Critical Care Training for Non-Critical Care-Trained Providers

Now What Do I Do?
Just-In-Time Learning Documents

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My Patient Is Hypotensive... Now What Do I Do?

1) Think about cause (and treat immediately reversible ones)

- Warm skin
- Wide pulse pressure
- Low diastolic pressure

- Cool skin
- Narrow pulse pressure
- Low diastolic pressure

Hypotension

Distributive
- Septicemia (most common)
- Meds/Sedation
- Neurogenic
- Anaphylaxis
- Adrenal insufficiency

Low Cardiac Output
- Large IVC
- Distended neck veins

- Collapsed IVC
- or neck veins

Hypovolemic
- Hemothage
- Third-spacing
- Fluid losses
- Over-diuresis

Cardiogenic
- Cardiomyopathy
- Acute coronary syndrome
- Arrhythmia
- Acute valvular disease

Obstructive
- Pulmonary embolism
- Tension pneumothorax
- Cardiac tamponade

- Ultrasound, ECG
- Chest radiograph

2) Assess for volume tolerance (additional volume will not hurt) and responsiveness (additional volume will improve the situation)

- Consider: comorbidities (e.g., heart failure, chronic kidney disease), severity of hypoxemia, cardiac function, volume status

- If volume tolerance and volume responsiveness are likely, move to Step 3 below

- If tolerance and responsiveness unlikely, skip to #4

- If uncertain:
  - Call for Help!
  - Use advanced tools if available (e.g., ultrasound, pulse pressure variation)

3) Give fluid bolus and reassess

- Give 500 mL Lactated Ringer’s IV and reassess

- Consider additional 500 mL boluses if blood pressure rises or urine output increases

- For patients with ARDS, limit initial resuscitation to 1-2L and be very judicious with additional fluids

4) Start norepinephrine

- Start at 0.02 mcg/kg/min; titrate to mean arterial pressure (MAP) > 65 mmHg or the patient’s typical baseline blood pressure
“My Patient is Hypotensive Despite Fluids and Norepinephrine...Now What Do I Do?”

1) Call for Help!

2) Reassess the situation:
   • Are the blood pressure measurements accurate?
   • Do I have the correct diagnosis?
   • Do I have source control? (e.g., is there a surgical infection that requires drainage or debridement, does the patient have a parapneumonic effusion?)
   • Is my antimicrobial coverage appropriate?

3) Start vasopressin at 0.03 units/minutes if norepinephrine > 0.2 mcg/kg/min

4) Consider placing arterial line and central venous catheter, if not already present

5) Next steps:
   • Evaluate for sepsis-induced or primary cardiomyopathy with bedside ultrasound or formal echocardiogram, electrocardiogram, and $S_{cv}O_2$ (provided the patient has a central line)
      
      If echocardiogram consistent with cardiomyopathy or $S_{cv}O_2 < 60%$:
      - Consider inotrope (dobutamine 2.5 mcg/kg/min)
      - Consider repleting calcium to normal (ionized calcium > 1.0 mmol/L)
   
   • Consider stress-dose steroids (hydrocortisone 50 mg q8 hours IV). Spot cortisol or ACTH stimulation testing are usually not helpful
   
   • Re-evaluate fluid tolerance and responsiveness. Consider judicious 500 mL boluses
   
   • Evaluate acid-base status: Consider continuous renal replacement therapy or bicarbonate infusion if the patient has a severe metabolic acidosis and pH <7.1

6) If vasopressor needs continue to increase, consider Palliative Care Consultation for goals of care discussion
My Patient is Tachycardic... Now What Do I Do?

1) Obtain an electrocardiogram

2) Follow the steps below

   Step 1: Assess for new hemodynamic instability (hypotension, chest pain, altered mental status)
   - Hemodynamically unstable
     - Call for Help! (to discuss cardioversion)
     - Bring code cart (with defibrillator) to room
     - Assess the rhythm
     - If sinus rhythm, consider hemorrhage and pulmonary embolism. Assess for tension pneumothorax if on the ventilator.
     - If non-sinus rhythm, perform synchronized cardioversion (200 J)
   - Hemodynamically stable

   Step 2: Assess QRS duration
   - Narrow Complex (QRS < 120 msec)
   - Wide Complex (QRS > 120 msec)
     - Consult Cardiology (Concern for stable ventricular tachycardia)

   Step 3: Assess if the rhythm is regular or irregular
   - Regular (same distance between QRS complexes)
     - See Atrial Fibrillation card
   - Irregularly irregular (different distances between QRS complexes) with no P waves
     - Flutter Waves
     - No clear P waves or P waves are immediately after the QRS
     - If heart rate > 140, consider SVT. Proceed with trial of adenosine (Call for Help! or consult cardiology if unfamiliar with adenosine)

   Step 4: Assess for P waves and Flutter Waves
   - P waves before every QRS and QRS after every P wave. P waves are upright in leads I and II.
   - Consult Cardiology if patient's tachycardia does not follow this algorithm

   Evaluate causes of sinus tachycardia (see below)

2) Evaluate for causes of sinus tachycardia
   Do not just start a beta-blocker to improve the heart rate. Identify and treat the specific cause of the sinus tachycardia.
   - Pain and anxiety
   - Fever / infection
   - Hypoxemia
   - Intravascular volume depletion (e.g., over-diuresis, vomiting/diarrhea, NPO)
   - Blood loss (including non-obvious sources like the retroperitoneum)
   - Alcohol withdrawal
   - Pulmonary embolism (uncommon cause of sinus tachycardia in absence of hypoxemia, hemodynamic changes, shortness of breath)

   Note: thyroid studies are typically unhelpful in critically ill patients and should not be ordered unless other clinical signs point toward hyperthyroidism as likely diagnosis.
My Patient Is In Atrial Fibrillation (or Flutter)... Now What Do I Do?

1) Obtain an electrocardiogram if not done already

2) Follow the steps below

   1. Assess for new hemodynamic instability (hypotension, chest pain, altered mental status) if not done already
   2. Hemodynamically unstable
      - Call for help (to discuss cardioversion)
      - Order stat ECG
      - Bring code cart (with defibrillator) to room
      - Perform synchronized cardioversion (200 J)*

   3. Hemodynamically stable
      - Metoprolol 5 mg IV (can be repeated up to 3x total)
      - Dilatazem 0.25 mg/kg IV once and dilatazem infusion (15 mg/hour = max dose)
      - Effective response (heart rate < 110 and no hypotension)
      - Convert to oral dosing: Metoprolol 25 mg PO q 6 hours (dose can be increased if not meeting goal)
      - Call pharmacy to help dose dilatazem (based on rate of infusion)

   4. Effective response (heart rate < 100)
      - Consider anticoagulation (see below)

   5. Ineffective response (heart rate > 110 or hypotension develops)**
      - Amiodarone 150 mg IV bolus followed by infusion (use PowerPlan and discuss with pharmacy)
      - Effective response (heart rate < 100)
      - Consult Cardiology

   * In septic/critically ill patients already on vasopressors prior to the start of atrial fibrillation the likelihood of successful cardioversion is low and often we proceed to Step 3 without cardioversion
   ** If heart rate > 110 but no hypotension has developed can trial the other agent before proceeding to Step 3

3) Evaluate for common causes of new onset atrial fibrillation

   - Sepsis/critical illness (most common cause in the ICU)
   - Ischemic heart disease or valvular disease
   - Anemia
   - Medications (e.g. vasopressors)
   - Alcohol withdrawal
   - Thyroid disease (typically TSH should not be tested in critically ill patients)
   - Pulmonary embolism (uncommon cause, do not automatically order CTPA)
   - Sleep disordered breathing

4) Consider anticoagulation

   Call for Help! to make decision about anticoagulation in the next 12 hours.

For many critically ill patients, including those whose atrial fibrillation is driven by sepsis or respiratory failure, the risks of systemic anticoagulation outweigh the benefits. In these patients re-evaluate the need for systemic anticoagulation once they are stable enough to transfer to the acute care service (depending if they are still having issues with atrial fibrillation).
My Patient’s Central Venous Oxygen Saturation Is Abnormal... Now What Do I Do?

1) What information do we get from the central venous oxygen saturation?
   The central venous oxygen saturation ($S_{cv}O_2$) is the oxygen saturation of venous blood drawn from a central line whose tip resides in the distal superior vena cava. It is a surrogate for the mixed venous oxygen saturation (drawn from the pulmonary circulation, $S_aO_2$) and is determined by the balance between oxygen delivery to the tissues (determined by hemoglobin concentration [Hgb], arterial oxygen saturation ($S_aO_2$), and cardiac output) and tissue oxygen consumption, which is determined by metabolic activity. The normal value for the $S_{cv}O_2$ is typically 65-70%.

2) Before you act on a measured value, confirm the location from which it was sampled. Blood gases drawn from peripheral IVs, veins in the arm or hand or the femoral vein cannot be used to assess a central venous saturation. Only if the sample was drawn from a central line should you proceed to the next steps.

3) Interpreting the $S_{cv}O_2$ and responding to deviations from normal

   - **Low** ($< 60\%$): If $P_aO_2$ low, support oxygenation. If [Hgb] < 7 g/dL, transfuse PRBC.
     - Evaluate for sources of low cardiac output: Echo with low EF, Hypovolemia.
     - Dobutamine, Fluid bolus

   - **High** ($> 75-80\%$): Strongly consider sepsis.
     - Consider other less likely sources: Anaphylaxis, Cyanide intoxication.

   **Call for Help!** if you are starting dobutamine.
My Non-Intubated Patient Is Hypoxemic… Now What Do I Do?*

1) Ensure the pulse oximeter is providing accurate data
   Bad pulse oximetry waveforms suggest erroneous data. If unable to rectify the problem, check an arterial blood gas to measure the PaO2.

2) Evaluation upon initial presentation
   - Plain chest radiograph
   - Arterial blood gas
   - Basic laboratory studies (WBC count, B-type natriuretic peptide)
   - Electrocardiogram (if indicated)

3) Initial management algorithm

   ![Initial management algorithm diagram]

   **Note:** The decision to intubate is never based on specific SpO2 or PaO2 threshold and, instead must take into account an assessment of the entire clinical picture including the patient’s work of breathing, mental status and hemodynamic stability.

4) Initiate disease/problem specific interventions

<table>
<thead>
<tr>
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<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart failure and/or volume overload</td>
<td>Diuresis</td>
</tr>
<tr>
<td>Large pleural effusions</td>
<td>Diuresis, consider thoracentesis</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Antibiotics</td>
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<tr>
<td>Lobar or whole lung collapse</td>
<td>Chest physiotherapy</td>
</tr>
<tr>
<td>COPD / Asthma exacerbation</td>
<td>Corticosteroids, inhaled bronchodilators</td>
</tr>
<tr>
<td>Suspected pulmonary embolism</td>
<td>Consider CT pulmonary angiogram *, lower extremity duplex</td>
</tr>
</tbody>
</table>

   * For known or suspected COVID-19 patients, discuss the risk/benefits of traveling for CT scan

5) What is the target SpO2 and PaO2?
   - SpO2: 88-96%
   - PaO2: 60-90 mm Hg

Critical Care Skills for Non-Critical Care Providers
My Non-Intubated Patient is Hypoxemic
My Patient Just Got Intubated... Now What Do I Do?

1) Choose Your Ventilator Settings

*Mode*: Volume assist control

*Tidal Volume*: 8 ml/kg of ideal body weight

*Rate*: Based on an assessment of the patient’s minute ventilation needs. This can be done based on an assessment of the patient’s bicarbonate:

<table>
<thead>
<tr>
<th>Bicarbonate (mEq/L)</th>
<th>Target Minute Ventilation (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22-26</td>
<td>6-8</td>
</tr>
<tr>
<td>16-20</td>
<td>10-12</td>
</tr>
<tr>
<td>&lt; 12</td>
<td>15-20</td>
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</tbody>
</table>

*F*₁Ø₂*: 1.0

*PEEP*: 5 cm H₂O

2) Place Orogastric Tube

This is for enteral access for medications. Tube feeds can be held at this stage and should not be immediately started in patients on escalating doses of vasopressors.

3) Choose Your Sedation and Pain Management Plan

*Sedative*: Propofol infusion. Titrate for Richmond Agitation Sedation Score (RASS) score of 0-1.

*Pain Control*: Start with fentanyl boluses (25-100 µg q 30 min prn); Change to infusion if insufficient.

4) Check a Chest Radiograph to Confirm Position of Endotracheal and Orogastric Tube

5) Obtain a Blood Gas in 15-30 minutes

- Check the acid-base status: Adjust ventilator rate accordingly with the goal of achieving a pH relatively close to normal (7.35-7.45). This can be difficult to achieve with a severe primary metabolic acidosis. Further details on how to adjust the ventilator rate is provided in the information sheet “I Just Got The Blood Gas Results... Now What Do I Do?”

- Check the PₐO₂: If the PₐO₂ > 100 mm Hg, decrease the F₁O₂ to target SₚO₂ > 88%. Further changes in PEEP and F₁O₂ can be made by monitoring SₚO₂ rather than checking repeat blood gases. For patients with ARDS, follow the PEEP/ F₁O₂ ladder.

To avoid oxygen toxicity, do not allow the SₚO₂ to remain at 100%.
I Just Received Blood Gas Results On My Ventilated Patient… Now What Do I Do?

1) Assess oxygenation (this cannot be done with a venous blood gas)
   - $P_aO_2 < 60$: Increase $F_iO_2$ and/or increase PEEP
   - $P_aO_2 > 100$: Decrease $F_iO_2$ until $S_pO_2$ 90-96%

2) Assess and address the acid-base status

   ![Diagram of acid-base status]
   - $P_aCO_2 > 45$: Respiratory Acidosis
   - $HCO_3^- < 22$: Metabolic Acidosis
   - $P_aCO_2 < 35$: Respiratory Alkalosis
   - $HCO_3^- > 26$: Metabolic Alkalosis

   For patients with chronic hypercapnea (e.g., severe COPD), the goal $P_aCO_2$ is their baseline $P_aCO_2$.

3) Adjustments in the ventilator rate
   A simple rule of thumb can be used to determine the proper change in the respiratory rate:
   \[
   \text{New rate} = \text{Current rate} \times \frac{\text{Current } P_aCO_2}{\text{Target } P_aCO_2}
   \]
   Call for Help! if desired rate is > 35

4) In What Situations Will I Have Trouble Achieving The Goal pH or $P_aCO_2$
   There are several situations in which it can be difficult to achieve the goal $P_aCO_2$ or pH
   - Severe ARDS: in patients with a high dead-space fraction, it can be hard to normalize $P_aCO_2$ and pH despite a high minute ventilation (Most patients can tolerate a pH down to 7.15 in these situations). Call for Help!
   - Severe metabolic acidosis: despite significant decreases in $P_aCO_2$, the pH may remain low. Call for a Help!
   - Overbreathing the ventilator: decreases in the set respiratory rate will not achieve a change in minute ventilation. The patient will continue to over-breathe the ventilator

5) How Long Before I Need to Get Another Arterial Blood Gas
   - After changes in $F_iO_2$ or PEEP: repeat ABG is not necessary. Follow $S_pO_2$
   - After changes in the set rate: wait 15-30 minutes before the repeat ABG

Critical Care Skills for Non-Critical Care Providers
Responding To Blood Gas Results
My Patient May Be Ready to Come Off the Ventilator… Now What Do I Do?

1) Assess Readiness for a Spontaneous Breathing Trial

Is the primary problem getting better?
Are they requiring an F\textsubscript{I}O\textsubscript{2} < 0.4 and a PEEP < 8 cm H\textsubscript{2}O?
Is the minute ventilation < 15 L/min?

If the answer to all questions is “Yes,” proceed to the next step. If the answer is “No,” continue volume assist control

2) Lighten Sedation (often referred to as Spontaneous Awakening Trial, SAT)
Turn propofol off. Some patients may require a low-dose of propofol due to anxiety around the time of the spontaneous breathing trial

3) Start Spontaneous Breathing Trial (SBT)
Place the patient on Pressure Support of 5 cm H\textsubscript{2}O with a PEEP of 5 cm H\textsubscript{2}O for 30 minutes

4) Assessing the Spontaneous Breathing Trial

5) Assess Mental Status and Ability to Protect Airway

Normal mental status: Extubate patient

Altered mental status: Extubate patient if they have:

- A good cough
- A gag reflex
- No-to-minimal airway secretions
My Intubated Patient Is More Hypoxemic... Now What Do I Do?

1) **Check equipment, consider calling the respiratory therapist for help**
   Ensure the following:
   - Patient remains connected to the ventilator circuit and circuit is intact
   - No inadvertent changes F\textsubscript{I}O\textsubscript{2}, PEEP or other settings
   - Endotracheal tube is patent and remains in correct position

   If the ventilator pressure alarm is sounding, consult the card on “The Peak Pressure Has Increased”

2) **Examine the patient and evaluate their interaction with the ventilator**
   - Listen for bilateral breath sounds. If breath sounds are asymmetric, consider pneumothorax or lung collapse and evaluate accordingly
   - If patient is agitated and having repeated peak pressure alarms, administer intravenous fentanyl bolus and consider increasing propofol

3) **Obtain diagnostic studies**
   - Arterial Blood Gas (venous blood gases cannot be used to assess oxygenation)
   - Chest radiograph

4) **Adjust the ventilator to improve oxygenation**
   - The two parameters on the ventilator that address oxygenation are F\textsubscript{I}O\textsubscript{2} and PEEP
   - Increase F\textsubscript{I}O\textsubscript{2}
   - If this does not resolve the situation, increase PEEP by 5 cm H\textsubscript{2}O
     - Expect a slow rise in oxygen saturation with increased PEEP
     - May cause paradoxical worsening of oxygenation $\rightarrow$ return to previous PEEP
     - May cause hypotension $\rightarrow$ return to previous PEEP
   - **Call for Help!** if these maneuvers do not resolve the situation. Discuss other strategies with your critical care consultant

5) **Treat reversible causes of hypoxemia if present**
   - Suction the patient to clear any mucus in the endotracheal tube or central airways
   - If chest radiograph reveals lobar or whole lung collapse, start chest physiotherapy
   - If worsening edema pattern on chest radiograph, consider diuresis or new diagnosis of ARDS (see ARDS sheet)

6) **Optimize other factors that affect oxygen delivery**
   - Check hemoglobin (Hgb) and transfuse red blood cells if [Hgb] <7 g/dL
   - Check S\textsubscript{C\textsubscript{O}}O\textsubscript{2} and call for help if < 60%
   - Review medications for those that can cause pulmonary vasodilation (e.g., calcium channel blockers) as this may worsen ventilation-perfusion matching

Critical Care Skills for Non-Critical Care Providers
Worsening Hypoxemia on the Ventilator
“My Patient is Agitated While Receiving Mechanical Ventilation… Now What Do I Do?”

The Patient Who Is Not Meeting Sedation Targets

Usually, patients who are not severely hypoxemic will be maintained in an alert or lightly sedated state. The degree of sedation is measured by the Richmond Agitation Sedation Score (RASS). The goal RASS is usually 0 (alert) to -1 (sedated but easily arousable). When the patient is out of this range (RASS > 0), the following step-by-step process can be used to resolve the issue.

Sudden Unexpected Agitation with Ventilator Alarms

Sudden, unexpected agitation in a previously calm patient can be due to a problem with the ventilator and/or ventilator circuit or a problem with the patient. The first step in this situation is to disconnect the patient from the ventilator and manually bag them with an anesthesia bag.

• If the agitation resolves, the problem is with the ventilator or the circuit. Consult the respiratory therapist.
• If the problem does not resolve, the problem is with the patient and can be anyone of a number of problems. Perform a focused physical exam and assessment of the patient. Call for Help!
My Patient is Developing ARDS... Now What Do I Do?

1) Confirm the Presence of ARDS and Classify Severity
Patients are deemed to have ARDS if they meet all 4 of the following criteria:

- Acute onset (<7 days) from known cause (e.g., COVID-19 infection)
- Bilateral opacities on chest radiograph
- $P_aO_2 / F_iO_2$ (P/F ratio) < 300 while on PEEP of 5 cm H$_2$O
- Not entirely due to pleural effusions, volume overload or cardiogenic edema

Classification of Severity: ($P_aO_2$ obtained from ABG; $F_iO_2$ expressed as a decimal)

- Mild: $200 \leq P_aO_2 / F_iO_2 < 300$
- Moderate: $100 \leq P_aO_2 / F_iO_2 < 200$
- Severe: $P_aO_2 / F_iO_2 < 100$

2) Initiate low tidal volume ventilation (often referred to as lung protective ventilation)
Change tidal volume ($V_T$) to 6 ml/kg predicted body weight (PBW)
Goals:

- Plateau Pressure < 30 cm H$_2$O:
  - If $P_{plateau} > 30$ cm H$_2$O: consider decreasing $V_T$ further, to as low as 4 ml/kg PBW
  - If $P_{plateau} < 30$ cm H$_2$O: maintain 6 ml/kg

- $S_aO_2 88 – 95\%$ (or $P_aO_2 55 – 80$ mmHg):
  - Use the PEEP/ $F_iO_2$ ladder. Start with the low ladder
  - Monitor for hypotension due to increased PEEP
  - Call for Help! with persistent or worsening hypoxemia

- pH >7.20 (Tolerate increases in $P_aCO_2$, “permissive hypercapnia”)

3) If $P_aO_2 / F_iO_2 < 150$ consider prone positioning
Note this requires substantial personnel to safely perform, so consider available resources

Protocol: Prone for 16 hours, then return to supine position
Repeat daily
Stop when $P/F >150$ on PEEP < 10 cmH$_2$O and $F_iO_2 < 0.6$ or if ineffective

4) If $P_aO_2 / F_iO_2 < 150$ and patient is not synchronous with the ventilator, start neuromuscular blockade
48-hour infusion of cis-atracurium
Ensure deep sedation (RASS -4 to -5)

5) Call for Help! if hypoxemia persists despite prone positioning and neuromuscular blockade
The Peak Inspiratory Pressure Is High... Now What Do I Do?

1) **What Determines Peak Inspiratory Pressure and What Is a “Normal” Value?**
The peak inspiratory pressure (PIP) reflects how hard the ventilator must “work” to deliver a breath and is a function of three variables: (1) the inspiratory flow rate and flow pattern; (2) airway resistance (including the endotracheal tube and circuit); and (3) the compliance of the respiratory system. Although it can vary based on the delivered volume and the inspiratory flow rate and pattern, a normal value is typically < 40 cm H$_2$O. Values above this threshold indicate the patient has high airway resistance and/or low compliance.

2) **What Are Common Factors That Increase Resistance and Decrease Compliance?**

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3) **How Do I Distinguish Between Resistance and Compliance Issues on the Ventilator?**
Perform an inspiratory pause maneuver. During the pause, there is no airflow and, therefore, resistance is no longer a factor. The pressure measured during the pause (referred to as the “plateau” or “static” pressure) is the pressure needed to keep the system open at that volume and reflects the compliance of the respiratory system. Static compliance ($C_{ST}$) is then calculated using the formula in the figure below. In healthy, non-intubated individuals $C_{ST}$ is about 100 ml/cm H$_2$O. Values < 20 ml/cm H$_2$O are indicative of very low compliance.

4) **Management**
Management varies based on whether you have a primary resistance or a primary compliance problem. This can be identified by looking at the pressure vs. time curves.

**Call for help** if unable to determine the cause or the plateau pressure > 30 ml/cm H$_2$O.
The Peak Inspiratory Pressure Has Increased… Now What Do I Do?

1) What Determines Peak Inspiratory Pressure?
The peak inspiratory pressure (PIP) reflects how hard the ventilator must “work” to deliver a breath and is a function of three variables: (1) the inspiratory flow rate and flow pattern; (2) airway resistance (including the endotracheal tube and circuit); and (3) the compliance of the respiratory system. If the flow rate and flow pattern have not changed, any change in PIP is due to either a change in resistance or a change in compliance.

2) What Are Common Causes of Changes in Resistance or Compliance?

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4) Management

Resistance Problem: (Peak pressure increased, plateau pressure unchanged)
- Suction the ET Tube
- Bronchodilators
- Check endotracheal and circuit tubing for kinks or patient biting on the tube

Compliance Problem: (Peak pressure and plateau pressure increased)
- Sudden change: rule out pneumothorax with chest radiograph and/or chest ultrasound
- Less sudden changes:
  - Chest radiograph
  - Review fluid balance
  - Examine the abdomen. Consider bladder pressure measurement if tense
The Respiratory Therapist Said My Patient Has AutoPEEP… Now What Do I Do?

1) What Is AutoPEEP and Why Is It a Problem?

Under normal circumstances, the entire delivered tidal volume is expired during exhalation. If expiratory time is insufficient (see below), some portion of the previously delivered breath may remain in the lungs at the time the next breath is delivered. If this happens on a repeated basis, the lungs become hyperinflated. This can lead to increased intrathoracic pressure which decreases venous return and impairs cardiac output. In severe cases, people become hypotensive and can even go into pulseless electrical activity.

2) When to Look For This?

- Patients with obstructive lung disease (e.g., COPD, asthma)
- Patients requiring a very high respiratory rate to compensate for severe metabolic acidosis
- Patients who are spontaneously breathing at a very high rate
- Unexplained hypotension or cardiac arrest while on mechanical ventilation

3) How to Recognize AutoPEEP on The Ventilator?

![Graph showing flow vs. time curve with and without AutoPEEP]

4) Management

**Initial Steps:**
- Decrease minute ventilation by lowering rate and/or tidal volume (this is ineffective for patients breathing above the set rate on the ventilator)
- Increase the inspiratory flow rate; change to a square wave flow pattern
- Increase sedation
- Initiate bronchodilators and consider steroids for patients with asthma and COPD

**Severe Cases:**
**Call for help!**
Initiate neuromuscular blockade

**Hypotension and/or bradycardia progressing toward PEA arrest:** disconnect from ventilator (the loss of cardiac output is a greater risk than a transient cessation of ventilation). Readjust ventilator settings using the above-noted steps with reconnection.
The Respiratory Therapist Said My Patient is Breath Stacking... Now What Do I Do?

1) **What Is Breath Stacking and When Does It Occur?**

   In volume assist control, the ventilator will attempt to deliver a full breath (i.e., tidal volume) every time a patient starts to inhale. If the patient initiates a breath before full exhalation of the preceding one (due to their own intrinsic drive to breathe), the machine senses the inhalation effort and delivers another breath. This results in a larger than desired tidal volume and higher peak inspiratory pressures.

   You will most commonly see this in patients receiving low tidal volumes as part of lung protective ventilation.

2) **What Does It Look Like on the Ventilator?**

3) **Is This a Problem That Needs to Be Addressed?**

   It depends:
   - **It is not a problem if**: Breath stacking is sporadic (e.g., once every 5 breaths) and/or the patient does not have severe oxygenation problems
   - **It is a problem if**: Breath stacking is frequent (e.g., every breath or every other breath) and/or the patient has severe oxygenation problems. This needs to be addressed

4) **A Step-wise Approach to Management**

   Step 1: Increase sedation with propofol and fentanyl to decrease respiratory drive

   Step 2: Increase the inspiratory flow rate

   Step 3: Add an end-inspiratory pause (0.25-0.3 second)

   **Call for Help if Steps 1-3 Do Not Fix the Problem**

   Step 4: Consider increasing tidal volume as long as the plateau pressure < 30 cm H₂O

   Step 4: Initiate neuromuscular blockade
My Patient’s Creatinine Rising or Urine Output is Decreasing... Now What Do I Do?

1) Gather more information about the issue by asking three questions:
   • In the last 24 hours: has the creatinine risen to 1.5 times the baseline?
   • In the last 24 hours: has the creatinine risen by >0.3 mg/dL?
   • In the last 12 hours: has the average urine output been lower than 0.5 ml/kg/hr?

   If “Yes” to any of the above, the patient has acute kidney injury; Go to Step 2 below
   If “No” to all of the above, monitor serum creatinine, potassium, and magnesium daily.

2) Rule out post-obstructive nephropathy:
   • Flush foley catheter and inspect for obstruction.
   • Obtain bladder scan: If bladder is decompressed, post-obstructive nephropathy unlikely.
   • If concern remains, obtain renal ultrasound to evaluate for hydronephrosis

3) If no evidence of post-obstructive nephropathy, pursue further evaluation
   • Measure urine sodium and creatinine
   • Obtain urinalysis with microscopy
   • Calculate fractional excretion of sodium [\(FE_{Na} = \frac{(\text{Urine Na/Serum Na})}{(\text{Urine Cr/Serum Cr})}\)]

4) Evaluate and treat for pre-renal nephropathy:
   Pre-renal etiology is likely with urine sodium < 10 and/or fractional excretion of sodium < 1%
   If present:
   • Assess for hypovolemia and cardiac dysfunction
   • Treat hypovolemia with fluid boluses; start with 1 liter lactated ringers in most patients
   • Treat hypotension using the approach laid out in “My patient is hypotensive…”

5) Evaluate and treat for intrinsic nephropathy:
   An intrinsic renal process is likely if urine sodium > 20 or fractional excretion of sodium > 1%
   or urine microscopy reveals muddy brown casts, granular casts, red or white cell casts
   • Avoid repeated fluid boluses
   • Review medication list for nephrotoxic medications
   • Monitor potassium, magnesium, calcium, phosphate

   Consult nephrology if:
   • Severe or worsening metabolic acidosis (bicarbonate < 15 mEq/l)
   • Hyperkalemia unresponsive to medical interventions (> 5.5 mEq/l)
   • The patient is anuric
   • Ongoing increases in creatinine and/or BUN

6) Work with the pharmacist to adjust the dose of medications based on the estimated glomerular filtration rate.
My Patient is Hyperkalemic… Now What Do I Do?

1) **What Is a Normal Serum Potassium?**
The normal range for serum potassium is 3.5 to 5.0 mEq/L. The higher the value above 5.0, the greater the risk of complications. Patients with chronic kidney disease can typically tolerate greater increases in serum potassium above normal than patients without chronic kidney disease. Most patients do not experience problems until the potassium rises above 6.0 mEq/L.

2) **Follow the steps below:**

![Flowchart diagram](image)

3) **What are the concerning changes on electrocardiography?**

If the problem is not addressed, the patient can progress to a sinusoidal pattern followed by ventricular tachycardia or fibrillation.

4) **Identify and address contributing causes hyperkalemia**
As you manage the problem, consider and address factors that may be leading to the rise in potassium:

- Acute kidney injury
- Cellular shifts due to metabolic acidosis
- Muscle breakdown in rhabdomyolysis
- Ischemic tissue injury
- Tumor lysis syndrome

**Critical Care Skills for Non-Critical Care Providers**
My Patient Is Hyperkalemic
“My Patient Has a Fever… Now What Do I Do?”

1) Perform a targeted history and exam to identify potential sites of infection
   • Examine central lines, urinary catheter, drains for erythema, pus
   • Intubated patients: assess for change in amount / quality of secretions, or worsening oxygenation
   • Abdominal exam for focal tenderness or rigidity (pancreatitis, acalculus cholecystitis.)
   • Assess surgical sites for purulence or erythema
   • Assess for recent diarrhea
   • Review medication list for sources of drug fever (e.g., antibiotics, anti-seizure meds)

2) Start work-up for infection:
   • Blood cultures x 2 (peripheral and central)
   • Chest radiograph
   • Endotracheal aspirate if chest radiograph and clinical data suggestive of pneumonia
   • Urinalysis with reflexive culture
   • Consider liver panel (cholecystitis, drug reaction) and lipase (pancreatitis)
   • If diarrhea, send stool for C. Diff PCR if patient has not recently received laxatives
   • Call for Help!
     - If specific procedures indicated (paracentesis, thoracentesis)
     - CT scan necessary for further evaluation as this will mandate patient transport and create infection control issues.

3) Evaluate need for antibiotics:
   Start broad spectrum empiric antibiotics if: hemodynamic instability, high clinical suspicion and no clear source: Cefepime and vancomycin
   Start targeted antibiotics if a likely source is identified.
   • HAP/VAP: vancomycin + either piperacillin/tazobactam, cefepime or meropenem. If recent MRSA swab negative, may hold vancomycin unless severely ill
   • Central line: vancomycin + cefepime
   • Intra-abdominal: piperacillin/tazobactam
   • Catheter associated UTI: ceftazidime, change the catheter
   • C-difficile: oral vancomycin. Add intravenous metronidazole for severe disease
   If patient is already on antibiotics, Call for Help! with antibiotic selection.

4) Evaluate for non-infectious etiologies of fever:
   Drug fever: rash, peripheral eosinophilia
   Transfusion-related (can check a direct antiglobulin test)
   Venous thromboembolism

5) Treat the fever
   Acetaminophen 1000mg every six hours unless liver dysfunction. Avoid non-steroidals which may worsen COVID-19 and may contribute to worsening kidney injury.
My Patient Has Altered Mental Status… Now What Do I Do

1) Initial Assessment

• Check vital signs: assess for shock (hypotension), hypoxemia, or infection (fever)
• Stat fingerstick glucose: if hypoglycemic (FSG < 70), give 1 ampule of D50
• Perform neurologic exam:
  - Focal neurologic findings: Call for Help! Consult neurology. Must weigh infection control risks of traveling for brain imaging
  - If history of seizures or exam concerning for non-convulsive status epilepticus (roving eyes): Call for Help! Consult neurology for electroencephalogram (EEG)
• Review medications (opiates, sedative/hypnotics), recent events/procedures:

2) Laboratory Studies

• Arterial blood gas to rule out hypercarbia
• Serum electrolytes to assess for hypo/hypernatremia, hypercalcemia, increased BUN
• Serum ammonia level in patients with cirrhosis
• Evaluate for infection with fever and/or leukocytosis:
  - Urinalysis with reflexive culture
  - Blood cultures x 2 (peripheral and central)
  - Chest radiograph
  - Consider respiratory viral panel / COVID-19 (if not already checked)
  - Lumbar puncture generally not indicated as risk of meningitis in hospitalized patients is low unless they underwent a neurosurgical procedure with violation of the dura

3) Consider Head Imaging

• Primary Indications: focal neurologic findings, increased risk of bleeding, sudden onset severe headache, or sudden change in level of consciousness
• Must weigh benefit of imaging with infection control risk of traveling for imaging

4) Management

• Assess ability to protect airway. Call for Help! Intubate if airway protection in question
• Suspected opiate overdose: naloxone 0.4 mg IV. May repeat up to 2 mg total
• Discontinue sedating medications
• Consider ventilatory support for patients with hypercarbia not related to opiates
• Address electrolyte disturbances
• Treat identified sources of infection
My Patient Has Delirium… Now What Do I Do?"

1) How Do I Recognize Delirium

• Symptoms range from a withdrawn state ("hypoactive delirium") to severe agitation ("hyperactive delirium"), with irritability, delusions, day-night reversal, and increased sympathetic activity (hypertension, tachycardia)
• ICU Nurses screen for delirium using a standardized bedside tool (CAM-ICU)

2) Evaluate for Contributing Factors

Delirium typically results from the combination of severe primary illness and the ICU environment.

Look for other contributing factors including:

• Untreated infection
• Hypoxemia
• Inadequately treated pain
• Altered day/night cycle and poor sleep
• Medications: Top culprits are benzodiazepines, antihistamines, antiemetics

3) Management

• Non-pharmacologic interventions focused on orientation and the environment
  - Frequent reorientation during the course of the day
  - Encourage visitation from family (as able based on infection control restrictions)
  - Lights on in the room during the day, off at night
  - Minimize noise and stimulation at night
  - Remove catheters and physical restraints when able
  - Mobilize and do physical and occupational therapy as able
  - Ensure patient has their glasses and/or hearing aids
  - Consistency in the nursing staff as able

• Pharmacologic interventions
  - Stop benzodiazepines, anti-histamines other contributing medications, particularly those with anticholinergic side effects
  - Dexmedetomidine or propofol for sedation in intubated patients with target of alert or mildly sedated (RASS 0 to -1)
  - Consider pharmacologic intervention for sleep (e.g. trazodone, quetiapine) if non-pharmacologic measures are ineffective

Severe agitated delirium: Call for Help!
- As needed haloperidol (2.5-5 mg IV in repeated doses) if severe agitated delirium poses a risk of harm to the patient (e.g. discontinuation of lines or tubes) or the staff
- May consider scheduled oral quetiapine if severe agitated delirium persists despite prn haloperidol

Critical Care Skills for Non-Critical Care Providers
My Patient Has Delirium
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