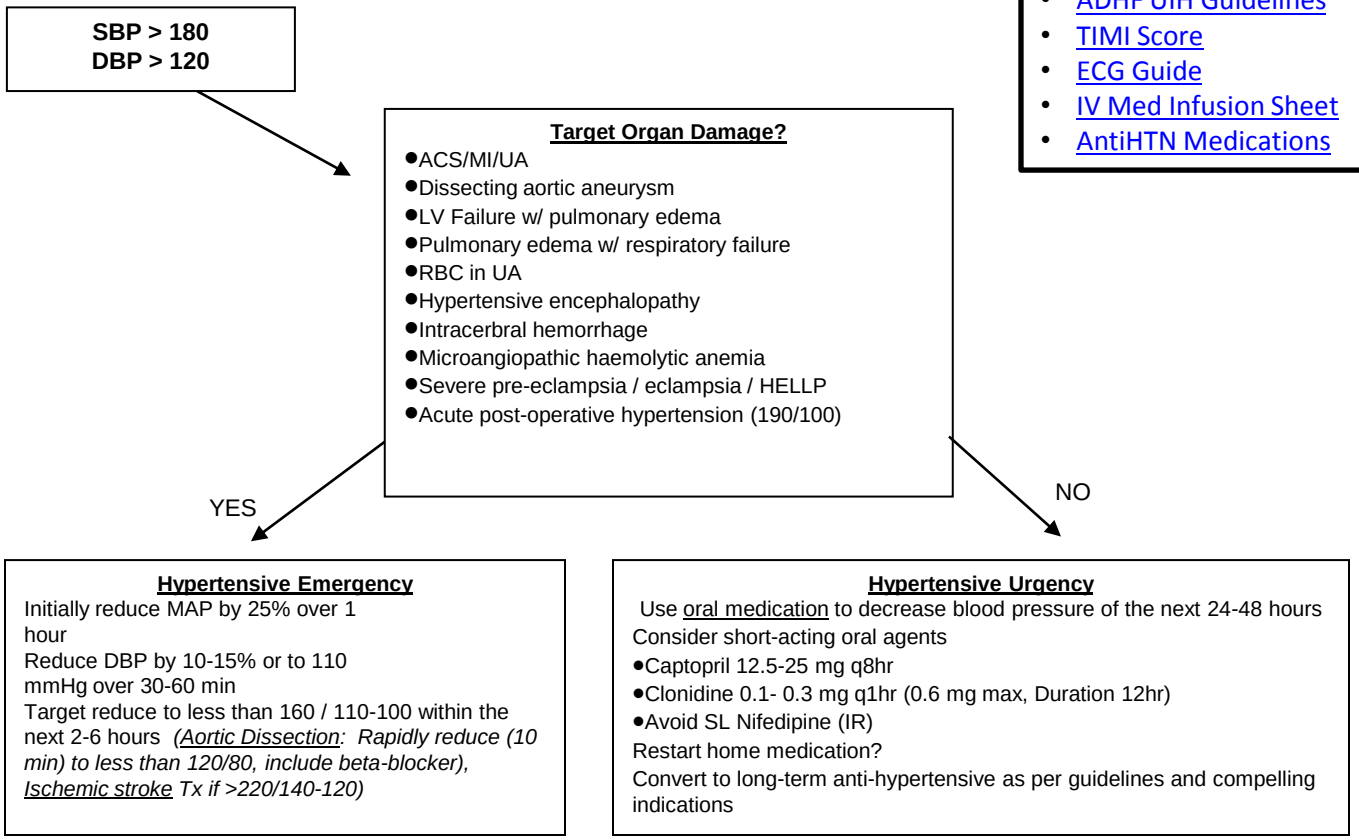
ICU Guidebook | Intensive Care Topics | HTN Crisis

When treating a HTN emergency, always consider invasive BP monitoring for more accurate vital signs.

When evaluation a HTN crisis, evaluate where in the disease spectrum the patient falls by following the algorithm below. Choose the appropriate medication based on the clinical scenario.

Quick Links

- Heart Failure
- ACS UIH Guidelines
- ADHF UIH Guidelines
- TIMI Score
- ECG Guide
- IV Med Infusion Sheet
- AntiHTN Medications



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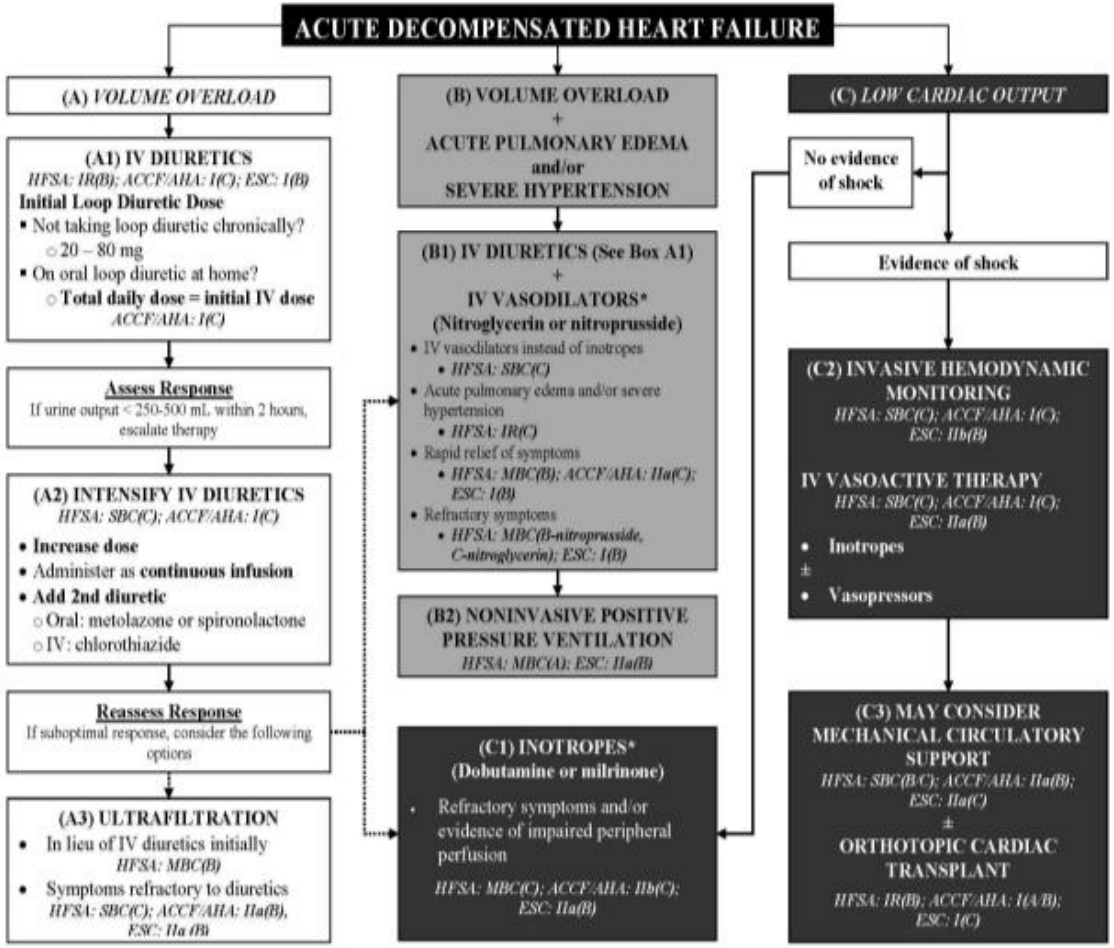
ICU Guidebook | Intensive Care Topics | Heart Failure

Always keep in mind the table below, a simplified version of the Forrester Classification. This helps you stratify your patient with Acute Decompensated Heart Failure and tailor therapy based on where in the disease spectrum they are.

Warm & Dry Outpatient treatment	Warm & Wet Diuretics + Vasodilators ***Pulmonary edema***
Cold & Dry Inotropes	Cold & Wet Inotropes, IABP, etc ***Cardiogenic Shock***

Quick Links

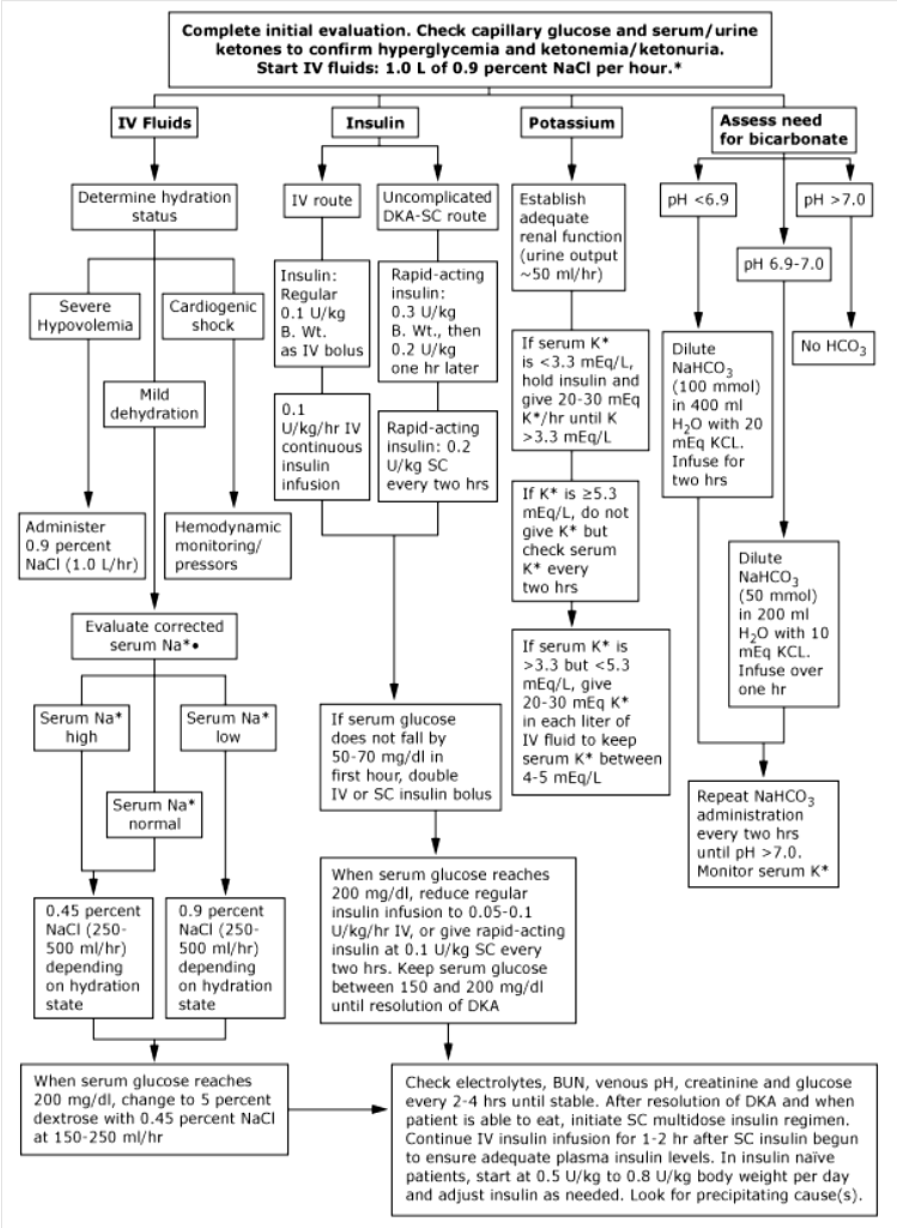
- HTN Crisis
- ACS UIH Guidelines
- ADHF UIH Guidelines
- TIMI Score
- ECG Guide
- IV Med Infusion Sheet



ICU Guidebook | Intensive Care Topics | DKA

DKA usually presents with serum glucose >250 mg/dl, arterial pH <7.3, serum bicarbonate <18 mEq/l, and moderate ketonuria ketonemia.

Follow the algorithm below for proper management.



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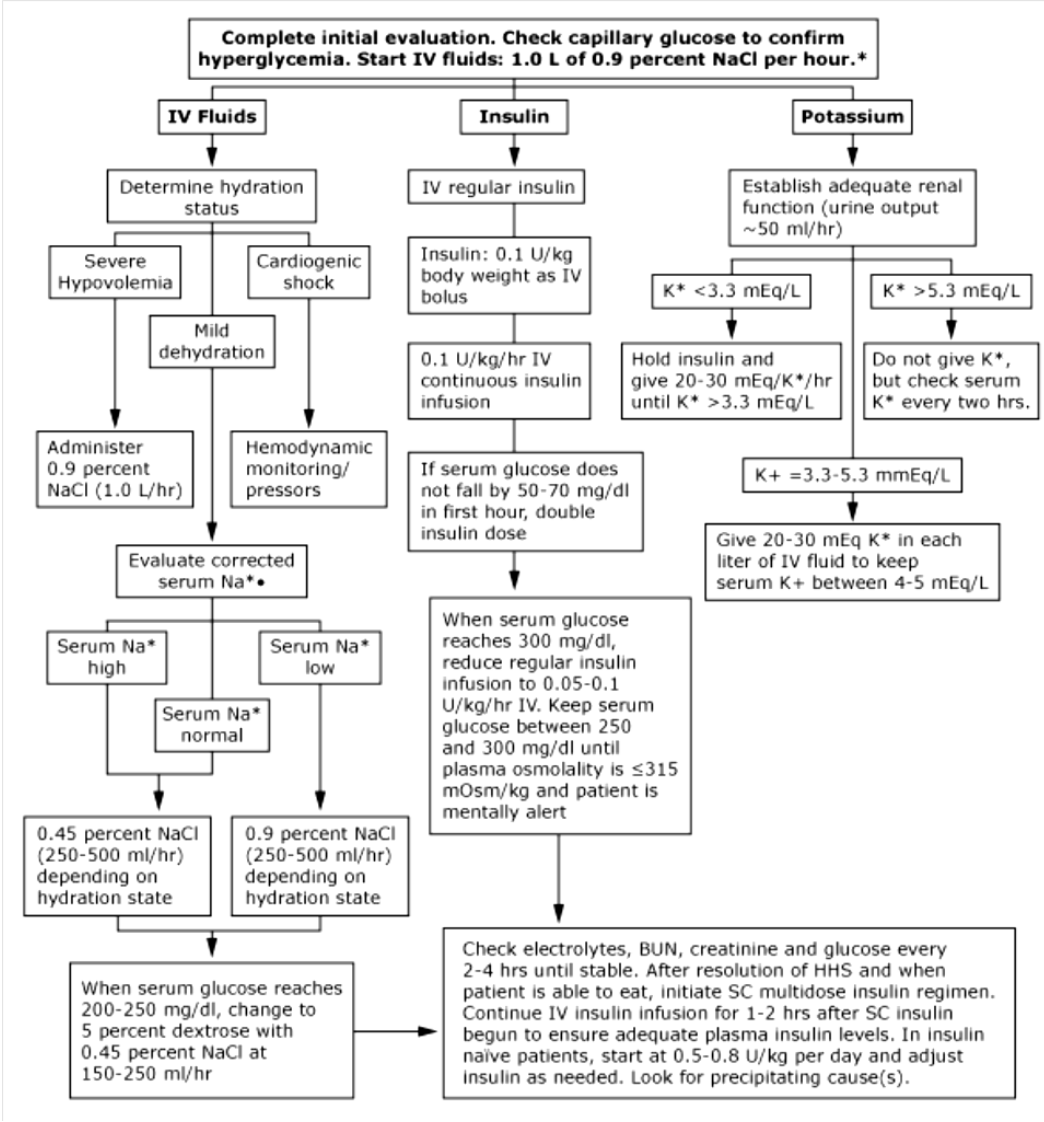
Quick Links

- Na Correction
- Anion Gap Calculator
- ABG Calculator
- Acid-base review
- HHS/HONK

ICU Guidebook | Intensive Care Topics | HHS/HONK

HHS / HONK usually presents with serum glucose >600 mg/dl, arterial pH >7.3, serum bicarbonate >15 mEq/l, and minimal ketonuria and ketonemia.

Follow the algorithm below for proper management.



Quick Links

- Na Correction
- Anion Gap Calculator
- ABG Calculator
- Acid-base review
- DKA

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ICU Guidebook | Intensive Care Topics | Antimicrobials

Quick empiric choices:
Meninges – Ceftriaxone/Vancomycin, consider Ampicillin | Aspiration – Cover for anaerobes, clindamycin
GU – FQ, bactrim, amp/gent | Skin – think community acquired MRSA: clindamycin, vancomycin
GI – FQ, metronidazole, pip/tazo | Lines – Vancomycin

Antibiotics for COPD Exacerbations (www.goldcopd.org)
Step 1 Assessment of antibiotic indications for COPD
· Three cardinal symptoms
· Increased dyspnea, increased sputum volume, increase sputum purulence
· Require mechanical ventilation
Step 2 Antibiotic Choices:
· High Risk: Levofloxacin
· Low Risk: Azithromycin, Doxycycline
Step 3 Thorough Eval for Other Causes of Exacerbation
• Drugs
• Arrhythmias (Afib)
• Coronary Ischemia
• Pneumothorax
• Viral Infection
•Pulmonary embolism

Management of Fungal Infections (www.idsociety.org)
Major risk factors for fungemia
· Recent use of broad-spectrum antibiotics (allow fungal overgrowth)
· Colonization of fungus in normal sterile location (ie-candiuria*)
Minor risk factors for fungemia
· Central venous catheter (TPN, chronic infusion therapy, hemodialysis)
· Multiple abdominal surgeries
· Critically ill patient
· Immunosuppression, steroid use
Common Yeast Pathogens
· Candida Albicans –Pathogen in 70-80% of fungemias, highly susceptible to fluconazole
· Non-albicans species
· C. glbrata – Dose-dependent susceptibility to fluconazole
· C. krusei – Must use micafungin, voriconazole to treat
· C. parapsilosis – Resistant to micafungin and other echinocandins
Treatment options for disseminated candidiasis
· Hemodynamically stable patient: Fluconazole 6 mg/kg (400-800 mg) IV/PO q24 (renal dose CrCL<50)
· Hemodynamically unstable patients: Micafungin 100 mg IV q24 (or other echinocandin)
· Ophthalmic examination to rule out endophthalmitis if documented fungemia
*Current IDSA guidelines recommend against the treatment of asymptomatic fungal cystitis unless high risk for developing disseminated candidiasis (neutropenic, urologic procedure)

Quick Links

- UIH Abx Guidelines
- UIH PNA Guidelines
- UIH VAP Guidelines
- Vancomycin dosing

Double coverage of Gram Negative Organisms
Rationale: Utilizing two different antimicrobial classes will increase the likelihood of active antimicrobial therapy in critically ill patients. Should only be used for empirical therapy. Discontinue after microbiological susceptibilities are reported.

Patients to consider double coverage (Clinicians should be selective in application!)
· Patients with febrile neutropenia (follow current U of I hospital guidelines)
· Patients with little physiologic reserve
· Severe sepsis and septic shock
· ARDS from infections cause
· Patient with significant exposure to anti-pseudomonal beta-lactam agents
· Patients with late onset (>14 days) nosocomial infections
· MDR organisms: Psuedomonas, Acinetobacter, KPC Klebsiella pneumoniae

How to double cover Gram-negative
· Aminoglycosides (Amikacin, Gentamicin, Tobramycin) are preferred over quinolones
· A single dose of an aminoglycoside has not been shown to increase the risk of AKI in septic shock patients
· Quinolones add little additional coverage to anti-pseudomonal beta-lactam agents (Micek et al. Antimicrob Agents Chemother. 2010)

Duration of treatment (Chastre. *JAMA*. 2003)
An 8 day course was shown to be non-inferior to an 15 day course (mortality)
There was more relapse with a short course in patients with Psuedomonal/Acinetobacter pneumonia when treated with a short course
Consider 15 day course in patients with:
MDR (High MIC) Psueomonas or Acinetobacter pneumonia
Patients with slow clinical response (>4 days)
Patients with severe hypoxia

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How to order Vancomycin

- Check your sources, confirm the medication is indicated
- Check table below for appropriate/inappropriate uses
- initial dose is based on actual body weight, subsequent doses based on blood levels
- Adult dose calculation:
  - initial dose = 15mg/kg based on total body weight
  - dosing interval based on CrCl: 80 = Q12h, 40-79 = Q24h, 25-39 = Q48h, < 25 15 mg/kg x 1 dose (see III E)

Pharmacokinetic level monitoring

- Obtain trough concentration (30 minutes prior to infusion) before 4th consecutive dose
- Adjust dose to obtain goal trough concentration of 10 - 20 mcg/mL
- Trough concentration 15 - 20 mcg/mL is recommended for bacteremia, endocarditis, osteomyelitis, meningitis and hospital acquired pneumonia caused by Staphylococcus aureus to improve clinical outcome

Frequency of vancomycin trough concentration monitoring:

1. For patients receiving > 5 days of vancomycin should have least one steady-state trough concentration obtained. Frequent monitoring (more than single trough concentration before 4th dose) for < 5 days or for lower intensity dosing (target trough vancomycin concentration < 15 mcg/mL) is not recommended.

2. For patients with stable renal function with goal trough concentration 15 - 20 mcg/mL, monitor vancomycin trough concentration once weekly for duration of therapy.

3. For hemodynamically unstable patients when goal trough concentration is 15 - 20 mcg/mL, more frequent than once weekly vancomycin trough concentration is recommended. Frequency of monitoring should be guided by clinical judgement.For patients with renal failure, follow levels, and re-dose for concentrations < 15 mcg/mL

I. Situations in which vancomycin use is appropriate or acceptable:	Situations in which vancomycin use is discouraged:
A. Treatment of culture documented infections caused by ß-lactam resistant gram-positive organism such as methicillin-resistant Staphylococcus aureus (MRSA) when no alternative antibiotic therapy is available. B. Treatment of culture documented infections caused by gram-positive organism in patients with immediate-type hypersensitivity reaction to ß-lactam antibiotics (urticaria, angioedema, or anaphylaxis) when no alternative antibiotic therapy is available. C. Empirical therapy for presumed gram-positive infection in patients with: 1. Neutropenic fever and severe mucositis, history of MRSA colonization or infection, suspected or known catheter-related infection or hypotension 2. Severe sepsis pending cultures 3. Skin and soft tissue infection not responding to other agents 4. Gram-positive organisms cultured from blood or sputum pending identification 5. Bacterial meningitis in pediatric patients 6. Hospital acquired or ventilator associated pneumonia D. Treatment of metronidazole-refractory C. difficile infections (oral vancomycin only	A. Routine surgical prophylaxis other than in a patient who has a life-threatening ß-lactam allergy, when indicated by the microbial environment, or when indicated based upon the patient's infection or colonization history. B. Empiric antimicrobial therapy for patients with neutropenic fever unless there is high clinical suspicion or evidence that indicates the presence of a gram-positive infection (see I.C.1. above) C. Treatment in response to a single blood culture positive for coagulase-negative Staphylococcus, if other cultures taken during the same time frame are negative D. Continued empiric use for presumed infections in patients whose cultures are negative for ß-lactam-resistant gram-positive microorganisms E. Systemic or local (antibiotic lock) prophylaxis for infection or colonization of indwelling central or peripheral intravascular catheter F. Selective decontamination of the digestive tract G. Eradication of MRSA colonization H. Primary treatment of C. difficile-associated colitis I. Routine prophylaxis of very low-birthweight infants J. Routine prophylaxis for patients on continuous ambulatory peritoneal dialysis or hemodialysis K. Treatment of infections caused by ß-lactam susceptible infections in patients without ß-lactam allergy L. Topical use of vancomycin solution for application of irrigation

For more information of Vancomycin dosing, check micromedx and/or UIC Clinical Care guidelines for Vancomycin use

Quick Links

- Antimicrobials
- UIH Abx Guidelines
- UIH PNA Guidelines
- UIH VAP Guidelines
- UIH Vanc Guidelines

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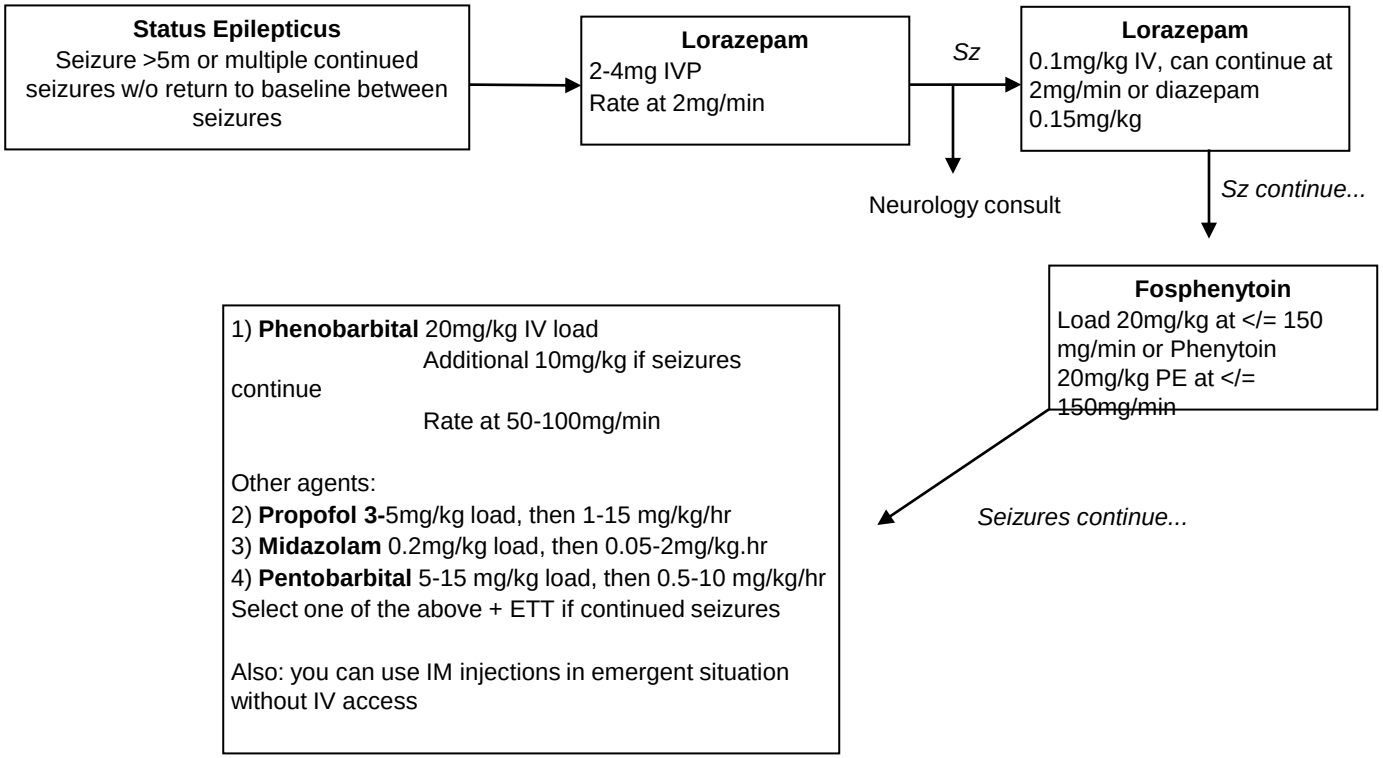
Initially: stay calm, put pt in lateral decubitus position, suctioning to bedside, pad bed rails and prevent injury, ABCs – oxygen, protect airway, get vitals incl. temp
Ask RN to call your senior

Causes: infection, metabolic (incl. Hypoglycemia), stroke, structural, trauma, neoplastic, iatrogenic, delirium tremens

Labs: accucheck; clin chem., Ca, mag, phos; also consider ABG, urine tox, serum tox, UA, EtOH level, drug levels; (can also consider prolactin level after seizure)
If seizure is over: assess pt, labs, meds, diagnoses, consider head CT; treat the underlying cause

Management
-airway: oxygen, ready to intubate
-thiamine 100mg IV push, then 1amp D50 IV push
-lorazepam 2-4mg IV/IM or diazepam at 2mg/min IV (up to 20mg) (whichever is available)
(have ambu bag available b/c diazepam can cause resp depression)
-phenytoin can be started in 2nd IV line; loading dose 18mg/kg (caution hypotension, arrhythmias)in IV until controlled; check lytes
Status epilepticus if >5min or 2 seizures with incomplete recovery àinvolve ICU, neuro, anesthesia



ICU Guidebook | Intensive Care Topics | Brain Death

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- UIH Brain Death Guidelines

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Clinical Criteria of Brain Death: *MUST HAVE STEP 1, 2, AND 3*

- **Step 1 Prerequisites**
  - Treat reversible causes of abnl neuro exam
  - Hypotension
  - Hypothermia (<32C)
  - Met Disturbances
  - Sig Drugs or Medications
  - Confounding Diseases
- Cause of Coma known, sufficient to cause brain/brain stem death, and history and imaging consistent with brain death
- **Step 2 Absence of Brain and Brainstem Function** *Two exams performed 6Hr apart*
  - Coma: absent cerebral motor responses in all extrem and face to noxious stimuli
  - Absent Brainstem Reflexes
    - Pupils
      - Size: midline to dilated 4-9mm
      - Absent response to bright light
    - Absent Corneal (touch edge of cornea)
    - Absent Gag (stimulate pharynx)
    - Absent Cough (tracheobronchial suction)
    - Ocular Movement
      - Absent oculocephalic
      - Absent deviation of eyes with cold water stimulation

- **Step 2a: Consider confirmatory test if Step 1 or 2 inconclusive**
  - Cerebral angiography
  - Brain scan
  - EEG
  - Transcranial dopler
  - Evoked Potentials
- **Step 3: Absent Respiratory Effort**, Apnea Test: absent resp efforts after $PaCO_2$ increases by more than 20mmHg above baseline

Tobin, ICU Book, pg 920

ICU Guidebook | Intensive Care Topics | Sedation

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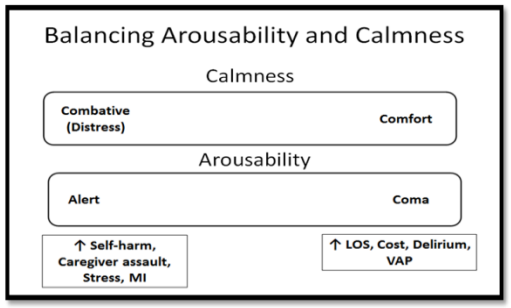
For sedation in the ICU, please read and follow the basic principles below.

Our ICU Sedation Medication sheet can be found here.
For use of precedex, more information can be found here.

1. **AVOIDANCE OF BENZODIAZEPINES**: New Society of Critical Care Medicine guidelines from 1/2013 recommend non-benzodiazepine sedatives for mechanically-ventilated patients to improve outcomes.
2. **DISCUSS THE PLAN OFTEN**: Sedation and Analgesia should be discussed frequently and involve ALL MEMBERS of the patient care team
3. **THERE IS NOT A "PERFECT" SEDATIVE AGENT:** Thus selection of an agent should be based up patient specific factors:
   - Hemodynamic stability (Avoid Propofol and Dexmedetomidine, Prefer Midazolam)
   - Probable duration of mechanical ventilation (Avoid Propofol use for greater than 48 hours)
4. **TREAT ANALGESIC REQUIREMT FIRST, THEN PROVIDE SEDATIVE AGENT**: Pain is undertreated in the ICU (up to 50-80% of patients report untreated pain in prospective studies)
5. **BALANCE CALMNESS AND AROUSABILITY – BOTH HAVE TO BE CONSIDERED:** Several studies have demonstrated that minimizing sedation on a daily basis is associated with improved patient outcomes (shorter ICU length of stay, short time of
6. +mechanical ventilation, less ICU delirium)
7. **ASSESSMENT IS THE KEY TO SUCCESS:** A standardized approach to assessing patient's level of sedation and analgesic requirements is imperative



SEDATION: Richmond Agitation Sedation Scale (RASS)		
Description	**Term**	**Score**
Overly combative, violent, immediate danger to staff	Combative	+4
Pulls or removes tube(s) or catheter(s); aggressive	Very agitated	+3
Frequent nonpurposeful movement, fights ventilator	Agitated	+2
Anxious but movements not aggressive or vigorous	Restless	+1
Alert and calm	Alert and calm	0
Not fully alert, but has sustained awakening (eye opening/eye contact) to voice (>10 seconds)	Drowsy	-1
Briefly awakens with eye contact to voice (<10 seconds)	Light sedation	-2
Movement or eye opening to voice (but no eye contact)	Moderate sedation	-3
No response to voice, but movement or eye opening to physical stimulation	Deep sedation	-4
No response to voice or physical stimulation	Unarousable	-5

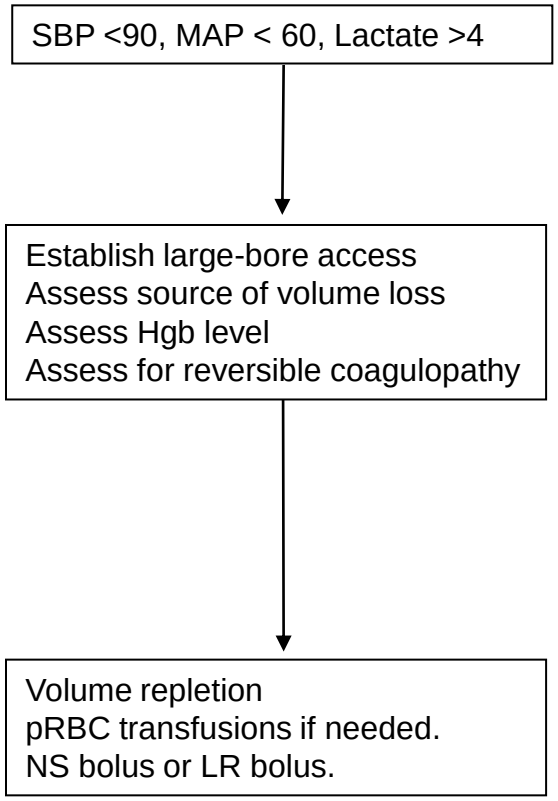
PAIN: Critical-Care Pain Observation Tool (CPOT)		
Indicator	**Description**	**Score**
1. Facial expression	Relaxed, neutral	0
	Tense	1
	Grimacing	2
2. Body movements	Absence of movements	0
	Protection	1
	Restless	2
3. Muscle tension	No resistance to passive movements	0
	Resistance to passive movements	1
	Strong resistance to passive movements, inability to complete them	2
4. Intubated Patients: Compliance with ventilator	Tolerating ventilator or movement	0
	Coughing but tolerating	1
	Fighting ventilator	2
OR	---	---
	Talking in normal tone or no sound	0
Extubated Patients: Vocalization	Sighing, moaning	1
	Crying out, sobbing	2
Total, range (Add boxes 1-4)		0-8

ICU Guidebook | Intensive Care Topics | Hypovolemic shock

Below is a quick algorithm on hypovolemic shock. Your main concern is to maintain proper hemodynamics. Your secondary concern, once you initiate efforts to improve hemodynamics, is to find out where the volume has been lost. Third spacing fluid loss can occur, but acute anemia of blood loss should always be assessed for. Obtain Hgb levels, evaluate the patient for possible Gi bleed or intra-abdominal bleeding.

Quick Links

- Glasgow score
- Shock
- Septic shock
- Cardiogenic shock



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ICU Guidebook | Intensive Care Topics | Acid base

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HOW TO ASSESS AN ABG?

General Approach:

1) pH: acidotic (<7.35) or alkalotic (>7.45)
2) pCO2: resp acidosis (>45mmHg) or alkalosis (<35mmHg)
**can look at pH and pCO2, and if same direction, then primary d/o is metabolic
3) pO2: hypoxic or non-hypoxic
*PaO2/FiO2: nL >400, <300 à Acute Lung Injury, <200 à ARDS
*A-a Gradient: PAO2 = 150 -(PaCO2/0.8)
nL = 2.5 + 0.25 (pt's age)
Elevated = V/Q mismatch = think PE, CHF, Pneumonia
4) HCO3: metabolic acidosis (>27mEq/L) or alkalosis (<21mEq/L)

Concerning levels from an ABG & VS that may suggest future need for intubation:

** PaO2/FiO2 <300-200*
** Increased PaCO2 + tachypnea*
** RR >30-35*
** PaO2<50 on 50% or greater FiO2*
** PaCO2 >55 w/ nL lung fxn (I.e no COPD, fibrotic lung dz)*
** pH <7.3*

COMPENSATION??

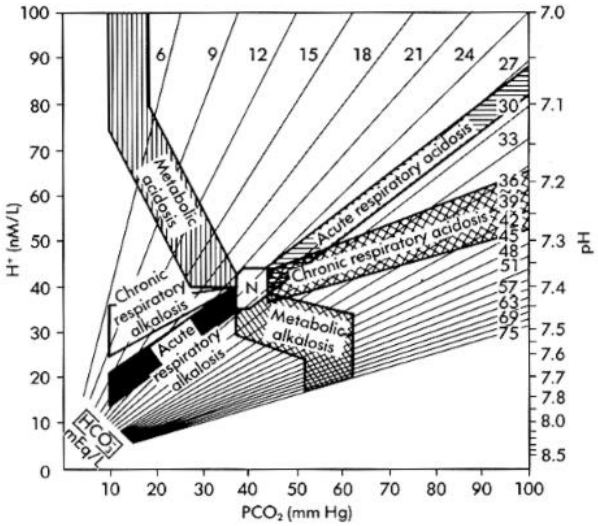
1) Simplistic rule? RULE OF 80 (add last 2 digits of pH + PaCO2)
*pH + PaCO2 = 80: pure resp d/o
*pH + PaCO2 <70: met acidosis
*pH + PaCO2 >90: met alkalosis
2) Met acidosis: PaCO2 = 1.5 (HCO3) + 8 +/-2
PaCO2 decrease 1.25mmHg per mEq/L change in HCO3
3) Met alkalosis:
PaCO2 increase 0.75mmHg per mEq/L change in HCO3
4) Resp acidosis:
Acute: HCO3 increase 1mEq/L per 10mmHg ↑PaCO2
Chronic: HCO3 increase 4mEq/L per 10mmHg ↑PaCO2
5) Resp alkalosis:
Acute: HCO3 decrease 2mEq/L per 10mmHg ↓PaCO2
Chronic: HCO3 decrease 4mEq/L per10mmHg ↓PaCO2

Later, look at:

1) Anion Gap: Na - (HCO3 + Cl) (NL 12 +/- 2)
Think MUDPILES (methanol/metformin, uremia, DKA, Paraldehyde, INH/Iron, Lactate, Ethylene
Glycol, Salicylates, Cyanide)
2) Delta Gap (also known as corrected HCO3) = (AG -12) + HCO3 = 24 +/- 2
presence of delta gap means concomitant metabolic acidosis or alkalosis on top of an AG acidosis
<20 =concomitant metab acidosis
>26 =concomitant metab alkalosis
3) Osmol Gap: 2Na + glc/18 +BUN/2.8
corrected Osmol Gap for ETOH = ETOH/4.6
corrected OG >10 points to methanol or ethylene glycol exposure

Quick Links

- Na Correction
- Anion Gap Calculator
- ABG Calculator



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ICU Guidebook | Intensive Care Topics | Decision making capacity

Basic definitions:
*Competence/Incompetence: legal designations determined by courts/judges

Decision-Making Capacity: clinically determined by physician's evaluation

To assess decision making capacity
Ask the patient 5 questions:
1. What is your present medical condition?
2. What is the treatment that is being recommended for you?
3. What do you think might happen to you if you decide to accept (or not accept) the recommended tx?
4. What do we, as your medical team, think might happen if you decide to accept (or not accept) the recommended tx?
5. What are the alternatives available and what are the consequences of accepting each?

Ask yourself 5 questions:
1. Can the pt communicate a choice?
2. Can the pt understand the essential elements of informed consent?
3. Can the pt assign personal values to the risks & benefits of intervention.
4. Can the pt manipulate the information rationally & logically.
5. Is the pt's decision making capacity stable over time?

Document that the pt has decision-making capacity for the following reasons:
***** Pt understand his present medical condition and the tx that is being recommended.
* He understand the risks, consequences, and alternatives of accepting/not accepting the tx.
* He can communicate a choice.
* He understands the essential elements of informed consent.
* He can assign personal values to the risks/benefits of intervention.
* He can manipulate information rationally & logically.
* His decision-making capacity is stable over time.
**if capacity is in question, obtain complete evaluation fro Psychiatry.

ICU Guidebook | Intensive Care Topics | Death

When a patient in the ICU dies, the following should be your immediate steps:

Was this expected? What happened?
Was the Attending called?
Autopsy desired?
Organ donation?
Review chart for other med/family issues

In the Room:
Explain the purpose of the pronouncement to family.
Ask if family wishes to be present, Also, ask if family would like the chaplain to be present
Address any questions from family.

Pronouncement:
ID pt.
Note that the patient is NOT hypothermic (warm and dead).
Note general appearance of pt and if any spontaneous mvmt.
Note no rxn to verbal or tactile stimulation.
Note no pupillary light reflex (pupils should be fixed/dilated).
Note no breathing or lung sounds or heart beat/pulse
when to call coroner: if pt was in hospital <24hrs, death w/ unusual circumstances, or if death was assoc w/ trauma regardless of cause of death

Orders to be done.
1. Expiration order on Powerchart.
2. Fill out paper documentation.
3. Call Gift of Hope –ROBI (regardless if organ donor or not) -630.758.2600, www.robi.org

Documentation---What to write in your death note:
Called to bedside by RN to pronounce pt's name or Code blue called at time. Resuscitation efforts stopped at time.

Template Death note
Use the note below. Modify to represent specific case.

DEATH NOTE

<Document all above findings here. What happened? Document time.>

No spontaneous movements were present. There was not response to verbal or tactile stimuli. Pupils were mid-dilated and fixed. No breath sounds were appreciated over either lung field. No carotid pulses were palpable. No heart sounds were auscultator over entire precordium. Patient pronounced dead at date & time. Family and resident (or attending physician) were notified. Document if coroner was notified. The family accepts/declines autopsy. The family <accepts/declines> organ donation.
<Document if pt was DNR/DNI vs. Full code.>

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Adult Critical Care IV Medication Infusion Sheet : A quick reference sheet.

> Vasopressors

Drug	Receptors	Clinical Effect	Indication
Dopamine (3-10 mcg/kg/min) (Less severe, SBP 90-80) (10-20 mcg/kg/min)	α1 ++ β1 +++ β2 + DA ++ Dose de-pendant	DA effect does not appear clinically relevant. Less likely to causemyocardial ischemia? Positive iontropic and chronotropic at lower doses, but less than dobutamine Vasopressor	Cardiogenic Shock Distributive shock (Less severe, SBP 90-80)
Norepinephrine (0.01-1 mcg/kg/min)	α1 ++++ β1 +++	Vasopressor (Potent) No reflex bradycardia	Distributive shock (1st Line Agent for Sep-sis)
Epinephrine (0.04-1 mcg/kg/min)	α1 +++ β1 +++ β2 ++	Positive iontropic and chronotropic ef-fects No afterload reduction Becomes α > β with escalating doses	Distributive Mixed shock Cardiogenic shock
Phenylephrine (0.05-8 mcg/kg/min)	α1 ++++	Pure vasopressor No tachyarrhythmias Less potent than NorEpi	Distributive shock No Central Access
Dobutamine **(0.04-1 mcg/kg/min)**	α1 β1 +++ β2 + DA	Positive iontropic and chronotropic ef-fects Some afterload reduction	Cardiogenic shock (add second agent for hypotension) Decompensated HF
Vasopressin **(0.03-0.04 unit/min)**	Smooth muscle V1 receptor agonist	Pure vasopressor Maintains pressor activity in Acidosis ? Safety in CAD, MI, Bowel Ischemia	Distributive (vasopressin deficiency in sepsis?)
Milrinone (50 mcg load, 0.375-.75mcg/kg/min) *Renal Dose Adjust	PDE inhib-itor	Non-catecholamine, positive iontropic and chronotropic effects Afterload reduction	Decompensated HF

ICU Guidebook | Intensive Care Topics | AntiHTN

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Drug	MOA	Arterial or Venous Dilation	Onset (Peak)	Duration	Kinetics	Dose	Dose Adjustment (Max)	Notes
Labetalol	Alpha and Non-selective Beta blocker	Arterial	2-5 min (15 min)	2-4 hr	Hepatic (Conjugation)	10-20 mg q10min then 1-2 mg/min	Up to 8 mg/min (300 mg per 24 hours)	-Fpo = 25% -Avoid if bradycardic, decomp. CHF
Esmolol	Cardio-selective beta blocker	Arterial via ↓ CO	1 min	10-20 min	RBC Esterase	500 mcg/kg LD then 25-50 mcg/kg/min	↑ 25 mcg/kg/min q10min (300 mcg/kg/min)	-Avoid if bradycardic, decomp. CHF
Clevidipine (NF)	DHP Ca-channel Blocker	Arterial	1-5 min	10 min	RBC Esterase	1-2 mg/hr	Double dose q2-5mins (16 mg/hr)	-Only studied to 96 hours -Lipid emulsion (0.5 mg/mL)
Nicardipine	DHP Ca-channel Blocker	Arterial	5-15 min	4-6 hr	Hepatic (CYP 3A4)	5 mg/hr	↑ 2.5 mg/hr q5min (15 mg/hr)	-Preferred in ischemic stroke, ARF, HTN encephalopathy
Enalaprilat	ACE Inhibitor	Arterial	15 min (1 hr)	6 hr	Renal (Unchanged)	1.25 mg	↑ 1.25 mg q12hr (5 mg q6hr)	-Avoid in ARF, AS, renal stenosis, hyperkalemia
Sodium Nitroprusside (5 CN, 1 Fe, 1NO)	Nitrate (↑ cGMP)	Arterial and Venous	< 1 min	1-2 min	1. Complex degrades in blood releasing cyanide 2. CN metabolized by mitochondrial rhodanase to thiocynate (Liver/RBC) 3. Thiocyanate cleared via kidney	0.5 mcg/kg/min Usual Range [2-5 mcg/kg/min]	↑ 0.25 mcg/kg/min q3-5 min (10 mcg/kg/min)	-Good initial agent -Coronary steal -Tolerance -Cyanide toxicity Dose > 5 mcg/kg/min Add Thiosulfate infusion -Thiocynate toxicity* In renal dysfunction
Nitroglycerin	Nitrate (↑ cGMP)	Venous (Arterial at high doses)	2-5 min	10-20 min	Hepatic (Reductase, Hydrolysis)	5-15 mcg/min Usual Range [50-150 mcg/kg/min]	↑ 5-10 mcg/min q5min (400 mcg/min)	-Use as adjunct therapy in ACS / Pulm Edema -Tolerance in 24 hrs
Hydralazine	Unknown	Arterial	10-20 min	3-8 hr	Hepatic (Acetylation)	IV 10-20 mg PO 25 mg	Repeat 10-20 mg q 4-6 hr (40 mg dose IV)	-Prolonged and variable effects- avoid in acute management -Pre-eclampsia
Fenoldopam (NF)	Dopamine Type-1 receptor agonist	Arterial	5 min (15 min)	30-60 min	Hepatic (Conjugation)	0.1 mcg/kg/min	↑ 0.05-0.1 mcg/kg/min q15min (1.6 mcg/kg/min)	-Sulfate sensitivity

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Ventilation

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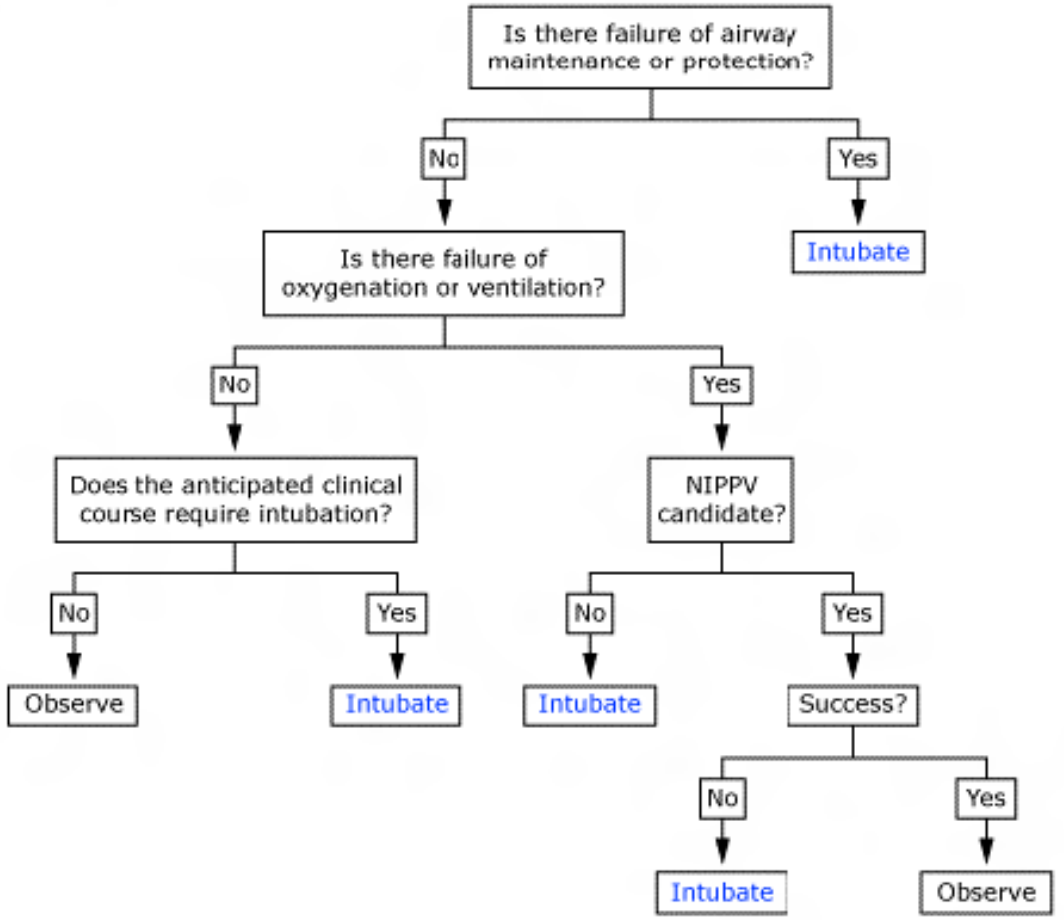
UIH Clinical Care Guidelines: Intubation

Concerning levels from an ABG & VS that may suggest future need for intubation:

** PaO2/FiO2 <300-200*
** Increased PaCO2 + tachypnea*
** RR >30-35*
** PaO2<50 on 50% or greater FiO2*
** PaCO2 >55 w/ nL lung fxn (I.e no COPD, fibrotic lung dz)*
** pH <7.3*

If you're thinking about this then you should probably be calling anesthesia



ICU Guidebook | Mechanical Ventilation | Ventilator modes

Vent Modes:

• Assist control: vent delivers a minimum set number of breaths, and patient initiated breaths trigger fully-assisted vent breaths. Tachypnea can lead to resp alkalosis, breath-stacking and auto-PEEP

• Synchronized Intermittent Mandatory Ventilation: vent delivers a minimum number of supported breaths synchronized with patient's efforts. Additional patient initiated breaths are not vent supported, but the patient must overcome resistance of vent circuit during spontaneous breaths.

SIMV=AC when patients are not spontaneously breathing.

• Pressure support: vent supports patient initiated breaths with a set inspiratory pressure. A partial vent support sometimes used to evaluate for weaning

• Continuous positive airway pressure: patient breathes spontaneously while vent maintains constant airway pressure

Volume targeted vs. Pressure targeted

• Volume-targeted: vent delivers a set tidal volume, pressure depends on airway resistance and compliance. Patient remains at risk for barotraumas / volutrauma from high pressures.

• Pressure-targeted: vent delivers volume until a set pressure is achieved. Now, tidal volume is dependent on airway resistance and compliance. Patient remains at risk for low tidal volumes and inadequate minute ventilation.

Remaining Variables

1. FiO2: fraction of inspired oxygen
2. PEEP: positive end-expiratory pressure, to help prevent alveolar collapse and increase oxygenation. Will also increase intrathoracic pressure and decrease preload, usually to a greater degree than its reduction on afterload – MAY decrease cardiac output. Auto-PEEP can occur when patient has inadequate time to exhale before next breath is delivered, typically signaled by end-expiratory flow > 0 before next breath is delivered.
3. Inspiratory time: Normal I:E ratio is ~1:2, but can be controlled on ventilator, use for management of obstructive diseases
4. Inspiratory flow rates: usually 60, increased inspiratory flow rates achieve set volume or pressure in a shorter amount of time, and decrease inspiratory time and allowing for a longer expiratory time before next breath. This can prevent auto-PEEP in obstructive disease and allow better ventilation.
5. Peak inspiratory pressure: determined by airway resistance and compliance.
6. Plateau pressure: pressure at end of inspiration when flow has ceased, dependent on compliance.

Increased plateau pressure suggests decreased compliance

ICU Guidebook | Mechanical Ventilation | Weaning/Extubation

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Rapid shallow breathing calculator

Weaning Trial Criteria
- FiO2 < 0.4 with pO2 > 60 and PEEP < 8
- The patient can take spontaneous breaths over the vent with RR < 20
- SBP > 90 without pressors
- The initial indication for intubation is resolving

Extubation criteria
- Minute ventilation < 10 L/min.
- **Tobin index** (Rapid Shallow Breathing Index) **:** spontaneous RR ÷ TV in L < 105
- Dead space < 50%.
- MIF (maximal inspiratory force) < – 20 (the more negative, the better)

Failure to wean:
F *Fluid overload® diurese if indicated.*
A *Airway resistance® check endotracheal tube; is it obstructed or too small?*
I *Infection® treat as indicated.*
L *Lying down, bad V/Q mismatch® elevate head of bed.*
T *Thyroid, toxicity of drugs® check TFT's, check med list.*
O *Oxygen ® increase FiO2 as patient is taken off ventilator.*
W *Wheezing ® treat with nebs.*
E *Electrolytes, eating ® correct K/Mg/PO4/Ca; provide adequate nutrition.*
A *Anti-inflammatory needed? ® consider steroids in asthma/COPD.*
N *Neuromuscular disease, neuro status compromised ® think of myasthenia gravis, ALS, steroid/paralytic neuropathy, etc; assure that patient is in fact awake and alert.*

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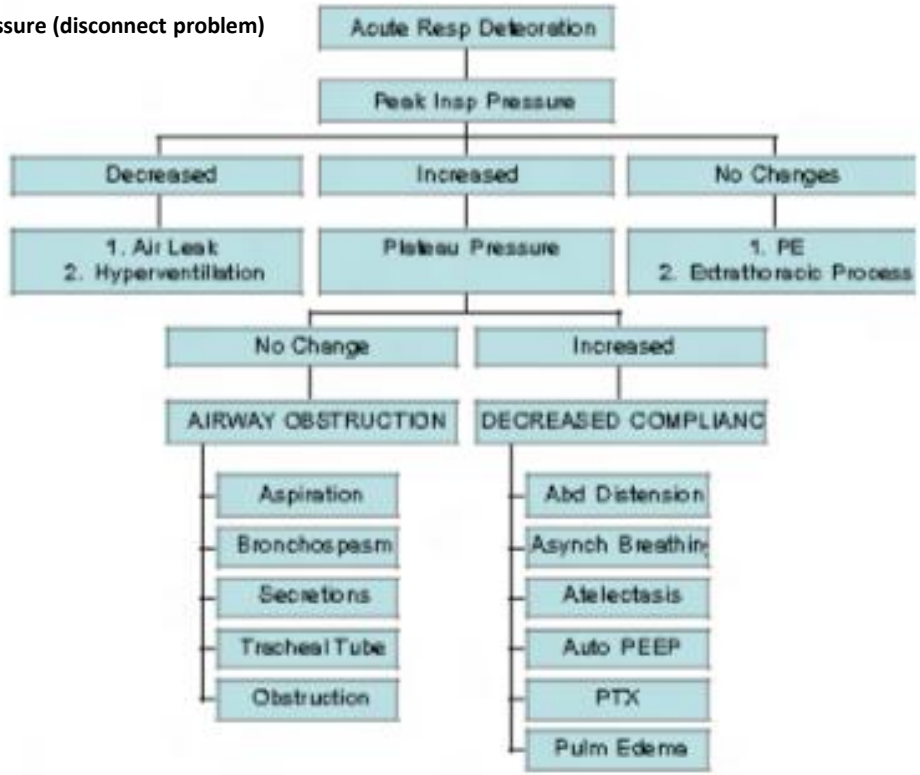
ICU Guidebook | Mechanical Ventilation | Troubleshooting

Simple Rules
- Low pO2 = oxygenation issue = increase FiO2, increase PEEP (to recruit more alveoli).
- High pCO2 = ventilation issue = Increase Minute Ventilation by increasing TV or rate (suction, bronchodilators).

High Peak pressures & High Plateau Pressures (non-compliant lungs)
- Pulmonary edema
- Worsening consolidation
- ARDS
- Atelectasis
- Mainstem intubation
- Tension PTX
- Decreased chest wall compliance

High peak pressure low & normal plateau pressure (airway problem)
- Bronchospasm
- Mucous plug
- Secretions
- Obstructed tubing
- Patient biting tube

Low peak pressure & low plateau pressure (disconnect problem)
- Consider disconnected tubing
- Lost airway



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Online ICU Guidebook

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P+C

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CV

- ECG Basics
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GI

- Child-Pugh-Turcot score
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Pulm

- How to assess an ABG
- ABG Calculator
- O2 / NIPPV
- Thoracentesis
- Lights Criteria

Other

- Heparin dosing
- Argatroban dosing

ECG INTEPRETATION:
1) RATE: Count the large block between 2 consecutive R's → 300-150-100-75-60-50
*Source of rhythm? SA node (60-100/min), Atrial (75/min), AV (40-60), Vent (30-40)

2) RHYTHM: *Is there a P for every QRS?
*Check consecutive P-P distance for consistency.
*Check consecutive R-R distance for consistency.

3) AXIS: Look at leads I & aVF

Lead I	Lead aVF	Axis
Up	Up	Normal axis (-30 to +100)
Up	Down	Left axis (-30 to -90)
Down	Up	R axis deviation (+90 to +270)
Down	Down	Extreme R axis deviation (-90 to -180)

*Find the most isoelectric lead. The axis is 90 from this lead OR can look at the tallest lead

4) INTERVALS:

PR	0.12 to 0.20 sec (3-5 small blocks)
QRS	<0.12 sec (<3 small blocks)
QT	0.34 to 0.42 sec (~ _RR interval)

*PR interval: short → WPW vs. longer (Heart block
*QRS widened (RBBB, LBBB, vent rhythm, hyper K+, ventricular rhythm
*Prolonged QT(MI, myocarditis, diffuse myo dz, hypoCa2+, hypothyroidism, subarach hemorrhage, drugs (sotalol, amiodarone), hereditary

5) HYPERTROPHY:

RAE (P pulmonale)	LAE (P mitrale)	RVH	LVH (if QRS <0.12s)
*Tall P >2.5mm in lead II *Large diphasic P w/ large initial phase in V1	*P > 0.12sec *Diphasic P w/ downward terminal phase > 1mm wide 1mm deep in V1 *M-shaped P in I, II, or aVL	*qR pattern in V1 (very specific for RVH) *RAD >110 *R >S in V1 *R in V1 > 7mm *S in V1 >2mm *rSR' in V1 w/ R'>10mm	*R in I + S in III>25mm *R in aVL >11mm *R in aVF >20mm *S in aVR >14mm *R in V5 or V6 + S in V1 >35mm *Largest R + Largest S in precordial leads >45mm

6) INFARCTION/ISCHEMIA:
Progression:
Hyperacute T waves→Inverted T waves →Q wave (0.04sec &/or >25% height or R wave)→ST segment elevation

Q waves: q, ABSENT in V1-V3, definitely ABSENT in V2-V3
**pathologic Q = >0.04seconds, >5mm or 1/3 the R wave

Location	Leads	Vessels
Anterior	V2-V4	LAD
Anteroseptal	V1-V4	LAD
Anterolateral	V1-V6, I, aVL	LAD, diagonal
Inferior	II, III, aVF	RCA, circumflex
Lateral	I, aVL, V5-V6	Circumflex, diagonal
Posterior	Large R wave V1-V3 ST depression in V1-V2	RCA

7) BLOCKS:
*1st degree: PR interval >0.22 sec
*2nd degree:
Mobitz Type I (Wenkebach): progressively lengthening PR interval w/ dropped QRS
Mobitz Type II (bundle of His, requires pacemaker): constant PR w/ dropped beats
*3rd degree: complete dissociation of p waves from abnl QRS complexes

8) BUNDLE BRANCH BLOCK/HEMIBLOCK
RBBB:
QRS>0.12 sec
R-S-R' in V1 or V2 >0.12sec
Wide S in I, aVL, V5, V6
LBBB:
QRS>0.12 sec
R-R' in I, V5, and V6
Wide S in V1-V2
Absence of Q waves in I, V5, V6
T wave inversions in lateral leads

Hemi blocks (Left fascicular blocks): axis deviation w/ no definable cause.
*Anterior fascicular block: left axis deviation (may be physiologic)
*Posterior fascicular block: right axis deviation (pathologic)
CANNOT DIAGNOSE HYPERTROPHY OR MI BY EKG IF BBB EXISTS

9) EFFUSION:
Low voltage → R waves < 5mm in limb leads, < 10mm in precordial leads

10) ST OR T WAVE CHANGES ASSOC W/ VENTRICULAR HYPERTROPHY:
LVH: ST depression w/ downward concavity & TWI in leads where QRS + (V5/V6)
ST elevation w/ upright T waves in leads where QRS - (V1/V2)
RVH: ST depression w/ downward concavity & TWI (V1/V2 & s/t II, III, aVF)

ICU Guidebook | Procedures&Calculators | Central line

A central line is useful for many interventions. Consider central line placement in **any** critically ill patient being admitted to the MICU; however, the benefits and risks of central line placement always need to be considered.

Specific Indications:
•Venous access is needed for intravenous fluids or antibiotics and a peripheral site is unavailable or not suitable
•Central venous pressure measurement
•Administration of chemotherapeutic drugs or total parenteral nutrition (TPN)
•For hemodialysis or plasmapheresis

Contraindications:
Uncooperative patient
Uncorrected bleeding diathesis
Skin infection over the puncture site
Distortion of anatomic landmarks from any reason
Pneumothorax or hemothorax on the contralateral side

Supplies:
CVC kit
Portable/Bedside Ultrasound

Method:
Read the following document:: NEJM—CVC Placement
Procedure video: NEJM Videos in Clinical Medicine > CVC Placement

Complications:
Pneumothorax (3-30%)
Hemopneumothorax
Hemorrhage
Hypotension due to a vasovagal response
Pulmonary edema due to lung re expansion
Spleen or liver puncture
Air embolism
Infection

PROCEDURE TEMPLATE

PROCEDURE:
Internal jugular central venous catheter, U/S guided.

INDICATION:

PROCEDURE OPERATOR:

CONSENT:

PROCEDURE SUMMARY:
A time-out was performed. The patient's <LEFT/RIGHT> neck region was prepped and draped in sterile fashion using chlorhexidine scrub. Anesthesia was achieved with 1% lidocaine. The <LEFT/RIGHT> internal jugular vein was accessed under ultrasound guidance using a finder needle and sheath. U/S images were permanently documented. Venous blood was withdrawn and the sheath was advanced into the vein and the needle was withdrawn. A guidewire was advanced through the sheath. A small incision was made with a 10 blade scalpel and the sheath was exchanged for a dilator over the guidewire until appropriate dilation was obtained. The dilator was removed and an 8.5 French central venous quad-lumen catheter was advanced over the guidewire and secured into place with 4 sutures at <__> cm. At time of procedure completion, all ports aspirated and flushed properly. Post-procedure x-ray shows the tip of the catheter within the superior vena cava.

COMPLICATIONS:

ESTIMATED BLOOD LOSS:

ICU Guidebook | Procedures&Calculators | Arterial line

An arterial line is useful for accurate BP monitoring, frequent vital signs and frequent arterial access such as blood gases.

Indications:
Continuous monitoring of blood pressure, for patients with hemodynamic instability
For reliable titration of supportive medications such as pressors/inotropes/antihypertensive infusions.
For frequent arterial blood sampling.

Contraindications:
Placement should not compromise the circulation distal to the
placement site
Do not place if Raynauds, Thromboangiitis obliterans, or other active issues.
Do not place if active infection or trauma at the site

Supplies:
A-line kit
Sterile equipment

Method:
Read the following document:: NEJM—A line Placement
Procedure video: NEJM Videos in Clinical Medicine > A line Placement

Complications:
Arterial spasm
Bleeding
Infection

PROCEDURE TEMPLATE

PROCEDURE:
Radial artery line placement. (A-line)

INDICATION:

PROCEDURE OPERATOR:

CONSENT:

PROCEDURE SUMMARY:
The patient was prepped and draped in the usual sterile manner using chlorhexidine scrub. 1% lidocaine was used to numb the region. The <LEFT/RIGHT> radial artery was palpated and successfully cannulated on the first pass. Pulsatile, arterial blood was visualized and the artery was then threaded using the Seldinger technique and a catheter was then sutured into place. Good wave-form was obtained. The patient tolerated the procedure well without any immediate complications. The area was cleaned and Tegaderm was applied. Dr. ____ was present during the entire procedure.

ESTIMATED BLOOD LOSS:

ICU Guidebook | Procedures&Calculators | ABGs

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Quick Links
- Na Correction
- Anion Gap Calculator
- ABG Calculator

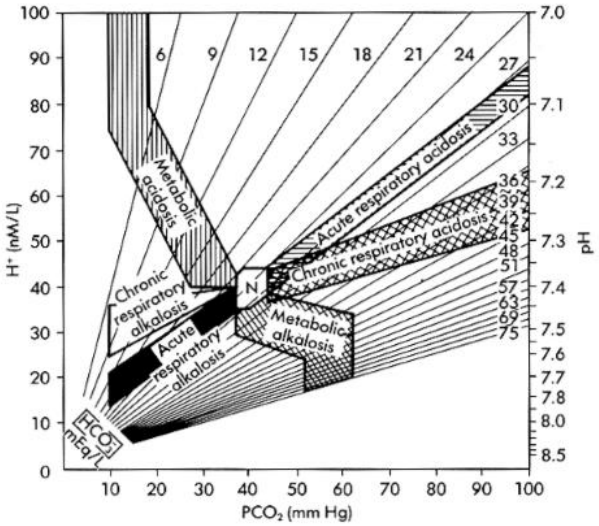
HOW TO ASSESS AN ABG?

General Approach:

1) pH: acidotic (<7.35) or alkalotic (>7.45)
2) pCO2: resp acidosis (>45mmHg) or alkalosis (<35mmHg)
**can look at pH and pCO2, and if same direction, then primary d/o is metabolic
3) pO2: hypoxic or non-hypoxic
*PaO2/FiO2: nL >400, <300 à Acute Lung Injury, <200 à ARDS
*A-a Gradient: PAO2 = 150 -(PaCO2/0.8)
nL = 2.5 + 0.25 (pt's age)
Elevated = V/Q mismatch = think PE, CHF, Pneumonia
4) HCO3: metabolic acidosis (>27mEq/L) or alkalosis (<21mEq/L)

Concerning levels from an ABG & VS that may suggest future need for intubation:

** PaO2/FiO2 <300-200*
** Increased PaCO2 + tachypnea*
** RR >30-35*
** PaO2<50 on 50% or greater FiO2*
** PaCO2 >55 w/ nL lung fxn (I.e no COPD, fibrotic lung dz)*
** pH <7.3*



COMPENSATION??

1) Simplistic rule? RULE OF 80 (add last 2 digits of pH + PaCO2)
*pH + PaCO2 = 80: pure resp d/o
*pH + PaCO2 <70: met acidosis
*pH + PaCO2 >90: met alkalosis
2) Met acidosis: PaCO2 = 1.5 (HCO3) + 8 +/-2
PaCO2 *decrease* 1.25mmHg per mEq/L change in HCO3
3) Met alkalosis:
PaCO2 *increase* 0.75mmHg per mEq/L change in HCO3
4) Resp acidosis:
Acute: HCO3 *increase* 1mEq/L per 10mmHg ↑PaCO2
Chronic: HCO3 *increase* 4mEq/L per 10mmHg ↑PaCO2
5) Resp alkalosis:
Acute: HCO3 *decrease* 2mEq/L per 10mmHg ↓PaCO2
Chronic: HCO3 *decrease* 4mEq/L per10mmHg ↓PaCO2

Later, look at:

1) Anion Gap: Na - (HCO3 + Cl) (NL 12 +/- 2)
Think MUDPILES (methanol/metformin, uremia, DKA, Propylene Glycol, INH/Iron/Infection, Lactate, Ethylene Glycol, Salicylates, Cyanide)
2) Delta Gap (also known as corrected HCO3) = (AG -12) + HCO3 = 24 +/- 2
presence of delta gap means concomitant metabolic acidosis or alkalosis on top of an AG acidosis
<20 =concomitant metab acidosis
>26 =concomitant metab alkalosis
3) Osmol Gap: 2Na + glc/18 +BUN/2.8
corrected Osmol Gap for ETOH = ETOH/4.6
corrected OG >10 points to methanol or ethylene glycol exposure

ICU Guidebook | Procedures&Calculators | Supplemental O2

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Supplemental Oxygen

Nasal Canula > Simple face mask > Venturi-mask > non-rebreathing mask

Nasal Canula
- 1L ~ 0.24 FiO2
- Each additional liter ~ adds 0.04 FiO2

Venturi mask
- Precise administration of O2
- Usual preset values of FiO2 of 24%, 28%, 31%, 35%, 49% and 50%

Nonrebreathing mask
- 0.80 to 0.90 FiO2

Non-Invasive Positive Pressure Ventilation (NIPPV) --BIPAP/CPAP

How does it work?
Increases alveolar ventilation
Decreases work of breathing
Helps rest pt's resp muscles
Assess pt's VS including O2sat, ABCs, and stability before deciding to pursue NIPPV
Contraindications of BIPAP/CPAP (using your common sense): severe encephalopathy, inability to cooperate/protect airway, high risk of aspiration, inability to clear secretions, upper airway obstxn, homodynamic instability
If stable à
1. Determine mode and delivery device to be used (BIPAP vs. CPAP, nasal vs. facial mask)
àBIPAP: IPAP (inspiratory + airway pressure): 6-10
*helps overcome the work of breathing, adjust this will help change pCO2
EPAP (expiratory + airway pressure): 2-4
*similar to PEEP on vent, adjust this will help change pO2 along w/ the amount of O2 supplied
**start low at IPAP of 7 and EPAP of 2 (keep AT LEAST 4-5 pressure difference btwn IPAP & EPAP or will just be like CPAP)
àCPAP: 5-7pressures
2. Monitor ABG q30-45minutes for the first 2 hours.
à if NO improvement in pH or pCO2, consider trial failure and may need to proceed w/ intubation.

WEANING TRIAL

1. Can consider if pt on FIO2 of <0.3 and PEEP of 5
2. Also calculate Rapid Shallow Breathing Index = RR/TV
à offers some predictive value of success of weaning
RSI >105 (failure to wean likely
RSI 51-104 = offer CPAP trila
RSI <50 (success weaning likely
**Remember to turn off all sedation for 4-6hrs prior to trial
3. If pt able to maintain oxygenation & ventilation w/o evidence of tiring after 30 min(then d/c mech vent

Indications for Intubation

Look for rapid shallow breathing and fatigue. Try to reverse underlying conditions.
1) airway protection 2) decline in mental status 3) pCO2 increasing 4) pO2 < 60, not responding to supp oxygen 5) pH <7.2; *Acute respiratory failure*: pO2 < 50 or pCO2 > 50 with pH <7.3 on RA

Quick Links

- Acid Base
- ABG Calculator
- A-a Gradient
- How to assess an ABG

ICU Guidebook | Procedures&Calculators | Thoracentesis

A thoracentesis is a very useful diagnostic procedure. Fluid analysis can be used to assess the nature of the effusion, and the need for further management such as antimicrobials.

Indications:
Consideration should be given to all pleural effusions
Pleural effusion which needs diagnostic work-up
Symptomatic treatment of a large pleural effusion

Contraindications:
Uncooperative patient
Uncorrected bleeding diathesis
Chest wall cellulitis at the site of puncture
Bullous disease, e.g. emphysema
Positive end-expiratory pressure (PEEP) mechanical ventilation
Only one functioning lung
Small volume of fluid (less than 1 cm thickness on a lateral decubitus film)

Supplies:
Thoracentesis kit
Bedside US Machine

Method:
Read the following document: NEJM > Thoracentesis
Procedure video: NEJM Videos in Clinical Medicine > Thoracentesis

Complications:
Pneumothroax
Hemothorax
Arrhythmias
Air embolism
Introduction of infection

PROCEDURE TEMPLATE

PROCEDURE:
Thoracentesis, U/S guided.

INDICATION:
Large pleural effusion.

PROCEDURE OPERATOR:

CONSENT:
Consent was obtained from the patient prior to the procedure. Indications, risks, and benefits were explained at length.

PROCEDURE SUMMARY:
A time out was performed. The patient was prepped and draped in a sterile manner using chlorhexidine scrub after the appropriate level was percussed and confirmed by ultrasound. U/S images were permanently documented. 1% lidocaine was used to numb the region. A finder needle was then used to attempt to locate fluid; however, a 22-gauge, 3 1/2-inch spinal needle was required to actually locate fluid. Fluid was aspirated on the second attempt only after completely hubbing the spinal needle. Clear yellow fluid was obtained. A 10-blade scalpel used to make the incision. The thoracentesis catheter was then threaded without difficulty. The patient had 1200 mL of clear yellow fluid removed. No immediate complications were noted during the procedure. Dr. _____ was present during the entire procedure. A post-procedure chest x-ray is pending at the time of this dictation. The fluid will be sent for several studies.

ESTIMATED BLOOD LOSS:

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A paracentesis is a useful procedure for fluid analysis of ascites and diagnoses of SBP. Spontaneous bacterial peritonitis can be asymptomatic in nearly 40% of patients, hence prompt diagnosis and treatment of SBP is required. Always consider performing a paracentesis on hospitalized patients with ascites. Paracentesis can be performed safely at bedside, or ultrasound –guided via radiology.

Indications:
To diagnose SBP, cancer; or may be therapeutic for pts with diagnosed liver disease
Contraindications:
Uncooperative patient, uncorrected bleeding diathesis, acute abdomen that requires surgery
intra-abdominal adhesions, distended bowel, abdominal wall cellulitis at the site of puncture, pregnancy.
Supplies:
This will vary at your site (JBVA/UIC). There are kits available at both institution. In general, this is waht you need:
16 G Angiocath (or a spinal needle) x 1
10 cc syringe x 1
Thoracentesis kit tubing x 2
Sterile gloves x 2
Betadine swab x 3
Sterile drape x 2
4x4 sterile gauze x 4
Band-aid x 1
If therapeutic paracentesis:
One-liter vacuum bottle x 5
Proper tubing and wall suction kit

Method:
Read the following document: NEJM Paracentesis
Procedure video: NEJM Videos in Clinical Medicine > Paracentesis

What to send fluid for:
- cell count with diff (PMN > 250 = SBP) (lavender top)
- culture (fill each blood culture bottle (2) with 10cc of fluid)
- gram stain (separate syringe or tube)
- LDH, protein, albumin, amylase (gold top tube)
- Cytology (send as much as you can – fill a sterile jug)

SAAG
Calculate the serum-ascites albumin gradient (SAag): subtract ascitic albumin from serum albumin
If > 1.1g/dl à portal hypertension
If < 1.1g/dl à not portal HTN and less likely to have SBP
(Note – if hemorrhagic, subtract 1 PMN for every 250 RBCs)

PROCEDURE TEMPLATE

PROCEDURE:
<Diagnostic?/Therapeutic?> paracentesis

INDICATION:

PROCEDURE OPERATOR:

CONSENT:
Informed consent was obtained after risks and benefits were explained at length.

PROCEDURE SUMMARY:
A time-out was performed. The area of the <LEFT/RIGHT> abdomen was prepped and draped in a sterile fashion using chlorhexidine scrub. 1% lidocaine was used to numb the region. The skin was incised 1.5 mm using a 10 blade scalpel. The paracentesis catheter was inserted and advanced with negative pressure under ultrasound guidance. Ultrasound images were permanently documented. No blood was aspirated. Clear yellow fluid was retrieved and collected. Approximately 65 mL of ascitic fluid was collected and sent for laboratory analysis. The catheter was then connected to the vaccutainer and <__> liters of additional ascitic fluid were drained. The catheter was removed and no leaking was noted. 50 g of albumin was intravenously during the procedure. The patient tolerated the procedure well without any immediate complications. Dr. ____ was present during the procedure.

ESTIMATED BLOOD LOSS:

COMPLICATIONS: none

Complications:
Persistent leak from the puncture site
Abdominal wall hematoma
Perforation of bowel
Introduction of infection
Hypotension after a large-volume paracentesis
Dilutional hyponatremia
Hepatorenal syndrome
Major blood vessel laceration
Catheter fragment left in the abdominal wall or cavity

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HEPARIN DOSING

(UIC Guidelines)

Assess for h/o bleeding PUD, recent stroke or bleeding, recent surgery, guaic negative

Initial:

Weight (kg)	IV Bolus (~65u/kg)	Infusion (~13u/kg/hr)
< 50	3000	600
51-60	3500	700
61-70	4000	900
71-80	5000	1000
81-90	5500	1100
91-100	6000	1200
>100	7000	1400

Maintenance: recheck PTT in 6hrs after every change

aPTT:

< 45	reassess IV/bag/pump: repeat full bolus and increase by 200u/hr
45-60	repeat _ bolus and increase by 100units/hr
60-80	no change: repeat PTT until 2 consecutive therapeutic levels, then daily
80-115	decrease rate by 100units/hr
116-195	HOLD for 1 hr, then decrease by 200units/hr
>195	recheck PTT stat, hold until results return: check for signs of bleeding: consider protamine sulfate or blood products if signs of active bleeding

Protamine Sulfate reversal of heparin:

1) Overdose with bleeding (call senior): 1-1.5mg for every 100units of heparin
After 30-60min: 0.5-0.75mg per 100 units
After 60 min: 0.25-0.375mg per 100 units
2) elevated aPTT and/or bleeding with maintenance heparin:
give 25-50mg of protamine sulfate,
OR protamine SO4 = 2(heparin infusion rate units/hr) / 100
3) elevated aPTT and/or serious bleed after SC heparin:
give 1-1.5mg for every 100units; give the first 25-50mg by slow IVP (approx 5mg/min); then give the balance over next 8-16hrs
NB: slow IVP of protamine sulfate at 5mg/min; max 50mg/dose
Hypersensitivity reaction to protamine sulfate: anaphylaxis (esp if pt is sensitive to fish, prior protamine sulfate, s/p vasectomy or infertile)

Order a baseline aPTT, Hct, and plt count prior to initiation of Argatroban
Standard bag: Argatroban 250mg/D5%W 250mL –Conc: 1 mg/mL

Initial Dosing:
1) If no hepatic impairment □ 2mcg/kg/min
2) If moderate hepatic impairment □ 0.5mcg/kg/min
3) Max dosing weight is 140kg and max rate is <10mcg/kg/min
4) Goal aPTT: 60-100 seconds

Protocol for dosing adjustments of argatroban:

aPTT	Change of rate of infusion	Next aPTT test
30-39	+1.0mcg/kg/min	2hrs
40-59	+0.5mcg/kg/min	2hrs
60-100	0	Next am
101-119	-0.5mcg/kg/min	2hrs
>120	-1.0mcg/kg/min	2hrs

Protocol for dosing adjustments of argatroban w/ HEPATIC IMPAIRMENT

aPTT	Change of rate of infusion	Next aPTT test
30-39	+0.2mcg/kg/min	2hrs
40-59	+0.1mcg/kg/min	2hrs
60-100	0	Next am
101-119	-0.1mcg/kg/min	2hrs
>120	-0.2mcg/kg/min	2hrs

Interpretation of INR upon initiating warfarin:

1) Co-adm of argatroban and warfarin produces synergistic effects on INR.
2) INR should be >4 before d/c of argatroban infusion.
3) Estimated INR for warfarin dose alone = 0.185 + [(0.51) x (measured INR)]

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Here is a summary of must-read landmark articles for CCU

Credits

- **ICU Guidebook**
  Many generations of Chief Residents have contributed to the creation of this ICU Guidebook. The Guidebook was updated and made digital by the 2012-2013 crew. The most recent update, which included mainly spelling corrections, was performed by the 2013-2014 crew in September 2013.