HOUSESTAFF
MICU HANDBOOK

2015-2016

LOYOLA MEDICINE
We also treat the human spirit.*
To all residents/medical students/fellows:

Welcome to the MICU. The MICU is a very unique environment which stresses teamwork between residents, interns, fellows, and nursing staff, and can be one of the most rewarding rotations in your medical training.

This handbook is provided as a resource to help you through these next 4 weeks, as well as the remainder of your training. Obviously, it is not all – inclusive, but will serve as a good introduction to the MICU and a nice reference. You should try to at least glance over this handbook in the first couple of days of the rotation, and then make a more thorough perusal during the remainder of the month. If you have any thoughts on improvements, additions, or subtractions from the handbook, please let us know.

Good Luck and Have Fun! We look forward to working with you.

Ed and the pulm-cc co-fellows

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ICU Nurse Welcome Page
Welcome MICU Residents!!

**Patient Care**
- Let the Charge Nurse know of any admissions or potential admissions as soon as you are aware.
- If you are planning to order a CT, MRI or any test that requires the nurse to travel with the patient, please let us know ASAP. If the patient is unstable, the resident will be asked to accompany us.
- If you put in stat orders on a patient, let the nurses know right away... we are not always by a computer to check.
- Please **Do Not Touch the Infusion Pumps**. If you would like something titrated or discontinued, let a nurse know!
- Please Do Not silence alarms (monitors, IV pumps, or Ventilators).
- After examining a patient, make certain restraints are on, side rails are up, and the bed is in low position.

**Nurses Station**
- Please Plug-In COW’s after you are done with rounds!!
- Please introduce yourself to all of our secretaries so they can identify you if you have a phone call.
- If you page a colleague, please pick up the phone when it rings. If you need to leave the nurses station, tell the secretary who you paged and where to find you when they call back. Please don’t call the desk and ask us to look around for somebody. If they have a pager just page them.

**MICU Necessities**
- If a patient needs a CXR, EKG’s, morning labs, or weaning parameters, please enter them the night before. Restraints need to be updated daily.
- Most of our patients should have some very simple orders that make a big difference in their care and outcome. Please make sure SCD’s, SQ Heparin, Prevacid, stool softeners, and PT/OT are ordered for the appropriate patients, of course there will be some contraindications to these orders.
- When putting in a central line or performing a procedure, please fill out the CLIP form

**Nighttime**
- Please observe “Silent Night” after 9 PM and speak quietly while on the unit.
- Before going to bed for the night, please check with the nurses to see if there is anything that they may need ordered before turning in.
Things to know about the ICU

Responsibilities:

- In addition to participating in the admission of patients to their primary service, the night float intern is responsible for cross covering all patients on their service as well as those patients on the pulmonary transplant service.
- Senior residents are responsible for admissions to the MICU as determined by the fellow. Overnight admissions are the responsibility of the night float senior resident who will then staff the patient with the ICU fellow on call/overnight attending.

Overflow patients - will be triaged as follows:

- Patients awaiting floor beds will have their care assumed by the appropriate floor team (even though the patient is still physically located in the MICU).
- If both MICU services are over cap, the MICU fellow/attending will identify appropriate patients to be managed by the Transplant Attending/Fellow with the assistance of the CCU housestaff.

Transfer policy:

- Make sure the fellow or attending OK all transfers before you transfer them out of the ICU
- Before 1PM, as soon as a transfer order has been placed by the ICU service, sign-out will be called to Gen Med (or other accepting team) who will at that time resume responsibility for the patient even if the patient is still physically in the MICU.
- After 1PM patients stay on the MICU list overnight and to be called out to GM in the morning (MICU team is responsible for these patients until they are signed out in the morning to GM).
- Transfers to go GM 5-8 unless they are a bounceback to GM 1-4; have transfer summary in early.
- To transfer, please page 91048 (Hospital admissions) and speak with the admissions center. They will then direct you to page a specific hospitalist to transfer the patient.
- Please place the “transfer patient” order to the specific service once transferred.
- Transfers to non Gen-Med resident run services can only be done if the patient is physically out of the MICU or has been stable in the MICU for 48 hours (and couldn’t be transferred out due to lack of beds).
When to call the MICU fellow?
- Any change in hemodynamic parameters of a patient as well as mentation.
- Any ventilator changes other than increasing FiO2
- Any significant clinical issues with transplant patients (patients are very tenuous!)
- With any potential transfers out of the MICU
- To staff all new admission to the MICU during the day and overnight if not staffed with the in house intensivist
- The ICU fellow is responsible for evaluations during the day. Evaluations that are to be admitted to the MICU will be communicated to the senior resident who is then responsible for the admission. Overnight admissions are the responsibility of the night float senior resident who will then staff the patient with the ICU fellow on call/overnight attending.

Pulmonary Transplant patients:
- Transplant admissions overnight are done by the senior resident
- All admissions need to be staffed with the fellow
- Call the fellow with ANY significant clinical changes or with any questions
- If you cannot reach the fellow, call the transplant attending directly
- NF intern: Page or call the daytime transplant fellow with signout in the am before you leave!

Night Float
- At least one senior resident from each team should be present for sign out.
- Remember that you’re not the only doctor in the house; call your senior resident when you need help. It’s always better to call than to not call. ALWAYS. If still unsure, please call your fellow with questions.
- Some nights of the month there is an in house intensivist attending with whom you will staff new patients and run questions by
ICU Tips From Attendings

*The only thing that is more boring than listening to you read your H&P is listening to you read someone else’s H&P

*Your notes need to be complete, but that doesn’t mean I need to hear about the family history in your presentation

*The assessment and plan should be given by organ system WITH DIAGNOSES (example: problem number one – septic shock due to pneumonia)

*Know the antibiotics as day #/ length of course (ie day 4 of 10)

*For ABGs- read them as pH/ pCO2/ pO2 and nothing else (I don’t need to hear the calculated bicarb or base excess)

*The only thing that will ever get you in trouble is not calling when you need help

*Trust the RNs and RTs

*Don’t change the vents without talking to the fellow.

*Get your notes in early
Daily ICU Checklist

- Get signout from night float intern, inform senior resident and fellow of any significant events
- Examine sickest patients/ patients with significant changes overnight/ new patients
- **Check labs**
  - In addition to normal daily labs that you may see on any medicine patient, ICU patients may have morning blood gases. Please pay close attention to blood gases especially if they are mechanically ventilated.
- **Vitals**
  - Subtle changes in HR and BP are especially important to know in hemodynamically unstable patients.
  - Make sure you note blood pressure changes both as systolic/diastolic BP and as mean arterial pressures (MAPs).
  - Note if BP/MAPS are recorded non-invasively (cuff pressures) or with an arterial line
  - BP/MAPS need to be reported with changes in pressor doses since both of those affect a patient’s hemodynamic status.
  - Telemetry is found on the ICU monitors at the nurses station, not on the floor.
- **Examining the patient:**
  - Lines and tubes
    - Central lines → Which side, Type (cordis, triple lumen, PICC etc.) **DON’T FORGET ABOUT PICCs**
    - Arterial lines → Which side, also try and figure out how the wave form looks, if it’s working correctly or dampened due to clots etc.
    - Foley catheter
    - ET tube (only note if any changes in position occurred overnight)
    - PLEASE LOOK AT THE BLUE LAMINATED SHEET NEAR THE DOOR AND DOUBLE CHECK # OF DAYS EACH LINE AND FOLEY HAS BEEN INSERTED IN PATIENT
  - Drips
    - **Pressors** → Which kind, current dose (usually dosed in mcg/kg/min or units if vasopressin)
    - **Sedation** → Examples include propofol, Precedex (dexmedetomidine) and versed (midazolam) drips. Don’t forget that these medications can be ordered as PRN pushes as well. Please note drip rate changes overnight and/or how many pushes patient received
    - **Analgesia** → Examples include fentanyl, morphine, dilaudid. Same as sedation above for dosing and note if pushes ordered instead of drips.
    - **Other drips** → heparin, bicarb etc.
  - Physical exam
    - Check **pupils** and assess for responsiveness. Brief neuro exam on every sedated patient to assess problems. Note that patient may need daily sedation vacation to assess this (see section on sedation vacations).
    - Check for **clonus** if appropriate.
ANSWER THESE QUESTIONS EVERY DAY:

- Is the patient uncomfortable or over sedated?
- If the patient is uncomfortable, is it because of pain or anxiety/agitation?
  - This will determine which drug you titrate (analgesic vs. anxiolyis)
- Can I do a sedation vacation today to assess weaning? (See below)
- Does the patient need more/less access (Central lines, foley, arterial lines) or can they come out?

Check the Vent

- Look at the ventilator settings and then look at what the patient is doing.
  - Note patient’s respiratory rate and compare it to set ventilator rate
  - Note if patient is “double-stacking” or not otherwise synchronous with the ventilator (ask someone to show you how to check for this)
- IF the patient is in VOLUME CONTROL MODE:
  - Note the set tidal volume, PEEP, FiO2, Flow rate and waveform (square vs. ramp)
  - Check peak and plateau pressure – Ask someone to show you how and until told otherwise, do it under supervision.
  - Here’s the CLIFF notes version: Make sure patient is in volume control, square waveform and with a flow rate of 60 L/M. Then hit the inspiratory pause button and record peak, plateau and resistive pressures. Place patient back on previous ventilator settings.
  - Caveat: Plateau pressures will work if patient is in ramp waveform, but you won’t get accurate airways resistance.
- IF the patient is in PRESSURE CONTROL MODE:
  - Note the following: Inspiratory pressure, inspiratory time, current tidal volume patient is taking on this pressure and inspiratory time.

ANSWER THESE QUESTIONS EVERY DAY TO ASSESS WEANING (also see “weaning” section on page 18):

- Is this patient hemodynamically stable? (not on pressors)
- Is this patient awake?
- Have I fixed the underlying cause of his respiratory failure?
- Have I weaned his ventilation to as close to physiological as possible?
- For most people, this is VC, RR 12-14 (patient breathing over the ventilator comfortably), PEEP <=5, FiO2 <= 40%.
- (NEVER use the term “MINIMAL VENT SETTINGS” if Dr. Tobin is your attending).
- If YES to the above three, can I try a spontaneous breathing trial (SBT)?
- Hold tube feeds if you are assessing a patient who will likely be extubated. Resume tube feeds if SBT fails.

Review today’s CXR – Ask yourself if the patient needs a CXR for the next day (newly ventilated, or has various lines/catheters put in like a balloon pump, ECMO etc.). If yes, then order one for tomorrow NOW.
• Transferring patients
  o If patient is to be signed out to gen med, then page 91048 for patient placement and let them know you are transferring someone. They will tell you which hospitalist to talk to (unless bounce back, then goes to resident team). Page said hospitalist and sign patient out. **Place transfer order.** Do this **after 0730** and **before 1300**. If you do this after 1300, then your team will cover overnight.
  o For NON GEN MED RESIDENT services, patient has to physically be on the floor or in the MICU for 48 hours from time of transfer order placement to be signed out.

• Please **f/u with transplant service** on all lung transplant patients at least daily. Make sure to follow up on their rec ve immunosuppressive therapy, prophylactic abx, etc

• Orders for the next day → Assess if patient needs a **morning ABG**, then order one.

• Check and make sure patients are **on GI prophylaxis** (Ventilated patients in the ICU or on stress dose steroids) and **DVT prophylaxis** (Heparin/lovenox)

• Lastly, Dr. Hutchinson’s pneumonic to make sure you don’t miss anything:
  o **FAST HUGS BASIC**
  o Feeding (tube feeds)
  o Analgesia
  o Sedation
  o Thromboembolic prophylaxis
  o Head of bed elevated to 30 degrees
  o Ulcer prophylaxis → Mechanical ventilation or Stress dose steroids
  o Glycemic control (110-180)
  o Spontaneous Breathing Trial Assessment
  o Bowel regimen
  o Activity (PT/OT)
  o Skin Care
  o Indwelling foley care (removable?)
  o Catheters → Lines, how long in patient and can we remove.
ICU Rounds – Oral Presentations

**The key to a good oral presentation is organization, completeness, and brevity. All significant changes since the last rounds need to be mentioned, but small changes in labs etc... can be addressed with the senior and/or fellow before or after rounds. It is a good idea, at least initially, to run through the presentation prior to rounds to make sure it is organized and complete.

SOAP FORMAT:

S:
24 hour events: started on pressor/ weaned off pressors, intubated/extubated, transfused, etc

Currently: intubated & sedated; has no complaints, is confused, etc.

O:
Vital signs: Temperature (max and current), RR, HR (state if rate controlled, or on cardizem drip, etc), BP (state if on/off pressors) INCLUDING MAP, O2 sat (on amount of O2 – if vent see below)

Ventilator settings: Mode (AC-vol or pressure control, SIMV, PS), Rate (and if patient is breathing over the vent), Tidal Volume, FiO2, PEEP, Compliance, Resistance FOR ALL AC. Weaning parameters (if available)

Exam: focused! Only pertinent positives and negatives

Labs: only significant; most attendings prefer you read off entire cbc w diff, bmp

Microbiology: new culture results

Radiology: significant findings

A/P:
xx y/o male/female with xx disease admitted to the MICU with xx
ICU Progress Notes (SOAP format)

**Ask your seniors for templates!**

24 hour events:

**Subjective:**

O: Vital signs (Tmax/min, RR, HR, BP, SpO2)
  Vent settings: (Mode/Rate/Tidal Volume/Fio2/PEEP)

**ABG:**

Drips (pressors, analgesics, sedatives, insulin, etc)

Physical Exam (include the presence of any central lines/chest tubes/foleys/ng tubes)

**Labs:**

Microbiology: Respiratory cultures/blood cultures/urine cultures/CSF cultures

**Medications:**

**Radiology:**

Assessment/Plan: ___y/o male with _____ who was admitted to the MICU on _____ for _____
ICU Formulas

**Ventilator and Respiratory failure:**

**A-a Gradient** = \[ (P_{atm} - P_{H2O}) \times FI02 - (PaCO2/R) \] - PaO2

\[
\begin{align*}
P_{atm} &= 760\text{mmHg (though Fahey says Chicago is above sea level so } P_{atm} \text{ here is 747mmHg)} \\
P_{H2O} &= 47\text{mmHg} \\
R &= 0.8
\end{align*}
\]

Normal A-a gradient = \((\text{age} + 4)/4\)

**Compliance** = Tidal volume (cc)/ (Plateau pressure – PEEP)
(normal compliance = 60-100)

**Airway Resistance** = \((\text{Peak pressure} – \text{Plateau pressure}) / \text{Flow (L/sec)}\)

*Keep in mind that vent gives your flow in L/min so you have to convert it*
(normal resistance = <10)

**Minute Ventilation**: RR x Vt (in L)

**Plateau Pressure**: goal <30

**Cardiovascular**

**Cardiac Output**: SV x HR
Normal = 75cc x 75 bpm = ~5LPM

**MAP** = D + 1/3 PP
= SBP + 2/3DBP
Normal = 75-105

**SVR** = \((\text{MAP-CVP/CO}) \times 80\)
Normal = 800-1200

**Anion Gap** = \(\text{Na} - (\text{Cl} + \text{HCO3})\)
Corrected for low albumin = \(\text{Na} - (\text{Cl} + \text{HCO3}) + 2.5(4 – \text{serum albumin})\)

**Stroke Volume Variation (SVV)**
<10% = not fluid responsive
>13% = likely to respond to fluids

**Fick Equation**
\[\text{CO} = \text{VO2}/[10(\text{CaO2-CvO2})]\]

**O2 Content or CaO2** = \(1.34 \times \text{Hgb} \times \text{O2 sat}\)
Normal = 20ml O2/dL
Oxygen Delivery or DO2 = CaO2 x CO  
Normal = 1000ml/min or 1 LPM

O2 Consumption or VO2 = 250 cc/min

Renal/Acid-Base

Sodium Correction for Glucose: For each 100mg/dL increase in glucose, sodium decreases by 1.6mEq/L

Serum Osmolarity: 2(Na + K) + BUN/2.8 + glucose/18  
(normal = 270-290 mOsm/kg)

Serum Osmolar Gap: calculate – measured, normal <+/-10 (remember to correct for EtOH)

Corrected Serum Ca= measured Ca mg/dL + 0.8 x (4 – serum albumin g/dL)

Fractional Excretion of Sodium (FENa) = 
(Urine sodium x Plasma creatinine)/(Plasma Sodium x Urine creatinine)

FENa<1% = prerenal
FENa>2% = ATN
FENa 1-2 = either

*Substitute urea for sodium, and you get the FEurea. <35% = prerenal

Free Water Deficit for Hypernatremia = 0.6 x Weight (kg) x [(Plasma sodium/Desired plasma sodium)-1]
### Hemodynamics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right atrial pressure (RAP)</td>
<td>2-6 mmHg</td>
</tr>
<tr>
<td>Right ventricular pressure (RVP)</td>
<td>15-25mmHg</td>
</tr>
<tr>
<td>Pulmonary artery systolic pressure (PASP)</td>
<td>15-25mmHg</td>
</tr>
<tr>
<td>Pulmonary artery diastolic pressure (PADP)</td>
<td>8-15mmHg</td>
</tr>
<tr>
<td>Mean pulmonary artery pressure (MPAP)</td>
<td>6-12mmHg</td>
</tr>
<tr>
<td>Left atrial pressure (LAP)</td>
<td>6-12mmHg</td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure (PCWP)</td>
<td>6-12mmHg</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>4-8 L/min</td>
</tr>
<tr>
<td>Cardiac index</td>
<td>2.5-4 L/min</td>
</tr>
<tr>
<td>SVR</td>
<td>800-1200 dynes sec/cm5</td>
</tr>
<tr>
<td>PVR</td>
<td>&lt;250 dynes sec/cm5</td>
</tr>
</tbody>
</table>
The Ventilator

- **Please do not change the ventilator without talking to the fellow/senior resident first!!!**
- Please place a “Mechanical ventilation subsequent” order in the computer detailing your changes so RTs are aware. Please also talk to either the RT or the RN about your changes.
- **Non Invasive Modes:**
  - **BiPAP**
    - Relatively airtight fitting mask attached to a positive pressure ventilator
    - Patient driven respiratory rate and inspiratory time, but you set the inspiratory pressure and PEEP.
    - Indications:
      - High pressure pulmonary edema
      - Certain types of hypoventilatory failure (COPD exacerbations etc.)
      - Immunosuppressed patients with hypoxemic respiratory failure, fever, and pulmonary infiltrates.
    - Check **ABGs about 1-2 hours** after placing patient on BiPAP or adjusting settings.
    - **Absolute contraindications to BiPAP:**
      - Altered mental status resulting in an inability to comply with mask
      - Inability to protect airway/high aspiration risk (BiPAP can increase risk of aspiration in these patients)
      - Hemodynamic instability (pressor requirements)
      - Severe metabolic acidosis
  - **CPAP**
    - Continuous positive airway pressure
    - Basically PEEP without an inspiratory pressure
    - Useful in patients with OSA, or Obesity Hypoventilation Syndrome
- **Invasive Modes:**
  - Check **ABGs about 15-30 mins** after any significant changes
  - **Assist Control (AC)**
    - **Volume Control** → Fixed tidal volumes, varying peak and plateau pressures depending on lung/chest wall compliance. **Always report peaks/plateaus with volume control as these vary.**
    - **Pressure Control** → Fixed airway pressures, varying tidal volumes depending on lung/chest wall compliance. **Always report tidal volumes with pressure control as these vary.**
• Length of pressure driven inspiration is set by an **Inspiratory time** (i-time) which determines how long the ventilator should generate your pressure driven breath.

  o **Synchronized Intermittent Mandatory Ventilation (SIMV)**
    ▪ Used predominantly by anesthesia and in the SICU, as a rule, don’t use in MICU.
    ▪ Essentially volume control with ventilator delivering set tidal volumes at a set respiratory rate.
    ▪ If patient decides to take spontaneous breaths, there is no support to these breaths (ventilator just lets them take whatever tidal volume they can do on their own). The idea is that this is supposed to assist with weaning and extubation, this is largely unproven.
    ▪ Can provide pressure support to spontaneous breaths if needed.

  o **Pressure Support Ventilation (PSV)**
    ▪ **Spontaneous** mode of ventilation which is pressure driven. Spontaneous means that patient sets their own RR and i-time (compare this to pressure control where there is a minimum set RR and inspiratory time that will cause ventilator to deliver breaths)
    ▪ Set inspiratory pressure and PEEP, resulting in variable tidal volumes.
    ▪ If patient is apneic for too long, the last assist control mode (VC or PC) will kick in automatically (back-up ventilation).
    ▪ Can to be used to extubate people but we do T-Piece trials at LUMC. Ask your friendly neighborhood pulmonary fellow to teach you about “**flow by**” and how to get weaning parameters directly from the ventilator.

  o **BiLevel (APRV or Airway Pressure Release Ventilation)**
    ▪ Ask your friendly neighborhood pulmonary fellow if interested. You will never use this mode.

• **Rate**
  o 12-14 breaths per minute is good starting point
  o You want the patient breathing about 4 bpm over set rate, if not, assess why (too sedated, paralyzed or otherwise altered)

• **Tidal volume**
  o **5-8cc/kg** ideal body weight (IBW) (use an online calculator for IBW)
  o Ballpark (small patient: 400cc, medium pt: 500cc, large patient: 600cc)
  o **4-6cc/kg** IBW for ARDS

• **FiO2**
  o Start at 100% and titrate down to keep sat >92%
  o Want FiO2 <60% to avoid O2 toxicity

• **Decreasing PEEP**
  o Abrupt reduction in PEEP may produce severe hypoxemia that takes days to reverse (may take up to 2 weeks for re-recruitment of alveoli). This is typically seen in ARDS patients.
• Standard way of noting/presenting vent settings:
  o Volume control: VC/RR/Vt/PEEP/FiO2%
  o Pressure control: PC/RR/Pi/PEEP/FiO2%. Then say i-time.

**Weaning**

• Assess readiness to wean on a **DAILY** basis
  o ANSWER THE FOLLOWING QUESTIONS:
    ▪ Is this patient hemodynamically stable? (not on pressors)
    ▪ Is this patient awake?
    ▪ Have I fixed the underlying cause of his respiratory failure?
    ▪ Have I weaned his ventilation to as close to physiological as possible?
      ▪ For most people, this is VC, RR 12-14 (patient breathing over the
        ventilator comfortably), PEEP <= 5, FiO2 <= 40%.
      ▪ **(NEVER use the term “MINIMAL VENT SETTINGS” if Dr. Tobin is your
        attending).**
      ▪ If YES to the above three, can I try a spontaneous breathing trial (SBT)?

• Spontaneous Breathing Trial (**SBT**)
  o Way to trial a patient to assess his readiness to wean.
  o At Loyola, this is done with a **T-piece**. A device attaches to the ET tube which is
    open to room air. Patients essentially breathe room air on their own through the
    ET tube.
  o Duration: **30-60 minutes** (Longer SBTs will cause patient to tire out because they
    are essentially breathing through a straw).
  o Subjective and objective parameters to look at to determine a successful SBT
    ▪ **RSBI** ➔ Rapid Shallow Breathing Index
      ▪ Diaphragm fatigue is characterized by a patient taking shallow
        breaths (low tidal volumes or Vt) with a fast respiratory rate (RR)
        i.e **rapid** (fast RR), **shallow** (low Vt) **breathing**.
      ▪ The ratio of the RR/Vt is a measure of this. High = respiratory
        distress, low = good respiratory function. This is called the RSBI.
      ▪ RSBI > 105 predicts unsuccessful extubation. Remember,
        however, that RSBI < 105 does not always predict successful
        extubation
    ▪ **NIF** ➔ Negative inspiratory force
      ▪ A method to measure the force generated by a patient’s
        diaphragm during spontaneous breathing.
      ▪ Requires a cooperative patient and an RT using a Wright’s
        spirometer (can be approximated by the ventilator) to measure
        this pressure.
      ▪ Normal NIF is -60 or less (NIF is measured by **negative** pressures)
      ▪ We look for -20 or less when extubating someone
    ▪ Evidence of **hypoxemia** (Decreased O2 saturations/Increased RR/ABG) or
      hypoventilation (ABG, mental status, respiratory fatigue etc.)
• Evidence of **hemodynamic instability** (including increased pressor requirements)

• Any evidence of **respiratory distress/failure** → Accessory muscle use, patient has “the look”.

• **Cuff leak**
  - Theory is that prolonged intubation with a cuff causes tracheal edema around the cuff site which can cause problems after extubation.
  - Way to test this is to have RT deflate ET cuff and determine if there is an appropriate leak of air during inspiration.
  - Essentially, ask RT to tell you if patient has cuff leak or not.
  - Treat with steroids if needed.

• **Extubate** if patient passes SBT
  - Done by RT
  - Make sure patient/family understands that there is appx 15-20% chance of re-intubation.
  - Place the “extubate patient” order in the computer.
Things to know when intubating a patient

- “Code respiratory” = anesthesia intubating your patient in the ICU.
- “Code blue” = anesthesia intubating your patient on the floor.
- **Know the most recent potassium value (cannot use succinylcholine if high K)**
- Some things anesthesia does in the room
  - Bag patient with 100% oxygen
  - Sedate patient, usually with etomidate** (rapid onset – 1 min, duration about 3-5 minutes), occasionally with ketamine.
  - Paralyze patient
    - Succinylcholine: Rapid neuromuscular depolarizing agent, contraindicated in hyperkalemia. Duration of action of minutes.
    - Rocuronium: Longer acting non-depolarizing neuromuscular agent. Duration of paralysis is about 30-60 minutes.
    - Vecuronium: Longer acting non-depolarizing neuromuscular agent. Duration of paralysis is about 45-75 minutes.
  - Intubate
  - Leave
  - ** Etomidate doesn’t theoretically cause hypotension, but intubated people usually end up hypotensive for various reasons. So if patient is in shock or bordering on hemodynamic instability, consider ordering pressors prior to intubation

- **Ventilator settings**
  - Mode: Volume control for the most part
  - RR: 12-14
  - Tidal Volumes: 6-8cc/kg IBW,
    - Ballpark → small patient: 400cc, medium pt: 500cc, large patient: 600cc
  - PEEP: 5
  - FiO2: 100%
  - Place “mechanical ventilation initial order panel” in computer with settings
  - **Blood gas within 30 minutes** of intubation

- **Order CXR** (for now and for tomorrow morning)
  - ETT 2-5 cm above the carina (Between carina and clavicles).
  - If ETT needs to be pushed in or out, ask RT to do it.
  - Repeat CXR every time you change ETT positioning

- **Order Sedation/Analgesia** – Order set under “Adult critical care analgesia/sedation” There are many options, here are some general suggestions
  - Hemodynamically stable patient intubated purely for airway protection (Rare occurrence)
    - Try **just fentanyl** → drip or pushes. This is both analgesia and sedation. Don’t forget that fentanyl drips are mcg/kg/hr (huge doses possible).
    - Add on **propofol** or **Precedex** for agitation if needed
o Hemodynamically stable patient intubated for respiratory failure 2/2 underlying disease (pulmonary or otherwise)
  ▪ The difference this time is that you may need to “rest” patients and control their respiration until the acute issue resolves. This may require deeper sedation/anxiolysis than simply fentanyl.
  ▪ Fentanyl gtt or pushes for analgesia/sedation
  ▪ Propofol or Precedex** for anxiolysis if needed

o Hemodynamically unstable patient
  ▪ Fentanyl gtt/pushes
  ▪ Try Propofol but can cause hypotension
  ▪ If propofol causes significant hypotension/increased pressor requirements, switch to pushes of a benzo → versed (midazolam) 1-2 mg q2-4 hrs. If still not controlled, then do versed gtt.
  ▪ Remember that versed is lipophilic and after 1-2 days can result in prolonged sedation due to distribution in adipose tissues. Patients with renal failure can also have problems because versed is hepatically metabolized into active byproducts that then must be renally cleared.

o Anyone on prolonged paralytics
  ▪ Always use fentanyl gtt for duration of paralysis because you have no idea if they are in pain.

o ANSWER THIS QUESTION
  ▪ Is the patient uncomfortable because of pain or anxiety/agitation? This will determine which drug you use (analgesic vs. anxiolysis).

o ** Precedex = Dexmedetomidine, specifically used when planning to extubate. Attending only order. See drug table later in this handbook for more info.
Specific Orders/Sets in the MICU

- **MICU generic admission order set** – MICU admissions

- **Adult Critical care analgesia and sedation** – Order all initial sedation/analgesia. Can order versed/fentanyl pushes independently.

- **Adult Sepsis LUMC** – Use for all septic patients, will give you priority in pharmacy for getting chosen antibiotics.

- **IP Insulin IV drip** – For insulin drips

- **Heparin Nomogram (Low, intermediate and high range)** – For heparin gtt (look at specific nomogram order set for the correct indications for each nomogram

- **Transfuse RBCs/Plasma/Platelets**

- **Mechanical Ventilation initial** – Order **panel** for initial ventilation orders

- **Mechanical Ventilation subsequent** – change vent settings

- **Respiratory culture order panel** – should include Blind BAL for intubated patients
ACUTE RESPIRATORY DETERIORATION

PEAK INSPIRATORY PRESSURE

(Decreased)
- Air Leak
- Hyperventilation

(Increased)

(No Change)
- Pulmonary Embolus
- Extrathoracic Process

PLATEAU PRESSURE

(No Change)

AIRWAY OBSTRUCTION
- Aspiration
- Bronchospasm
- Secretions
- Tracheal Tube
- Obstruction

(INCREASE)

DECREASED COMPLIANCE
- Abdominal Distension
- Asynchronous Breathing
- Atelectasis
- Auto-PEEP
- Pneumothorax
- Pulmonary Edema
Protocol for Low Volume Ventilation in ARDS

GOALS: TV = 6 mL/kg, Ppl < 30 cm H₂O, pH = 7.30 - 7.45

I. FIRST STAGE:
   1. Calculate patient's predicted body weight (PBW)‡
      *Males: PBW = 50 + [2.3 × (height in inches - 60)]
      *Females: PBW = 45.5 + [2.3 × (height in inches - 60)]
   2. Set initial tidal volume (TV) to 8 mL/kg PBW.
   3. Add positive end-expiratory pressure (PEEP) at = 5 - 7 cm H₂O,
   4. Reduce TV by 1 mL/kg every 2 hours until TV = 6 mL/kg PBW.

II. SECOND STAGE
   1. When TV down to 6 mL/kg, measure plateau pressure (Ppl).
      A. Target Ppl < 30 cm H₂O.
      B. If Ppl > 30 cm H₂O, decrease TV in 1 mL/kg steps until Ppl drops below 30 cm H₂O or TV down to 4 mL/kg.

III. THIRD STAGE
   1. Monitor arterial blood gases for respiratory acidosis.
      A. Target pH = 7.30 - 7.45
      B. If pH 7.15 - 7.30, increase respiratory rate (RR) until pH > 7.30 or RR = 35 bpm.
      C. If pH, < 7.15, increase RR to 35 bpm. If pH still, < 7.15, increase TV at 1 mL/kg increments until pH > 7.15.
A Brief Pressor Review

<table>
<thead>
<tr>
<th>DRUG</th>
<th>Alpha1</th>
<th>Beta 1</th>
<th>Beta 2</th>
<th>DA</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenylephrine</td>
<td>+++</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>SVR↑, CO may↑</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>+++</td>
<td>++</td>
<td>0</td>
<td>0</td>
<td>SVR↑, CO may↑</td>
</tr>
<tr>
<td>Dopamine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5-2mcg/kg/min</td>
<td>0</td>
<td>+</td>
<td>0</td>
<td>++</td>
<td>renal/splanchnic blood flow↑</td>
</tr>
<tr>
<td>5-10mcg/kg/min</td>
<td>+</td>
<td>++</td>
<td>0</td>
<td>++</td>
<td>SVR↑, CO↑</td>
</tr>
<tr>
<td>10-20mcg/kg/min</td>
<td>++</td>
<td>++</td>
<td>0</td>
<td>++</td>
<td>SVR↑</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>0/+</td>
<td>+++</td>
<td>++</td>
<td>0</td>
<td>SVR↓, CO↑</td>
</tr>
</tbody>
</table>

A Detailed Pressor Review

<table>
<thead>
<tr>
<th>Drug</th>
<th>Receptors</th>
<th>Clinical Effect</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dopamine</td>
<td>α1 +++</td>
<td>DA effect does not appear clinically relevant. Less likely to cause myocardial ischemia?</td>
<td></td>
</tr>
<tr>
<td>(3-10 mcg/kg/min)</td>
<td>β1 +++</td>
<td>Positive inotropic and chronotropic at lower doses, but less than dobutamine Vaspressor</td>
<td></td>
</tr>
<tr>
<td>(Less severe, SEP 90-80)</td>
<td>β2 +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10-20 mcg/kg/min)</td>
<td>DA ++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Dose dependent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>α1 +++</td>
<td>Vasopressor (Potent)</td>
<td>Cardiogenic Shock</td>
</tr>
<tr>
<td>(0.01-1 mcg/kg/min)</td>
<td>β1 +++</td>
<td>No reflex bradycardia</td>
<td>Distributive shock (1st Line Agent for Sepsis)</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>α1 +++</td>
<td>Positive inotropic and chronotropic effects</td>
<td>Cardiogenic Shock</td>
</tr>
<tr>
<td>(0.04-1 mcg/kg/min)</td>
<td>β1 +++</td>
<td>No afterload reduction</td>
<td>Mixed shock</td>
</tr>
<tr>
<td></td>
<td>β2 +</td>
<td>Becomes α = β with escalating doses</td>
<td>Cardiogenic Shock</td>
</tr>
<tr>
<td>Phenylephrine</td>
<td>α1 +++</td>
<td>Pure vasopressor</td>
<td>Cardiogenic Shock</td>
</tr>
<tr>
<td>(0.05-3 mcg/kg/min)</td>
<td></td>
<td>No tachyarrhythmias</td>
<td>No Central Access</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>α1 +++</td>
<td>Positive inotropic and chronotropic effects</td>
<td>Cardiogenic Shock</td>
</tr>
<tr>
<td>(0.04-1 mcg/kg/min)</td>
<td>β1 +++</td>
<td>Some afterload reduction</td>
<td>(add second agent for hypotension)</td>
</tr>
<tr>
<td></td>
<td>β2 +</td>
<td></td>
<td>Decompensated HF</td>
</tr>
<tr>
<td></td>
<td>DA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vasopressin</td>
<td>Smooth muscle V1 receptor agonist</td>
<td>Pure vasopressor</td>
<td>Distributive (vasopressin deficiency in sepsis?)</td>
</tr>
<tr>
<td>(0.03-0.04 unit/min)</td>
<td></td>
<td>Maintains pressor activity in Acidosis</td>
<td></td>
</tr>
<tr>
<td>Milrinone</td>
<td>PDE inhibitor</td>
<td>Non-catecholamine, positive inotropic and chronotropic effects</td>
<td>Decompensated HF</td>
</tr>
<tr>
<td>(50 mcg load, 0.375-7.5mcg/kg/min)</td>
<td></td>
<td>Afterload reduction</td>
<td></td>
</tr>
<tr>
<td>*Renal Dose Adjusted</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Norepinephrine first line in septic shock, followed by vasopressin, if needing to add a third consider epinephrine rather than phenylephrine (more evidence for)
**Sepsis**

**There are multiple PDFs online to help guide management of sepsis at http://emr.lumc.edu/ClinicalProtocol/**

**Make sure you use the sepsis admission order set when admitting a septic patient to the ICU**

<table>
<thead>
<tr>
<th>TABLE 1. Diagnostic Criteria for Sepsis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infection, documented or suspected, and some of the following:</strong></td>
</tr>
<tr>
<td><strong>General variables</strong></td>
</tr>
<tr>
<td>Fever (&gt;38.3°C)</td>
</tr>
<tr>
<td>Hypothermia (core temperature &lt;36°C)</td>
</tr>
<tr>
<td>Heart rate &gt;90/min1 or more than two 2 above the normal value for age</td>
</tr>
<tr>
<td>Tachypnea</td>
</tr>
<tr>
<td>Altered mental status</td>
</tr>
<tr>
<td>Significant edema or positive fluid balance (&gt;20 mL/kg over 24 hr)</td>
</tr>
<tr>
<td>Hyperglycemia (plasma glucose &gt;140 mg/dL or 7.7 mmol/L) in the absence of diabetes</td>
</tr>
<tr>
<td><strong>Inflammatory variables</strong></td>
</tr>
<tr>
<td>Leukocytosis (WBC count &gt;12,000 μL–1)</td>
</tr>
<tr>
<td>Leukopenia (WBC count &lt;4000 μL–1)</td>
</tr>
<tr>
<td>Normal WBC count with greater than 10% immature forms</td>
</tr>
<tr>
<td>Plasma C-reactive protein more than two 2 above the normal value</td>
</tr>
<tr>
<td>Plasma procalcitonin more than two 2 above the normal value</td>
</tr>
<tr>
<td><strong>Hemodynamic variables</strong></td>
</tr>
<tr>
<td>Arterial hypotension (SBP &lt;90 mm Hg, MAP &lt;70 mm Hg, or an SBP decrease &gt;40 mm Hg in adults or less than two 2 below normal for age)</td>
</tr>
<tr>
<td><strong>Organ dysfunction variables</strong></td>
</tr>
<tr>
<td>Arterial hypoxemia (Pao2/Fio2 &lt;300)</td>
</tr>
<tr>
<td>Acute oliguria (urine output &lt;0.5 mL/kg/hr for at least 2 hrs despite adequate fluid resuscitation)</td>
</tr>
<tr>
<td>Creatinine increase &gt;0.5 mg/dL or 44.2 μmol/L</td>
</tr>
<tr>
<td>Coagulation abnormalities (INR &gt;1.5 or aPTT &gt;60 s)</td>
</tr>
<tr>
<td>Illus (absent bowel sounds)</td>
</tr>
<tr>
<td>Thrombocytopenia (platelet count &lt;100,000 μL–1)</td>
</tr>
<tr>
<td>Hyperbilirubinemia (plasma total bilirubin &gt;4 mg/dL or 70 μmol/L)</td>
</tr>
<tr>
<td><strong>Tissue perfusion variables</strong></td>
</tr>
<tr>
<td>Hyperlactatemia (&gt;1 mmol/L)</td>
</tr>
<tr>
<td>Decreased capillary refill or mottling</td>
</tr>
</tbody>
</table>
TABLE 2. Severe Sepsis

Severe sepsis definition = sepsis-induced tissue hypoperfusion or organ dysfunction (any of the following thought to be due to the infection)

| Sepsis-induced hypotension
| Lactate above upper limits laboratory normal
| Urine output < 0.5 mL/kg/hr for more than 2 hrs despite adequate fluid resuscitation
| Acute lung injury with PaO₂/FiO₂ < 250 in the absence of pneumonia as infection source
| Acute lung injury with PaO₂/FiO₂ < 200 in the presence of pneumonia as infection source
| Creatinine > 2.0 mg/dL (176.8 μmol/L)
| Bilirubin > 2 mg/dL (34.2 μmol/L)
| Platelet count < 100,000 μL
| Coagulopathy (international normalized ratio > 1.5)

LUMC SEPSIS RESUSCITATION BUNDLE

TO BE COMPLETED WITHIN 3 HOURS

1) Measure lactate (WBLA) level
2) Obtain blood cultures prior to administration of antibiotics
3) Administer broad spectrum antibiotics within 1 hour of diagnosis
4) Administer 30 mL/kg crystalloid for hypotension or lactate ≥ 4 mmol/L

TO BE COMPLETED WITHIN 6 HOURS

5) Non-invasive guidelines resuscitation goals:
   a. Lactate clearance of ≥ 10% if initial lactate was elevated (with ultimate goal being normalization of lactate)

6) Apply vasopressors for hypotension not responding to initial fluid resuscitation to maintain a mean arterial pressure (MAP) ≥ 65 mm Hg
   - a full-sterile central line should be placed

7) Invasive guidelines resuscitation goals:
   a. CVP 8-12 mmHg (non-intubated pts) or CVP 12-15 mmHg (intubated pts)

   PLUS

   b. Lactate clearance of ≥ 10% if initial lactate was elevated (with ultimate goal being normalization of lactate) AND SevO₂ ≥ 70% (ordered as SmvO₂)
LUMC Invasive Sepsis Guidelines

- Initiate Sepsis Order Set
- Think of Source Control and send cultures
- Initiate Broad Spectrum Antibiotics within 1 hour
- Supplemental O2. If hypoxemia despite NRB, intubation (see bottom right)
- IVF Bolus: Isotonic crystalloid 30 mL/kg bolus over 30 minutes
- Place full-sterile central line (IJ or subclavian)

**Fluid Resuscitation**

**Fluid loaded/not responsive**

**MAP**

MAP < 65

MAP ≥ 65

**Repeat Lactate + ScvO2**

≥ 10% Lactate Clearance AND ScvO2 ≥ 70%

**Goals Achieved**

No

Yes

**Disposition**

- Admission (ICU vs monitored bed)
- Periodically recheck for MAP > 65, good mental status, good UOP
- Trend lactate q4-6 hours until it is normal (if rises again, restart guidelines)

**Dynamic IVC Ultrasound**

Administer 500-1000 mL boluses of isotonic crystalloid until there is < 30% change in IVC size if not intubated or > 12% if intubated

**CVP**

Administer 500-1000 mL boluses of isotonic crystalloid until CVP 8-12 mmHg if not intubated and 12-15 mmHg if intubated

**Assess for improvement in end organ perfusion**: Is HR, MAP, UOP, mental status improving? If yes to any, check for volume overload (JVD, rales or worsening O2 saturation). If no evidence of volume overload, give another 500-1000 mL bolus of crystalloid. Most pts will require ~ 4-6 liters of fluid during initial resuscitation (first 6 hours)

**Vasopressors**

1. Titrate Norepinephrine (0.01 mcg/kg/minute)
2. Place sterile A-line
3. If MAP < 65 after Norepi between 0.05 - 0.1 mcg/kg/minute: add Hydrocortisone 50 mg q6h & Vasopressin 0.04 units/min
4. Next pressor of choice: Epirinephrine 0.01 mcg/kg/min (max dose 0.5 mcg/kg/minute)

**Consider Transfusion**

If Hgb 8.2 transfuse 1 unit pRBC
If Hgb 7-10: consider transfusion especially in elderly pts or with CAD

**Inotropes** (especially if heart appears hypodynamic on echo/US)

If Ca low, replete that first (500-1000 mg)
If Ca normal, then administer Dobutamine (2.5-20 mcg/kg/minute)

**Additional fluids**

If you were using CVP to determine fluid status, give an additional liter of crystalloid

**Intubate** to decrease pulmonary metabolic load (see below)

**Lung Protective Mechanical Ventilation**

- Ketamine is the preferred induction agent (1-1.5 mg/kg IV)
- Fentanyl is acceptable (0.3 mg/kg IV)
- Low TV (consider 6 cmH₂O/IRW) with a goal
  - Plateau Pressure < 30
  - PEEP > 10
  - Max PIP to 45

*Note that ScvO₂ is ordered as Mixed Venous Blood Gas (Smvo₂)*)
**Acid-Base**

1. **Acidosis (pH<7.36) or Alkalosis (pH>7.44)?**
2. **Primary metabolic or Respiratory process?**

<table>
<thead>
<tr>
<th>pCO₂</th>
<th>▼</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCO₃</td>
<td><em>▼</em></td>
</tr>
</tbody>
</table>

### Metabolic Acidosis
- check albumin!
- Actual gap = calc gap + 2.5 (4 pt’s albumin)

<table>
<thead>
<tr>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Winters formula to check for appropriate resp compensation:</td>
</tr>
<tr>
<td>Exp pCO₂ = 1.5[HCO₃] + 8 +/- 2</td>
</tr>
<tr>
<td>Obs &gt; exp pCO₂ = resp acidosis</td>
</tr>
<tr>
<td>Obs &lt; exp pCO₂ = resp alkalosis</td>
</tr>
</tbody>
</table>

2. △/△ = △gap + serum bicarb
   - If <24 = non-gap acidosis
   - If >24 = metabolic alkalosis

3. If no explanation for gap, check osm gap (difference between calc and meas osm)
   - Calc osm = 2[Na]+(gluc/18)+(BUN/2.8)

   Normal osm gap = 10-15
   >25 suggests meth or EG poisoning

<table>
<thead>
<tr>
<th>Non-gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Winters formula to check for appropriate resp compensation:</td>
</tr>
<tr>
<td>Exp pCO₂ = 1.5[HCO₃] + 8 +/- 2</td>
</tr>
</tbody>
</table>

2. If no explanation, check urine anion gap (normal = 20-80)
   - Urine AG = Urine Na + Urine K – Urine Cl
   - Ne-GUT-ive = GI loss
   - Positive = RTA

### PCO₂

<table>
<thead>
<tr>
<th>▲*</th>
</tr>
</thead>
<tbody>
<tr>
<td>▲</td>
</tr>
</tbody>
</table>

### HCO₃

<table>
<thead>
<tr>
<th>▲</th>
</tr>
</thead>
</table>

### Respiratory Acidosis

**Acute or Chronic**

**Acute:**
- For every 10 Δ pCO₂:
  - pH decrease by 0.08
  - HCO3 increase by 1

**Chronic:**
- For every 10 Δ pCO₂:
  - pH decrease by 0.03
  - HCO3 increase by 4

1. Check for respiratory compensation ΔpCO₂ = 2/3 (ΔHCO3)

2. Measure urine Cl:
   - Urine Cl<20 (volume responsive):
     - Vomiting, dehydration, diuretics
   - Urine Cl>20 (volume unresponsive):
     - Hypokalemia (<2), mineralocorticoid excess, Barttter’s/Gitelman’s

### Metabolic Alkalosis

1. **Acute or Chronic**

### Respiratory Alkalosis

**Acute:**
- For every 10 Δ pCO₂:
  - pH increase by 0.08
  - HCO3 decrease by 2

**Chronic:**
- For every 10 Δ pCO₂:
  - pH increase by 0.03
  - HCO3 decrease by 5
Liver Failure

- **Childs Score**: Takes into account bilirubin, albumin, INR, ascites, encephalopathy
  - Child A = 5-6, Childs B = 7-9, Childs C =10 or higher
- **MELD Score**: Takes into account INR, Creatinine, Bilirubin (use dot phrase .meld for fast calculation)
- **Paracentesis**
  - When to perform para: New onset ascites, when cirrhotics get admitted to the hospital (unless for something really minor), clinical deterioration (sepsis, encephalopathy, acute renal failure)
  - Locations: RLQ>LLQ>below umbilicus
  - No absolute INR or platelet count that is safe for a diagnostic tap (except in DIC)
  - For a large volume tap, INR should be <1.5 (careful of large volume in renal failure)
  - 25 gauge needle for diagnostic tap, remember to use the Z-technique.
- **Ascites diagnostic tests**
  - Routine: cell count, albumin, ascites/serum, protein, ascites/serum
  - Optional: glucose, LDH, amylase, gram stain & culture
  - **SAAG** = serum albumin – ascites albumin
    - >1.1 = portal htn
- **SBP** (spontaneous bacterial peritonitis)
  - **PMN’s**>250 and positive culture, (correction: for every 250 rbc, take one PMN away)
  - Treatment: antibiotics (ceftriaxone), IV albumin days 1 (1.5g/kg) and 3 (1g/kg), stop propranolol
  - Tap should be repeated at 48 hours, PMN’s should have decreased by 50%
  - Any GIB in a liver patient in the MICU should receive antibiotics! (5 days PPX w/ ceftriaxone 2g)
  - **PPX if history of SBP with Cipro** daily
- **Indications for albumin infusion**
  - If >4L is removed via paracentesis replace 6-8g albumin per liter taken
  - Hepatorenal syndrome
- **Hepatorenal syndrome**
  - Acute renal failure in severe liver disease (cirrhosis or acute liver failure)
  - Creatinine >1.5, does not improve with IVF hydration after 2 days
  - Treatment: octreotide (50-100 TID), midodrine (5-10 TID), albumin (25% 50ml TID) – decreases mortality
- **Alcoholic hepatitis**: Give prednisone if MDF score >32 and no contraindication, if contra give penoxyfilline
  - Can send urine ethyl glucuronide (to test for alcohol abuse)
- **Variceal bleeding treatment**:
  - Vasopressin (not used much due to side effects), octreotide (inhibits vasodilation), propranolol
  - Banding: 90% effective
  - Intractable cases: balloon tamponade, TIPS, shunt surgery, liver transplant
- **Cerebral edema develops in 75-80% of stage IV hepatic encephalopathy**
  - Cushing’s reflex – HTN, bradycardia
  - Goal cerebral perfusion pressure is >40-50 (CPP=MAP-ICP)
  - Goal ICP is <20
  - An ICP monitor should be placed for stage III or IV hepatic encephalopathy
  - Elevate head of bed not more than 30 degrees
  - Hyperventilate to pCO2 25-35
  - Medications: Mannitol, loop diuretics, IV lidocaine, pentobarb coma
  - Pentobarbitol coma results in EEG flatline; can eliminate EEG criteria for brain death
Approximate correlation between PaO2 and SaO2

PaO2  SaO2
40  ~70%
50  ~80%
60  ~90%
Oxygen Delivery Devices:

1. Nasal Cannula  
   a. 1 – 6 LPM  
   b. FIO2 0.24 – 0.44 (approx 4% per liter flow)  
   c. FIO2 decreases as Ve increases

2. Simple Mask  
   a. 5 – 8 LPM  
   b. FIO2 0.35 – 0.55 (approx 4% per liter flow)  
   c. Minimum flow 5 LPM to flush CO2 from mask

3. Venturi Mask  
   a. Variable LPM  
   b. FIO2 0.24 – 0.50  
   c. Flow and corresponding FIO2 varies by manufacturer

4. Partial Rebreather  
   a. 6 – 10 LPM  
   b. FIO2 0.50 – 0.70  
   c. Flow must be sufficient to keep reservoir bag from deflating upon inspiration

5. Nonrebreather  
   a. 6 – 10 LPM  
   b. FIO2 0.70 – 1.0  
   c. Flow must be sufficient to keep reservoir bag from deflating upon inspiration

The above are all low flow oxygen delivery systems, with exception of the Venti Mask, and therefore the exact FIO2 will be based on the patient's anatomic reservoir and minute ventilation.
Anaphylaxis/Angioedema:

Definition: Life-threatening syndrome of sudden onset with one or more of the following manifestations (generally #1+any other is considered anaphylaxis):

1. Skin: sudden urticaria, angioedema (88%)
2. Respiratory: bronchospasm, laryngeal edema/stridor (50%)
3. GI: nausea, vomiting, diarrhea (30%)
4. CV: hypotension, dysrhythmia (30%)
5. Constitutional: diaphoresis, pruritis, anxiety

Anaphylaxis: IgE-mediated immediate hypersensitivity reaction to antigen
Anaphylactoid: non-IgE-mediated, but present and are treated the same.

Etiology:

- 60% have idiopathic anaphylaxis
- Drugs: penicillins most common, ASA/NSAIDs, exercise, opiates, radiocontrast produces anaphylactoid reactions
- Food: nuts, fish most common, generally in teenagers
- Venoms: insect stings
- Blood products
- Latex

Treatment: 2% mortality w/ anaphylaxis

- ABC’s: intubate for stridor, severe dyspnea; get IV access, give IVF, lie flat
- **Epinephrine: drug of choice** 0.3 to 0.5 mL of 1:1000 (1 mg/mL) epinephrine intramuscularly into the anterior or lateral thigh
- **Antihistamines:** Use Both H1 and H2 blockade
- **Inhaled B agonists**
- **Corticosteroids:** useful to prevent biphasic anaphylaxis (10hrs out). For refractory hypotension: epinephrine gtt 5-15mcg/min, glucagon if on beta-blocker. Patients need to be discharged with an epi-pen and instructions on how to use. Should have allergy outpatient appointment to test for triggers.
- **For angioedema:** start with **decadron** 10mg q6 hours, **Benadryl** 50mg q6 hours, **famotidine** 50mg q6 hours
<table>
<thead>
<tr>
<th>Drug</th>
<th>Concentration</th>
<th>Dosing</th>
<th>Indication/Mechanism/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octreotide</td>
<td>1000 mg in 100 mL of D5W or NS</td>
<td>25-50 mcg/hr</td>
<td>For variceal bleeding; somatostatin analog</td>
</tr>
<tr>
<td>Pantoprazole</td>
<td>80 mg in 100 mL NS</td>
<td>80 mg bolus, then 8 mg/hr</td>
<td>For bleeding peptic ulcer; Proton pump inhibitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argatroban</td>
<td>125 mg in 125 mL NS (&gt;70 kg)</td>
<td>Argatroban order set - generally start at 0.5 mcg/kg/min, titrate to goal aP TT</td>
<td>Preferred first line agent for HT; Direct thrombin inhibitor; accumulates in hepatic dysfunction; falsely elevates INR</td>
</tr>
<tr>
<td></td>
<td>50 mg in 50 mL NS (&gt;70 kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bivalirudin</td>
<td>250 mg in 500 mL D5W or NS</td>
<td>Generally start at 0.02 mg/kg/hr, titrate to goal aP TT</td>
<td>PCI or can be used off-label for HT; Direct thrombin inhibitor; accumulates in renal dysfunction</td>
</tr>
<tr>
<td>Heparin</td>
<td>25,000 units in 250 mL D5W</td>
<td>Heparin order set - high range: DVT/PE, Intermediate range: ACS/AI, titrate to goal aP TT</td>
<td>DVT/PE/ACS/AI; inactivates thrombin by potentiation of ATII</td>
</tr>
</tbody>
</table>

**SELECT ANTIHYPERTENSIVE**

- **Class III antiarrhythmic**
- **Non-DHP calcium channel blocker**
- **β-1 receptor antagonist; short-acting; preferred for HR control only (e.g., dissection); limited BP effect**
- **β-3 receptor agonist**
- **Cardioselective phosphodiesterase inhibitor; Isootrope**
- **DHP calcium channel blocker**
- **Venous vasodilator**
- **Arteriolar-venous vasodilator; requires arterial line; caution use in renal failure**

**CONTINUOUS INHALED BRONCHODILATORS**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosing</th>
<th>Indication/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albuterol</td>
<td>0.5%, 20 ml bottle for continuous</td>
<td>5-15 mg/hr continuous; B2-receptor agonist</td>
</tr>
<tr>
<td>Ipratropium</td>
<td>0.02%, nebulizer for continuous</td>
<td>500-1000 mcg/hr continuous; Anticholinergic; saturable effect</td>
</tr>
</tbody>
</table>

**COMMON ANTI-INFECTIVES**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosing</th>
<th>Indication/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acyclovir</td>
<td>5-10 mg/kg IBW q8hr, adjust for renal function</td>
<td>N</td>
</tr>
<tr>
<td>Amikacin</td>
<td>Contact service pharmacist and/or ID for dosing recommendations</td>
<td>N</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>1-2 g q4-8hr, adjust for renal function</td>
<td>N</td>
</tr>
<tr>
<td>Amoxicillin-Clavulanate</td>
<td>1.5-2 g q8hr, adjust for renalin function 4 (4.5 g dosage may be used by ID)</td>
<td>N</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>250-500 mg q24hr, note anti-inhibitory dose 250 mg PO 3 x weekly</td>
<td>N</td>
</tr>
<tr>
<td>Aztreonam</td>
<td>2 g q8hr, adjust for renal function</td>
<td>N</td>
</tr>
<tr>
<td>Cephalosporin</td>
<td>70 mg x 1, 50 mg x 2q4hr thereafter (35 mg x 2q4hr for severe liver dysfunction)</td>
<td>N</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>2 g q8hr, adjust for renal function</td>
<td>N</td>
</tr>
<tr>
<td>Cefepime</td>
<td>1 g q8hr, adjust for renal function 2 (2 g q12hr for meningitis)</td>
<td>Y (N for febrile neutropenia)</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>1-2 g q24hr (2 g q48hr for meningitis)</td>
<td>N, Meningitis dosing requires approval</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>400 mg q12hr (give daily if CrCl&gt;50mL/min), 400 mg q8hr for pseudomonas</td>
<td>Y (IV), PO is not restricted</td>
</tr>
<tr>
<td>Colistin</td>
<td>2-5 mg/kg/day; IV W in 2-3 divided doses, adjust for renal function</td>
<td>N</td>
</tr>
<tr>
<td>Daptomycin</td>
<td>4-6 mg/kg actual BW x 2q4hr (q4hr if CrCl &lt; 30 mL/min)</td>
<td>Y</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>200-400 mg q24hr, (give 50% usual dose if CrCl&lt;50 mL/min, IV/PO dosing same)</td>
<td>N</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>Contact service pharmacist and/or ID for dosing recommendations</td>
<td>N</td>
</tr>
<tr>
<td>Imipenem</td>
<td>250-500 mg q8hr, adjust for renal function</td>
<td>N (for febrile neutropenia)</td>
</tr>
<tr>
<td>Linezolid</td>
<td>600 mg q12hr (IV/PO dosing same)</td>
<td>N</td>
</tr>
<tr>
<td>Meropenen</td>
<td>500 mg q8hr, adjust for renal function (2 g q8hr for cystic fibrosis/meningitis)</td>
<td>N (for febrile neutropenia)</td>
</tr>
<tr>
<td>Meropenen</td>
<td>400 mg daily (IV/PO dosing same)</td>
<td>Not restricted if using for CAP</td>
</tr>
<tr>
<td>Piperacillin-Tazobactam (Zosyn)</td>
<td>4500 mg q8hr for pneumonia and pseudomonas (220 mg q8hr for intra-abdominal)</td>
<td>After 12 hour interval, subsequent duration needs approval</td>
</tr>
<tr>
<td>Trimethoprim-Sulfamethoxazole (Bactrim)</td>
<td>15-20 mg/kg TMP divided q12hr, cellulois dosing (200-320 mg TMP 1-2 DS tabs) PO BID, various dosing regimens for PJP prophylaxis, adjust for renal function</td>
<td>N</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>10-15 mg/kg actual BW q12-48 hr depending on renal function</td>
<td>After 12 hour interval of ICU admission, subsequent duration needs approval</td>
</tr>
</tbody>
</table>

*See pharmacy website for suggested renal dosing: Loyola wired → Departments → Pharmacy → Clinical Resources → "Adult Renal Dosing Guide"**

**Antibiotic Approval Pages #13181, or contact ID service for approvals if they are following the patient. From 10 pm to 8 am, pharmacy will verify sufficient doses to bridge to 8 am, provided that drug selection and dose are appropriate. Any subsequent doses after 8 am will need antimicrobial stewardship program approval. Therefore, please sign-out to day shift team to get approval in the morning.**
- Ensure adequate volume resuscitation in using propofol
- Try Fentanyl drip first usually, followed by dexmedetomidine or propofol
- Avoid benzo drips for long periods of time; (better evidence for using above meds rather than benzos, but can be attending dependent). Pushes are better than drips.
Notes: