

ICU Workbook

Emergency Medicine/Critical Care APPE Rotation



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Welcome

Welcome to your integrated emergency medicine and critical care rotation. During the course of this rotation, you will be expected to follow a patient from the emergency department through their ICU admission. In doing so, we hope that you will gain a better understanding of the spectrum of acuity, the importance of a collaborative team-based approach to healthcare and become more familiar with critical illnesses commonly seen in emergency medicine and critical care. To get the most out of this experience, look for opportunities to learn something new. Write down and look up any terminology or acronyms that you may not be familiar with and be sure to ask lots of questions.

We look forward to working with you. If you have any questions on during your rotation, don't hesitate to reach out.

How to Complete this Workbook

Over the course of this rotation, you will see patients in the emergency department with the various conditions addressed throughout this workbook. Using a combination of medical record review, self-guided study, literature review, and discussions with the critical care team, you should be able to complete each of the sections on your own, ideally by following a patient in the ICU that you saw in the emergency department. After completing a section, be prepared to discuss with one of the rotation preceptors. The book does not necessarily follow the order in which it should be completed, each module can be done independently.

You are required to complete each section of this workbook before the end of this rotation.

Meet the Critical Care Team

Care for critically ill patients requires an integrated effort by each member of our ICU team. Each team member has a specific role! What follows is an explanation of the roles of each member on our team.

Physicians

Attending: The team leader is an attending physician who has received advanced training in Critical Care Medicine. In North America, physicians who wish to receive board certification in Critical Care Medicine spend from 1 to 3 years in a critical care fellowship depending on their specialties. Currently, board certification is available to those with primary specialties in pediatrics, internal medicine, surgery, anesthesiology and emergency medicine.

Fellows: Fellows have completed a residency. They have decided to extend their training in order to become board certifiable subspecialists. There are a variety of fellows who rotate through the ICU. Some have primary training in internal medicine and are pursuing their Pulmonary & Critical Care Medicine certification. Others have backgrounds in surgery, anesthesiology, or emergency medicine. It is the role of the Fellow to supervise the Residents, Interns and Medical Students, to assist with procedures, and to be available to answer patient care questions as they arise.

Residents: Senior residents from several services rotate through the ICU. In the medical ICU, the majority of our residents are from Internal Medicine or Emergency Medicine. In the Pediatric ICU, there are residents from Pediatrics, Emergency Medicine, and Surgery. In the Surgical/Trauma ICU, residents are from Surgery, Anesthesia, or Emergency Medicine. It is the responsibility of the residents to supervise interns and students, and to directly assist in patient care.

Interns: These are physicians in their first year of training following completion of medical school. They are responsible for direct patient care, note writing, order writing, and procedures. They must be directly supervised by a resident, fellow, or attending physician.

Medical Students: We have a variety of medical students rotating on the service, typically third and fourth year medical students doing electives and sub-internships.

Non-Physicians

Nurse Practitioners and Physician Assistants: Many ICU teams now utilize advanced practice providers (APPs) such as nurse practitioners or physician assistants to optimize patient care. Nurse practitioners are nurses who have received additional training allowing them to diagnose and treat patients. Physician assistants receive training focused on the diagnosis and management of diseases as well. Unlike residents and fellow, APPs are team based and do not rotate, so APPs often know the patients and team dynamics very well.

Nursing Staff: Many nurses in the ICU have advanced training and certification in critical care and are recognized as CCRNs. Other nurses have advanced education (nurse practitioners and clinical nurse specialists). Nurses provide around the clock care to our critically ill patients in 12-hour shifts. Shift change occurs between the hours of 7 am and 8 am and again between the hours of 7 pm and 8 pm. In addition to the nurses, there are often nursing students being trained in our units by other nurses. We occasionally have a critical care nursing student round with our team.

Respiratory Therapists: RTs are experts in many types of pulmonary treatments. They assist with ventilator management, can help you learn to obtain blood gases (ABGs), and test the ability of patients to breathe spontaneously by obtaining parameters such as vital capacity and negative inspiratory pressures. In a code situation, our RTs assist with intubation and can help support the patient with bag mask ventilation. In many hospitals, they are trained to perform endotracheal intubation. There are occasionally RT students working with the RTs.

Dieticians: Experts in nutrition assist us in making sure that all of our critically ill patients are receiving the nutrition they require in order to recover from their illness.

Medical Social Worker: Provides ongoing psychosocial assessments and support to patients and their family members.

Case Manager: Assists with ensuring that patients and families receive appropriate care and services once patients are ready to leave the Intensive Care Unit.

Chaplain Services: Provide spiritual support to patients, families and ICU staff.

Patient Care Technicians: Assist nurses with caring for patients -bathing, moving, exercising, feeding, ECGs.

Unit Assistant ("UA"): manages administrative tasks -reception, telecommunications, and chart maintenance.

Pharmacy Staff

Pharmacists: In our ICU, we have a critical care pharmacist who helps us review the medication lists of our patients, manage antibiotics, review potential drug interactions, dose medications appropriately in patients with renal or hepatic insufficiency, and many other invaluable functions.

Pharmacy Residents: Pharmacy residents will often be on rotation in the ICU at the same time you are. Introduce yourself to the pharmacy resident's as they can be a wealth of knowledge for you and may have time for topic discussions and teaching sessions.

Basic Terminology

Acute Respiratory Distress Syndrome (ARDS): Acute process of noncardiogenic pulmonary edema leading to shortness of breath, hypoxemia. May be caused by sepsis, aspiration, trauma, pneumonia, and pancreatitis. Diagnostic criteria exist -look them up!

Arterial line: A catheter used for continuously following blood pressures and/or obtaining frequent arterial blood gases or other labs. Typically, this is placed in a radial or femoral artery. The brachial or axillary artery may also be cannulated (as may the umbilical artery in neonates).

Watch a video on how to place an arterial line here:

<http://content.nejm.org/cgi/video/354/15/e13/>

Central Line: A catheter placed in a central vein (femoral, subclavian, internal jugular, or umbilical) used for stable, long-term access, administration of hypertonic solutions, administration of vasoactive substances, frequent blood sampling; or central venous pressure monitoring.

Watch a video on how to place central venous lines here:

Internal Jugular: <http://content.nejm.org/cgi/video/356/21/e21/>

Disseminated Intravascular Coagulation (DIC): A syndrome characterized by an imbalance between coagulation and fibrinolysis. Patients may have microthrombi, macrothrombosis, bleeding, and organ dysfunction. It can be seen in sepsis, malignancy, liver disease, trauma and a variety of other conditions.

Inotropes: Drugs that augment myocardial contractility

Mean Arterial Pressure (MAP): This is the number seen in the parenthesis next to the typical blood pressure measurement. We aim for a MAP of 65 or greater in most adult patients with sepsis.

It can be calculated: $MAP = [(2 \times \text{Diastolic Blood Pressure}) + \text{Systolic Blood Pressure}] / 3$

Peripherally Inserted Central Catheter (PICC): A long intravenous line inserted through a peripheral vein (usually the brachial vein) and terminating in a central vein (usually the superior vena cava) allowing long term, stable venous access for frequent blood draws, or infusions of medications.

Shock: a syndrome resulting in inadequate tissue perfusion and cellular oxygenation which may affect multiple organ systems.

Cardiogenic: Due to the inability of the heart to produce adequate cardiac output

Distributive: Due to maldistribution of blood flow (anaphylaxis, sepsis, neurogenic)

Endocrine: A rare condition due primarily to thyroid dysfunction (usually hypothyroidism) or adrenal insufficiency

Hypovolemic: Due to diminished blood volume (dehydration or blood loss)

Obstructive: Due to decreased cardiac output secondary to an obstruction such as pulmonary embolus or severe aortic stenosis

Sepsis: A syndrome characterized by life-threatening organ dysfunction caused by a dysregulated host response to infection.

Septic Shock: Sepsis with acute circulatory failure not responsive to fluid administration. These are patients with sepsis who require vasopressors and other advanced therapies.

Total Parenteral Nutrition (TPN): Nutrition support delivered via a central line to patients with significant dysfunction of their GI tract.

Vasopressors: drugs that increase vascular tone.

Preparing a Patient Presentation

During this rotation, you may be asked to present a patient to one of your preceptors. Critically ill patients are very complicated, and there are a host of issues that should be evaluated and discussed every day. In order to ensure that all items are addressed regularly, a standardized approach to patient presentation is used in the ICU. Please use this approach when presenting your patient.

Below is an example of a complete patient presentation for an initial workup (also known as a history and physical, performed on the first day that you see a patient). The patient's HPI note, active orders, and laboratory results will be crucial when preparing for this presentation.

Sample HPI Presentation

Chief Complaint (CC): Mr. Smith is a 55 old man with a past medical history significant for peptic ulcer disease and hypertension who presents with abdominal pain and hypotension.

History of Present Illness (HPI): Mr. Smith was in his usual state of health until about four days ago when he noted the gradual onset of nausea, vomiting, and mid abdominal pain about 2 hours following a dinner of escargot, raw ostrich and 4 glasses of wine. Initially, the pain was mid abdominal and mild. Over the course of that evening, the pain intensified, and localized in the right lower quadrant. He tried taking Tylenol, Tums and Pepto-Bismol without relief. Movement made the pain worse. Nothing made the pain better. His emesis was non-bloody and non-bilious. He had a normal bowel movement earlier in the day and had not had any diarrhea following the onset of his symptoms. He denied melena or hematochezia. He was seen in the emergency room the morning following the onset of his symptoms, was diagnosed with gastroenteritis, and sent home.

Over the next two days, his pain continued to worsen. This morning, he had temporary relief in his abdominal pain. However, shortly thereafter he noted that he was having a high temperature to 102.3, was shaking, and that he was very dizzy whenever he tried to get out of his bed and walk around. His ex-wife called 911 when she couldn't contact him by phone and found him passed out on the bathroom floor. Upon arrival, the paramedics noted a temperature of 103.2 degrees, a heart rate of 130 beats per minute, and a blood pressure of 83/47. An IV was started and normal saline was given en route to the emergency room.

In the emergency room, the patient was given 4 more liters of IV fluid with continuing low blood pressures. He was given Tylenol per rectum for his fever, as well as broad spectrum antibiotics. He was thereafter transferred to the ICU for further evaluation and management of persistent hypotension.

Past Medical History is significant for peptic ulcer disease and borderline hypertension.

Allergies include sulfa, which causes rash.

Patient's only medications at home were Tylenol

Social History: Mr. Smith lives in San Francisco. He has been divorced for 15 years. He works for SBC doing telephone repairs.

Health Related Behaviors: He has a 35 pack year history of tobacco use, as well as a history of meth and cocaine use. Last use of any of these was 20 years ago. He drinks socially about 1-2 times per week.

Family History is significant only for an uncle with an unknown type of hepatitis.

In addition to the above, the review of systems is significant for fevers, chills, sweats, anorexia, and dizziness with positional changes. He has also noted decreased urination and darker color of his urine.

Neurologically he is somewhat sleepy, but arousable with minimal stimuli.

Cardiovascularly, the patient remains hypotensive. After five liters of IV fluid and the initiation of dopamine at 5 micrograms per kilogram per minute, his blood pressure remains 92/53, and his heart rate is 140 beats per minute. His cardiac exam is significant for tachycardia, but is otherwise unremarkable.

From a respiratory standpoint, the patient had an oxygen saturation of 96% on room air at the time of presentation. However, over the last 30 minutes, his saturations have been dropping and he is now satting 92% on 6 liters of oxygen per minute by face mask. His respiratory rate has increased from 14 to 22 breaths per minute. An ABG (arterial blood gas) is pending.

Gastrointestinal exam is significant for rebound tenderness, guarding, and absence of bowel sounds. Liver function tests are normal. Amylase is mildly elevated at 263. The patient is NPO and a KUB of the abdomen shows free air under the diaphragm.

From a renal standpoint, Mr. Smith has been making very little urine since the time of admission. He has made a total of 20 mL of urine over the last 2 hours despite IV fluids. His BUN is elevated at 42, and his creatinine is 2.3. His baseline creatinine is 0.7. Urinalysis shows hyaline casts.

Hematologically, the patient has a normal hematocrit of 42.3% as well as normal platelet count. His INR is mildly elevated at 1.4. PTI is within normal limits.

From an infectious disease standpoint, two sets of blood cultures are pending. The patient remains febrile with a temperature of 102.7. His white blood cell count is 22.6 with more than 20% bands. He is currently on broad spectrum antibiotics including cefepime, metronidazole, and vancomycin.

The patient has no active endocrine issues.

My assessment is that this is a 55 year old patient with history of peptic ulcer disease and borderline hypertension who presents with septic physiology and possible acute lung injury versus ARDS in the setting of peritonitis.

My Plan:

Neurologically: We will continue to treat this patient's pain and closely monitor his mental status.

Cardiovascularly: We need to support this patient's blood pressure with additional IV fluids as well as pressors. He may benefit from a central line so that we can administer appropriate amounts of IV fluid and safely increase his vasopressor regimen. He will also likely benefit from an arterial line for closer blood pressure monitoring.

Respiratory status is concerning for ARDS or ALI in the setting of peritonitis. We will continue to supply supplemental oxygen, place an arterial line so that we can follow ABGs as necessary. He may require intubation if his respiratory status continues to decline.

From a GI standpoint, we will keep the patient NPO in anticipation of surgery for appendicitis.

From a renal standpoint, it is likely that this patient's renal failure is secondary to a combination of dehydration and hypotension leading to acute tubular necrosis. We will continue to provide IV fluids as well as to support his blood pressure and monitor both his urine output as well as his electrolytes/creatinine.

From a hematological standpoint, patient is stable.

From an infectious disease standpoint, we will wait for blood cultures, continue to treat with broad spectrum antibiotics to cover peritonitis, and will attempt to stabilize the patient so that he may be taken to the operating room for appendectomy.

From an endocrine standpoint we will closely monitor his blood pressures and consider stress dose steroids if the patient remains hypotensive despite adequate volume resuscitation and pressors. In addition, during his period of critical illness, we will closely monitor blood sugar levels and initiate insulin therapy if appropriate

Prophylaxis: As patient is critically ill we will start the patient on an H2 blocker for stress ulcer prophylaxis and administer subcutaneous heparin for DVT prophylaxis.

Additional Comments

Please note the stepwise fashion that the assessment and plan follows. Using this systematic approach is critical to ensuring that each system is addressed routinely.

Also, while it is not critical to include the details of every regimen in your assessment and plan, as a pharmacist, you should have these details available, including dose, route, frequency, planned duration of therapy, and total days of therapy thus far. For example, when presenting this patient, expect that your preceptor may ask what dose of vancomycin this patient is receiving, how often is it being given, how many doses have they received so far, and if a vancomycin loading dose was administered.

Remember your preceptor is likely to use this presentation as a jumping off point for a topic discussion, so be prepared to discuss interesting aspects of your patient's case!

ICU Follow-up Presentation

After the initial presentation, subsequent presentations to the same preceptor/team can be much more concise. Below is an example of a follow up presentation for the patient from the previous example. Most of this information will be available in the patient's chart. Check the most recent physician note, active orders, and laboratory results when preparing for this presentation.

Example Follow-Up Presentation

ID: This is our 55 year old patient with history of peptic ulcer disease and borderline hypertension who presented with septic physiology and acute lung injury in the setting of peritonitis.

Overnight Events: He was taken to the operating room by general surgery for an appendectomy. He received a total of 4 liters of IV fluid in the operating room and had no operative complications. His blood pressure and respiratory status have improved.

Physical Exam:

Vital signs: Patient's maximum temperature over the last 24 hours has been 38.3. Current temperature is 37.3. Heart rate has ranged from 80 to 125 and is currently 92. Blood pressure ranged from 60-140/35-92 and is currently 136/78. Mean arterial pressures have ranged from 45 to 96 and his current MAP is 82. Respiratory rate has ranged from 16-32 and is now 22. Oxygen saturation has ranged from 88-100% and is currently 98% on 4L O₂ by nasal cannula.

Neuro: Patient is alert and oriented this morning, complaining of some incisional pain. His pupils are equal, round and reactive to light. Extraocular movements are intact. Neuro exam is non-focal. HEENT: Eye exam as per above. OP has some mild erythema and voice is a bit hoarse. He complains of a sore throat.

Cardiovascular: Patient's heart is regular. No murmurs, rubs or gallops are heard

Lungs: Rales heard in the bilateral bases with decreased air entry throughout.

Abdominal exam: No bowel sounds are heard. Dressing is clean, dry and intact. There is some mild, diffuse abdominal tenderness without rebound or guarding. Tenderness is most pronounced in peri-incisional region.

Renal: No CVA tenderness. Patient has had 10 liters of fluid in over the last 24 hours and a total of 4 liters of output. One liter was in the form of NG tube output. The other 3 liters were in the form of urine. The net over the last 24 hours is 6 liters positive.

Extremities: No clubbing or cyanosis. There is some edema in the bilateral lower extremities and in the presacral area.

Data: Chest x-ray is significant for some bilateral lower lobe atelectasis and a small right sided pleural effusion; Labs show a white blood cell count of 12, which is down from 22 yesterday. Hematocrit has dropped from 42 to 33%. Electrolytes are within normal limits. Creatinine has returned to baseline of 1.4 and urine output is improving. Finger sticks have ranged from 82 to 120. Blood cultures show no growth to date.

Medications: Patient was on norepinephrine overnight but is not currently requiring pressors. He is on Cipro and Flagyl day 1 for treatment of peritonitis. He is also receiving ranitidine 150mg IV bid, subcutaneous heparin 5000 units q 8 hours, morphine prn pain, and normal saline is infusing at a rate of 125 mL per hour.

Assessment/Plan: This is a 55 y/o man post-op day #1 from emergent appendectomy admitted for sepsis and acute lung injury who appears to be improving.

Neurologically the patient has some abdominal pain. We will start a morphine PCA pump so that patient can control his pain.

Cardiovascularly the patient required aggressive fluids and levophed overnight but has improved and his hemodynamics are currently acceptable. We will continue to administer IV fluids until the patient is able to take PO.

Respiratory: The patient presented with acute lung injury. His respiratory rate has decreased and his oxygen requirement has improved. We will give him an incentive spirometer and encourage its use.

GI: patient is post op day #1 from an emergent appendectomy. He does not yet have any bowel sounds. He will remain NPO for the time being.

Renal: Patient presented with acute renal failure. Urine output and renal function appears to be improving. We will continue to monitor and replete electrolytes as needed. We will continue to administer fluids by IV today, but our goal will be to achieve a slightly positive to even fluid status as he is 6 liters up from presentation and we do not want to promote pulmonary edema.

ID: Continue antibiotics for peritonitis. Dosing appropriate for renal function. Continue to follow culture results.

Endocrine: Finger sticks have been within acceptable ranges. No supplemental insulin has been required.

Prophylaxis: Patient will be continued on his H2 blocker and DVT prophylaxis.

Tips for Successful Patient Presentations

Avoid common mistakes

- Abbreviations are for writing – not for speaking.
- If you don't know the jargon, don't use it.
- Don't invent new words.
- Pay attention to your audience.
- If someone uses an abbreviation that you aren't familiar with, ask them.
- Focus on pertinent findings. We don't need to know every lab value, but if something is out of range or changes your plan it should be included in your presentation
- Be aware that there are abbreviations that can cause confusion and errors. Below is a list of those abbreviations that should NEVER be used.

DO NOT USE	PREFERRED
U (for unit)	Write out/say unit
TIW (for three times a week)	Write/say 3 or three times weekly
MS or MSO4 (for Morphine Sulfate)	Write/say Morphine
MgSO4 (for Magnesium Sulfate)	Write/say Magnesium
QD (Latin for once daily)	Write/say once daily or daily
QOD (Latin for every other day)	Write/say every other day
QID (Latin for four times daily)	Write/say 4 or four times daily
ug (microgram)	Write/say microgram
QHS (Latin for at bedtime)	Write/say at bedtime
Trailing zero (x.0 mg)	NEVER write a zero by itself after a decimal point
Lack of leading zero	ALWAYS use a zero before a decimal point (0.X mg)

How to “wow” your audience

- Practice: In front of a mirror, to the resident on your team, to your significant other (leave out the name or other identifying patient info, please), to your dog, etc...
- Be confident: Avoid too many uhs & ums. Don't second guess yourself. Even if you don't feel confident, practice looking that way.
- NEVER make up information. It isn't safe for the patient, and you will get caught. The team will respect someone who is willing to say "I don't know" much more than someone who feels the need to make up information.
- Try to anticipate what your audience will want. If you don't know, ask. Error on the side of too much information rather than not enough. For shortened presentations, make sure that you HAVE all the information, even if you will not be presenting it all.
- Prior to your presentation, think about what you want to convey to your audience.
- Discuss your assessment and plan with a member of the team BEFORE you give your formal presentation.
- Read up on your patient's condition so that you can contribute to the assessment and plan.

Mechanical Ventilation/Acid Base/Pain, Agitation, Delirium

Please answer these questions regarding mechanical ventilation for your ICU patient. If your patient is not mechanically ventilated, please ask a member of the ICU team to direct you to an appropriate patient for the purposes of this exercise.

Please note: NEVER touch any of the knobs, buttons or other controls on the ventilator!!!

Suggested Reading:

Mechanical Ventilation Overview

<http://www.thoracic.org/professionals/clinical-resources/critical-care/clinical-education/mechanical-ventilation/index.php>

Interpretation of Arterial Blood Gases

<http://www.thoracic.org/professionals/clinical-resources/critical-care/clinical-education/abgs.php>

Rapid Sequence Intubation and Post Intubation Sedation and Analgesia

<https://www.aliemu.com/capsules/>

Pharmacology of Emergency Airway Management (Parts 1 and 2)

Requires login, but all content is free

Pain, Agitation, Delirium, Immobility and Sleep Disruption guidelines

https://journals.lww.com/ccmjournals/Fulltext/2018/09000/Clinical_Practice_Guidelines_for_the_Prevention.29.aspx

1. Was your patient intubated in the Emergency Department?
2. Why was this patient intubated/put on mechanical ventilation?
3. What medications did the patient receive for rapid sequence intubation, if any?
 - a. Was this regimen appropriate? Explain why other sedatives or paralytics would have been better/worse

4. What is the patient currently receiving for pain?
 - a. What is the patient's goal CPOT score?
 - b. What is the patient's most recent CPOT score?
 - c. Are there any changes you would suggest regarding this patient's analgesia at this time?
5. Is this patient receiving any sedative medications? If so, what are they receiving?
 - a. What is the patient's goal RASS score?
 - b. What is the patient's most recent RASS score?
 - c. Are there any changes regarding this patient's sedation that you would recommend at this time?
6. Is your patient receiving daily sedation vacations? If not, why not? Why is this important?
7. Is it appropriate to start weaning this patient off of sedation and/or analgesia at this time? Explain your rationale.

8. Is your patient undergoing daily spontaneous breathing trials? Why is this important? If not receiving, why not?

9. What is the patient's most recent CAM-ICU score?
 - a. What risk factors does this patient have that increase their risk of delirium (hint, refer to PADIS guidelines)

 - b. Is the patient receiving any medications to treat delirium? Is this appropriate?

10. Interpret the patient's first available blood gas

- a. List the ABG values below using this format: PaO₂/pH/PaCO₂/Bicarbonate
- b. Did the patient present with acidosis, alkalosis, or a normal pH?
- c. Was the primary issue metabolic or respiratory?
- d. Was the patient able to compensate at this time?
- e. What was the patient's anion gap at this time?
- f. What is your assessment based on this ABG (eg respiratory acidosis without compensation due to acute respiratory failure following opioid overdose)

11. Interpret the patient's most recent blood gas

- a. List the ABG values below using this format: PaO₂/pH/PaCO₂/Bicarbonate
- b. Does the patient have acidosis, alkalosis, or a normal pH?
- c. Is the primary issue metabolic or respiratory?
- d. Is the patient able to compensate at this time?
- e. What is the patient's anion gap?
- f. What factors do you think led to the change between the initial blood gas and the most recent one?
- g. If ABG still abnormal, why? What is the plan moving forward to correct this abnormality?

12. What do the following terms related to mechanical ventilation mean and why are they important? (Hint: The respiratory therapists are great sources of this kind of information)

a. FiO_2

b. PaO_2

c. PEEP

d. Alveolar recruitment

e. Pressure support

f. Volume control

g. Tidal volume

h. Ventilator rate

Nutrition, Electrolyte Replacement, Glycemic Control and Prophylaxis

Like anyone else, critically ill patients require nutrition to make energy for basic metabolic functions; however, their ability to eat is often limited by altered neurologic function, gastric motility issues, the presence of an endotracheal tube, or a number of other factors. As a result, critically ill patients typically receive either enteral nutrition through a tube or parenteral nutrition through an IV line. This section will help you identify how your patient is receiving nutrition support and will help you think through how this may impact your decisions as a pharmacist.

Critically ill patients often have a number of factors that can change their serum levels of various electrolytes. Critical illness can also lead to changes in how your body utilizes glucose. In addition, extreme glucose values, either high or low, can be detrimental for your patient. This module will help you learn to predict and manage some of the electrolyte and glucose changes that can be seen in critical illness.

Finally, critically ill patients may be at risk for complications such as venous thromboembolism (VTE), pulmonary embolism (PE), and GI stress ulcers. This section will help you weigh the pros and cons of prophylaxis against these events and ensure prophylactic agents are being used appropriately.

Suggested Reading:

ASPEN Guidelines

<https://onlinelibrary.wiley.com/doi/full/10.1177/0148607115621863>

ISMP Do Not Crush List

<https://www.ismp.org/recommendations/do-not-crush>

VTE Prophylaxis in Critically Ill

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3743339/>

Stress Ulcer Prophylaxis

<https://www.bmj.com/content/bmj/368/bmj.l6722.full.pdf>

1. Is your patient currently receiving nutrition support?
 - a. If so, what are they receiving? Include route, formula, and rate of administration. If not, why not?

2. How was this regimen selected for this patient? (Hint: Ask a dietician nicely)
3. If receiving enteral nutrition, what kind of tube is being used for administration?
4. Can medications be given through this tube?
5. Are medications being administered via this tube? If so, which ones?
6. Are there any medications that could be administered via this tube that are currently being given IV?
7. What are some common properties of medications that should not be given via an enteral tube?
8. How does the nurse prepare tablets for administration via an enteral tube? (Hint: Ask a nurse nicely)
9. Are there any medications that are being given as a tablet but are available as a liquid? Why do you think that is (hint: additives)?
10. Is the patient receiving any home medications via the enteral tube where the route and frequency have changed? If so, what and why?

11. Has this patient received any IV electrolyte replacement in the past 24 hours? If so, what did they receive and why?
12. Does your patient have any standing orders for electrolyte replacement? If so, what electrolytes can be replaced with these orders?
13. Using the electrolyte replacement protocol, determine how much IV potassium chloride a patient should receive for a serum potassium level of 3.4 mEq/L.
14. How much would you expect an adult patient's serum potassium level to increase after receiving 10 mEq of IV KCl?
15. What is the highest concentration of potassium chloride that should be given peripherally? Why?
16. What is the maximum rate of administration for potassium chloride?
17. What can happen if potassium chloride is given too quickly?
18. When treating hyperkalemia, what 3 medications can cause potassium to shift into the cells?

19. When treating hyperkalemia, medications and interventions can be used to remove potassium from the body?
20. Does your patient have any insulin ordered? If so, what orders are currently active?
21. How much insulin has your patient received in the past 24 hours? List insulin type, dose, frequency and total insulin requirement.
22. What was your patient's highest glucose level in the past 24 hours? Lowest?
23. Does your patient have any orders for a nurse to use if the patient's glucose level is than 70? Less than 50? If so, what are they?
24. Is the patient receiving any medications that could increase their serum glucose level? What medications would you expect to increase your patient's serum glucose level?
25. Is your patient receiving any anticoagulant medications for DVT prophylaxis? If so, what are they receiving? If not, why not, and at what point should DVT prophylaxis be added?
26. Does your patient have a sequential compression device on their lower extremities?

27. Is your patient receiving any stress ulcer prophylaxis?

- a. If so, what are they receiving? Is this appropriate? When should it be discontinued?
- b. What risk factors increase the need for stress ulcer prophylaxis?

Management of Sepsis, Hemodynamic Monitoring, and Vasopressors

The ICU can be a bit intimidating. Many of the patients are hooked up to machines, monitors and tubes of various sorts. In addition, many patients have low blood pressures and require a host of continuously infused medications to combat their hypotension. This chapter is meant to walk you through the latest guidelines for the management of sepsis, to help familiarize you with the types of monitoring that can be performed in the ED and/or ICU, and to teach you about some of the medications that are used to treat hypotensive patients.

Early, aggressive correction of blood pressure and early administration of antibiotics are the hallmark features of quality care in sepsis. Many institutions, including ours, have order sets to help guide physicians' management of septic patients both in the Emergency Department and in the ICU. Despite the seeming ease of implementing the recommended therapies through the use of protocols, many studies have shown that the protocols are not followed. In this next exercise, we will help you navigate the sepsis protocol, and ask you to determine whether or not your patient received timely and appropriate therapy.

Please keep in mind that you, the student, may help your patient receive such timely and potentially life-saving therapy by asking the physicians with whom you work whether or not the sepsis protocol is appropriate. However, before asking, you may want to think about whether or not your patient meets diagnostic criteria for sepsis.

Please answer as many of the following questions based upon your patient as possible. If your patient is not currently or has not been hypotensive during their hospital course, we ask that you please ask your team to direct you to a patient with sepsis or septic shock.

Suggested Reading:

Videos: <http://content.nejm.org/cgi/video/356/21/e21/>
<http://content.nejm.org/cgi/video/357/24/e26/>

Articles: <http://jama.jamanetwork.com/article.aspx?articleid=2492881>
<https://www.nejm.org/doi/full/10.1056/nejmoa1705835>
https://journals.lww.com/ccmjjournal/Fulltext/2021/11000/Surviving_Sepsis_Campaign_International.21.aspx

Other

<https://www.aliemu.com/courses/pharmacology-of-severe-sepsis-and-septic-shock/>
Requires login, free to make account

1. Define sepsis
2. Define septic shock
3. Describe 5 different signs of organ dysfunction
4. What is the SOFA score and how is it used in sepsis?
 - a. What was your patient's SOFA score on admission?
5. What was your patient's blood pressure on admission?
6. What was your patients mean arterial pressure (MAP) on admission?
7. What is your patient's blood pressure now?
8. What is your patient's MAP now?
9. Does your patient have an arterial line? Where is it located?
10. What is the purpose of an arterial line?

11. At any point, has your patient met the diagnostic criteria for sepsis or septic shock?

a. Which one? Explain your rationale

12. What is the patient's current MAP goal?

a. Why was this goal selected?

b. What is currently being done to achieve this goal?

13. What is a pulse pressure?

a. What is your patient's pulse pressure?

b. Is this high, low, or normal?

c. What does this suggest?

14. Does your patient have a central line?

a. If so, what type (triple lumen, PICC, other)

b. What medications are currently being given through the central line?

c. Why does the patient have a central line in place?

15. What was your patient's initial lactate level?

- a. Where was this obtained (ED, ICU, other)?
- b. What does this value tell you about your patient?
- c. Was a follow up level obtained? If so, what was that value?
- d. What does the follow up value tell you about your patient?

16. Were cultures obtained in the emergency department?

- a. What cultures were obtained?

17. Were antibiotics given in the emergency department?

- a. What antibiotics were given?
- b. Was this regimen appropriate at the time it was initiated? Explain your rationale
- c. When were the antibiotics given relative to the patient's arrival (eg, 45 minutes after ED arrival)
- d. Did this meet the goal timing of administration?

- e. What was the working diagnosis that lead to this regimen being selected?

18. Were the antibiotics modified once the patient reached the ICU?

a. What lead to this modification?

b. Was this change appropriate?

19. Were any organisms identified in the cultures obtained in the ED?

a. What organisms were identified?

b. Are susceptibility results available?

c. Were the antibiotics given in the ED active against the isolated pathogen(s)?

d. Were the antibiotics changes once an organism was identified? If so, what changes were made and was this change appropriate?

e. Were the antibiotics changed once susceptibility information was available? If so, what changes were made and was this change appropriate?

20. Is the patient's current antibiotic regimen appropriate? If so, why, if not, what changes would you suggest?

21. What is the patient's source of infection/diagnosis?

22. How long should the current antibiotic regimen be continued?

23. How much fluid and what type of fluid did the patient receive in the first 3 hours in the ED?

24. How much fluid and what type of fluid did the patient receive in the first 24 hours in the ICU?

25. What receptors do the following medications work on? What is the anticipated physiologic effect of these medications?

- a. Dopamine
- b. Dobutamine
- c. Epinephrine
- d. Phenylephrine
- e. Norepinephrine
- f. Vasopressin

26. Has your patient required any vasopressors during this admission?

- a. If so, which were used and what was the maximum dose administered?
- b. Was this choice appropriate? Please explain why this choice was better/worse than the other agents on the list above

27. Did this patient receive corticosteroids?

- a. If so, what corticosteroid regimen did they receive?
- b. Is this regimen appropriate?

Acute Ischemic Stroke

Acute ischemic stroke is a major cause of morbidity and mortality. Stroke is a time sensitive emergency, and delays in treatment have been associated with worse patient outcomes. As such, it is important for a pharmacist to know what information is needed to make the decision to administer alteplase to patients presenting with acute ischemic stroke and what interventions may be needed prior to administration in order to prevent delays in care.

Following the acute phase, there are interventions that can help promote recovery and prevent secondary stroke, both of which present an opportunity for pharmacists to make an impact on patient's recovery.

Suggested Reading

- Articles NINDs: <https://www.nejm.org/doi/full/10.1056/NEJM199512143332401>
 ECASS III: <https://www.nejm.org/doi/full/10.1056/NEJMoa0804656>
- Guidelines <https://www.ahajournals.org/doi/10.1161/STR.0000000000000211>
 <https://www.ahajournals.org/doi/10.1161/STR.0000000000000375>

1. When did your patient arrive in the emergency department?
2. What were their presenting signs and symptoms?
3. Would your patient have tested positive on the Cincinnati Stroke Scale when they arrived in the emergency department?
4. When was your patient last seen normal (time of symptom onset)?
 - a. Why is this important?

5. What imaging was done upon arrival to the emergency department?
 - a. What was the radiologists impression of this imaging?
6. What labs were ordered in the emergency department for this patient?
 - a. What laboratory values could exclude a patient from receiving alteplase?
7. What was your patient's NIHSS?
 - a. Are there NIHSS scores that would impact the decision to give alteplase?
8. What was your patient's blood pressure upon arrival?
 - a. Is there a blood pressure limit that would exclude a patient from receiving alteplase?
 - b. Did the patient require any medications to manage blood pressure upon arrival?
9. Does your patient have any co-morbid conditions?
 - a. Are there comorbid conditions that would impact the decision to give alteplase?

- b. Are there any co-morbid conditions that would change the amount of time you have to give alteplase (Hint: ECASS III)
- 10. Did your patient had any recent surgical procedures prior to arrival in the ED?
 - a. Would the timing of any surgical procedures impact the decision to give alteplase?
- 11. How old was your patient?
 - a. Do you think this factored into the decision to administer alteplase?
- 12. Did your patient receive alteplase?
 - a. If so, how long after arrival in the emergency department did they receive alteplase?
 - b. What is the goal time from ED arrival to alteplase? Was this within the goal time?
 - c. If not, why not?
- 13. Did the patient receive any neurosurgical or interventional radiology procedures to manage their symptoms? If so, what was done?
- 14. Has your patient received aspirin during this visit?
 - a. If so, when?

b. Was this appropriate? Why or why not?

15. What is your patient's most recent NIHSS?

a. Is it better, worse, or the same compared to their admitting NIHSS?

b. Based on the NINDS study, at what point would you expect to see recovery after administering alteplase?

16. Has the patient had a swallow evaluation?

a. If so, what did they find? If not, why not?

17. What can be done to reduce this patient's risk of having another ischemic stroke?

18. What are the plans for rehabilitation?

Optional Comments Page

We want this to be an outstanding learning experience and your feedback will help us improve!

Please let us know if there is anything else you would like to see covered in this workbook, if anything was too easy or difficult, or if you have any suggestions for improvement.