SIMULATION

Acute Exacerbation of COPD

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ABSTRACT:

Audience: This case is targeted to emergency medicine residents of all levels.

Introduction: Shortness of breath (SOB) is one of the top ten most common chief complaints seen in the Emergency Department, accounting for close to 10% of presenting complaints.[1] An acute exacerbation of chronic obstructive pulmonary disease (AECOPD) is a frequent culprit, accounting for roughly 15.4 million visits and 730,000 hospitalizations per year.[2] The diagnosis of treatment of mild to moderate AECOPD can be relatively uncomplicated; however, multiple factors can increase the complexity of management and pose additional challenges that the emergency physician (EP) must be prepared for. Severe AECOPD can necessitate the need for both Non-invasive positive pressure ventilator (NIPPV) such as bi-level positive airway pressure (BiPAP) as well as emergent intubation. Furthermore, managing the ventilator settings in patients with an AECOPD is far from routine, requiring an intricate understanding of pulmonary physiology.[3]

Educational Objectives: By the end of this simulation, learners will be able to (1) assess for causes of severe shortness of breath, (2) manage severe COPD exacerbation by administering appropriate medications, (3) identify worsening clinical status and initiate NIPPV, (4) assess the causes of hypoxia after establishing endotracheal intubation and, (5) identify indication for needle decompression and perform chest tube thoracostomy.

Educational Methods: This simulation was conducted with a high-fidelity mannequin with a separate low fidelity chest tube mannequin that allowed for hands-on practice placing a chest tube. A total of 16 PGY-1 residents participated in the simulated patient encounter.

Research Methods: Following the simulation and debrief session, all residents were sent a Likert scale survey via surveymonkey.com to assess the educational quality of the simulation. The survey contained the following questions; 1) Overall, this simulation was realistic and could represent a patient presentation in the Emergency Department, 2) Overall, the case contained complexity that challenged me as a learner, 3) This case helped to expand my medical knowledge, 4) I feel more confident in diagnosing and treating AECOPD, 5) I feel more confident in recognizing the indications for NIPPV and intubation, 6) This simulation offered an

opportunity to improve my procedural skills, 7) I feel more confident in setting up the ventilator, 8) I feel more confident in addressing ventilator alarms.

Results: Following the simulation and debrief session, all the participants (n=16), were provided a survey to assess the educational quality of the simulation. There were a total of 12 respondents and a hundred percent of them agreed or strongly agreed that the case contained complexity that challenged them. All of the respondents agreed that the simulation case was realistic and that the case helped expand their medical knowledge. Furthermore, all the learners agreed or strongly agreed that the case helped them in improving their procedural skills.

Discussion: This case combines a mixture of high fidelity and medium fidelity components to encompass both clinical knowledge and procedural skills. This case is effective in expanding beyond the basic approach to managing an AECOPD patient and forces learners to address clinical deterioration, escalate airway interventions, manage ventilator settings, and address ventilator alarms, including placement of a chest tube. Residents commented that this case was very realistic and particularly challenging because it highlighted gaps in their clinical knowledge and procedural skills. Residents were most challenged by identifying when to escalate care as well as how to manage ventilator settings in AECOPD patients.

Topics: Acute exacerbation COPD, intubation, positive pressure ventilation, ventilator alarms, chest tube thoracostomy.

USER GUIDE

List of Resources:

Learner Audience:
Medical Students, Interns, Junior Residents, Senior Residents

Time Required for Implementation:
Instructor Preparation: 30 minutes
Time for case: 20 minutes for single cases
Time for debriefing: 30 minutes per case

Recommended Number of Learners per Instructor:
4

Topics:
Acute exacerbation COPD, intubation, positive pressure ventilation, ventilator alarms, chest tube thoracostomy.

Objectives:
By the end of this simulation session, learners will be able to:

1. Formulate appropriate work-up for altered mental status (AMS)
2. Recognize hypokalemia and associated findings on ECG
3. Address hypomagnesemia in a setting of hypokalemia
4. Manage pulseless VT by following advanced cardiac life support (ACLS)
5. Recognize and address TdP
6. Provide care after return of spontaneous circulation (ROSC)
7. Consult intensivist and admit to intensive care unit (ICU)

Linked objectives and methods:
This case begins with the patient presenting with shortness of breath and a history of COPD. The learners will have to perform a primary assessment, identify signs of respiratory distress, and start initial interventions (objective #1). They will have to obtain further history and identify the likely diagnosis of AECOPD and then initiate disease specific treatment (objective #2). The patient will progress to respiratory failure and require escalation of interventions (objective #3 and #4). The ventilator high peak pressure alarm will trigger as the patient deteriorates, requiring the learner to evaluate for causes of post-intubation hypoxia and high peak pressures (objective #5). Learners will need to ultimately perform needle decompression and chest tube thoracostomy (objective #6).

Recommended pre-reading for instructor:
We strongly recommend reviewing the following articles and videos about managing ventilator alarms:

- Zgurzynski P. COPD. SAEM. Published 2019. Accessed March 14, 2023. At: https://www.saem.org/about-saem/academies-interest-groups-affiliates2/cdem/for-students/online-education/m4-curriculum/group-m4-respiratory/copd
- Celli BR, Barnes PJ. Exacerbations of chronic obstructive pulmonary disease. *European Respiratory Journal*. 2007;29(6):1224-1238. doi:10.1183/09031936.00109906
- Seigel T. Alarms from the ventilator: Troubleshooting high peak pressures. AliEM. Jul 30, 2013. At: https://www.aliem.com/alarms-from-ventilator-troubleshooting-high-peak-pressures/
- Ventilator Management. EM:RAP. (Video). At: https://www.emrap.org/episode/january2013/ventilator

If the instructor is unfamiliar with placing a chest tube thoracostomy, we recommend reviewing the following video:

- Mason, J. EM:RAP. (Video) At: https://www.emrap.org/episode/chesttube1/chesttube1

Results and tips for successful implementation:
This simulation was designed for emergency medicine residents to improve their resuscitation skills by managing a decompensating acute exacerbation of COPD that requires intubation and subsequently develops a tension pneumothorax and requires needle decompression and chest tube thoracostomy. The case was performed in a high-fidelity simulation setting using an additional low fidelity modified chest tube thoracostomy mannequin to simulate chest tube placement.

Some tips for successful implementation of this simulation include:

- Create teams of 3-4 learners, preferably with mixed levels of training to balance experience levels with management of severe AECOPD and ventilator management.
- Before the beginning of the case, we recommend the learners assign roles to help the case run smoothly.

USER GUIDE

- The portion of the case with ventilator alarms and chest thoracostomy placement can be entirely removed for junior learners.

This simulation was designed and implemented during the 2022-2023 academic year. It was conducted with first-year emergency medicine residents in a total of four separate in-person sessions. The debrief session was conducted in two large groups immediately after the simulation. All learners were from the same residency program.

Following the simulation and debrief session, participants (n=16), were provided a survey to assess the educational quality of the simulation, as well as open ended feedback. There were a total of 12 respondents (75% of participating residents). Figure 1 shows 100% of them agreed or strongly agreed that the case contained complexity that challenged them.

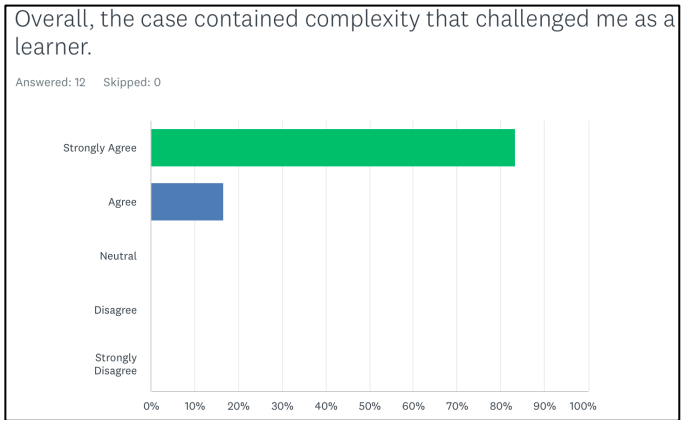

Figure 1

Figure 2 shows that all of them agreed that the simulation case was realistic. All of them agreed or strongly agreed that the case expanded their medical knowledge (Figure 3). In addition, the last figure showed that the learners agreed or strongly agreed that the case helped them in improving their procedural skills (Figure 4).

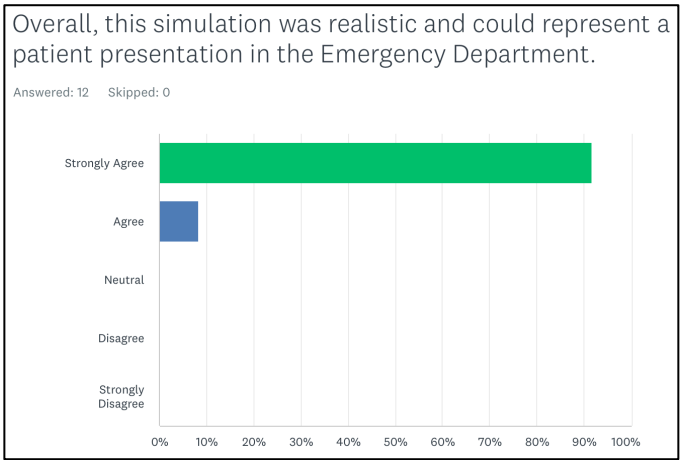

Figure 2

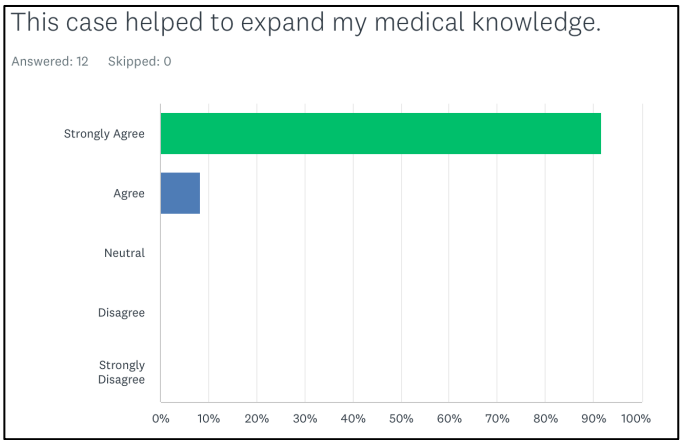

Figure 3

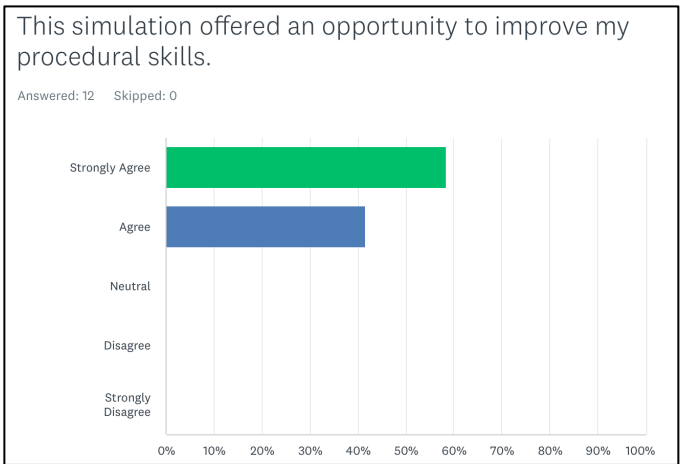

Figure 4

The most common suggestions for improvement surrounded utilization of NIPPV and managing ventilator alarms. One resident suggested pairing this case with another simulation that demonstrates the difference in ventilator settings based on disease process. Given the depth and complexity of ventilator

management, it may be beneficial to give a broad overview of ventilator settings and physiology prior to conducting this simulation. This may give learners the opportunity for spaced repetition and practical application of learned material. In addition, this case involves utilization of BiPAP as a ventilator adjunct; however, some learners progressed straight to intubation without a trial of BiPAP first. Learners could be encouraged to trial BiPAP by the nurse or by senior learners.

References/suggestions for further reading:

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11. Wang Y, Shen Z, Lu X, Zhen Y, Li H. Sensitivity and specificity of ultrasound for the diagnosis of acute pulmonary edema: a systematic review and meta-analysis. *Med Ultrason*. 2018;1(1):32-36. At: https://pubmed.ncbi.nlm.nih.gov/29400365/

INSTRUCTOR MATERIALS

Case Title: Acute Exacerbation of COPD

Case Description & Diagnosis (short synopsis): A 57-year-old male with congestive heart failure (CHF), coronary artery disease (CAD), and COPD presents with SOB. His vitals are initially hypoxic and tachycardic, and he is ill-appearing with respiratory distress. While in the emergency department (ED) he becomes more altered, and his respiratory effort diminishes as he begins to tire out. As the case progresses, he fails BiPAP secondary to agitation, and ultimately requires intubation. A short while after being placed on the ventilator, the peak pressure alarm sounds, and the patient will become hypoxic. The patient has developed a tension pneumothorax and requires needle decompression and chest tube placement. The patient will be admitted to the intensive care unit (ICU) with the diagnosis of hypercapnic and hypoxic respiratory failure secondary to acute exacerbation of COPD.

Equipment or Props Needed:
High fidelity mannequin
Medium fidelity chest tube mannequin
IV pole
Cardiopulmonary monitor
Airway supplies:

- Nasal cannula
- Non-rebreather mask
- BiPAP mask
- Laryngoscope blade and handle
- Endotracheal tube and stylet
- Bag-valve mask

IV supplies:

- 2 18gauge IV needles
- IV tubing

Chest tube supplies:

- Chest tube 24 French
- 2 Curved Kelley clamps
- Scalpel
- 1-0 Silk Suture
- Needle driver

Medications:

- Albuterol

- Ipratropium
- Methylprednisolone
- Prednisone
- Hydrocortisone
- Magnesium
- Azithromycin
- Doxycycline
- Dexmedetomidine
- Ketamine
- Succinylcholine
- Rocuronium
- Etomidate
- Propofol
- Fentanyl

Epinephrine

Confederates needed:
Primary Nurse

Stimulus Inventory:
#1 Point Of Care (POC) Glucose
#2 Arterial blood gas (ABG)
#3 Electrocardiogram (EKG
#4 Complete blood count (CBC)
#5 Complete metabolic panel (CMP)
#6 Troponin
#7 Lactate
#8 Brain natriuretic peptide (BNP)
#9 Electrocardiogram (ECG)
#10 Chest radiograph (CXR)

INSTRUCTOR MATERIALS

Background and brief information: A 57-year-old male is brought in by emergency medical services (EMS) to the ED at a tertiary care center for "shortness of breath."

Initial presentation: The patient is brought in from home by EMS for progressive shortness of breath for the past two days. The patient is ill-appearing, but able to answer questions in short sentences. He is tachypneic, hypoxic, and tachycardic.

How the scene unfolds: A 57-year-old male is brought in by EMS for shortness of breath. The patient is in respiratory distress and only able to answer in short sentences. If prompted by learners, EMS is available to provide the following information: patient has been complaining of progressive difficulty breathing over past two days in the context of running out of his home inhaler medications. Learners should recognize the signs of respiratory distress. Patient should be placed on the monitor, given 2 large bore IVs, and placed on supplemental oxygen. Learners should start empiric treatment for COPD exacerbation; they can defer to pharmacy for dosing if needed.

Laboratory studies, EKG, CXR should be ordered. Point of care testing including glucose and ABG can be ordered. Initial COPD treatment should be initiated. Bedside ultrasound can be performed to evaluate for cardiac contractility (acute coronary syndrome, congestive heart failure) and lung fields (B-lines congestive heart failure).

After primary and secondary survey are completed, the simulation nurse will inform the learners of declining mental status and decreased respiratory rate, which should prompt the learner to escalate care. Patient should be placed on BiPAP; learners should provide settings. Patient continues to be agitated pulling off the mask. Learners can initially try moderate sedation; however, patient continues to pull at mask, ultimately requiring intubation. Learners should provide ventilator settings. Regardless of settings given, shortly after being placed on the ventilator, the peak pressure alarm sounds, and the patient becomes hypoxic. Learners should consider inspiratory hold to evaluate for plateau pressure, disconnecting ETT, obstruction of ETT, pulmonary US for pneumothorax. Patient is diagnosed with tension pneumothorax and requires needle decompression and chest tube placement. Following chest tube placement, his hypoxia improves, and he is stable for admission to the ICU.

INSTRUCTOR MATERIALS

Critical actions:

1. Assess airway, breathing, and circulation
2. Connect patient to cardiopulmonary monitor and obtain large bore IV access
3. Obtain thorough history and perform complete physical exam
4. Assess for causes of shortness of breath
5. Initial pharmacologic therapy for AECOPD
6. Reassess patient's status and recognize clinical signs of decompensation
7. Identify indication for intubation
8. Assess causes of elevated peak airway pressure
9. Recognize indication for needle decompression and chest tube placement
10. Admit patient to intensive care unit

INSTRUCTOR MATERIALS

Case Title: Acute Exacerbation of COPD

Chief Complaint: "Shortness of breath"

Vitals: Heart Rate (HR) 110 Blood Pressure (BP) 152/106 Respiratory Rate (RR) 28
Temperature (T) 37.7°C Oxygen Saturation (O_2Sat) 88% on room air

General Appearance: 57-year-old male, ill appearing in respiratory distress, but awake and oriented times three. Speaking in short sentences.

Primary Survey:

- **Airway:** Patent
- **Breathing:** Accessory muscle use, tachypneic, decreased air movement, faint wheezes throughout all lung fields
- **Circulation:** 2+ radial pulse bilaterally

History:

- **History of present illness:** He has been feeling progressively short of breath for past two days.
- **Past medical history:** COPD, congestive heart failure, coronary artery disease
- **Past surgical history:** None
- **Patient's medications:** "Inhalers" (Budesonide and formoterol), aspirin 81mg, "water pill" (furosemide)
- **Allergies:** None
- **Social history:** Daily pack smoker for 30 years, occasional alcohol, methamphetamine use
- **Family history:** Does not know

Secondary Survey/Physical Examination:

- **General appearance:** Ill-appearing, diaphoretic, but awake and oriented. Trying to sit up in bed, speaking in short sentences
- **HEENT:** Atraumatic, pupils equal, round, and reactive to light bilaterally, pursed lip breathing
- **Neck:** No jugular vein distention
- **Heart:** Tachycardic, irregularly irregular rhythm, no murmurs

INSTRUCTOR MATERIALS

- **Lungs:** Tachypneic, minimal chest rise, decreased air movement, faint wheezes throughout all lung fields, accessory muscle use
- **Abdominal/GI:** Within normal limits
- **Genitourinary:** Within normal limits
- **Rectal:** Within normal limits
- **Extremities:** Within normal limits
- **Back:** Within normal limits
- **Neuro:** awake and oriented, GCS 15. Cranial nerves II-XII grossly intact. Motor 5/5 in all four extremities with equal sensation to light touch
- **Skin**: Diaphoretic, pink, warm
- **Lymph:** Within normal limits
- **Psych:** Within normal limits

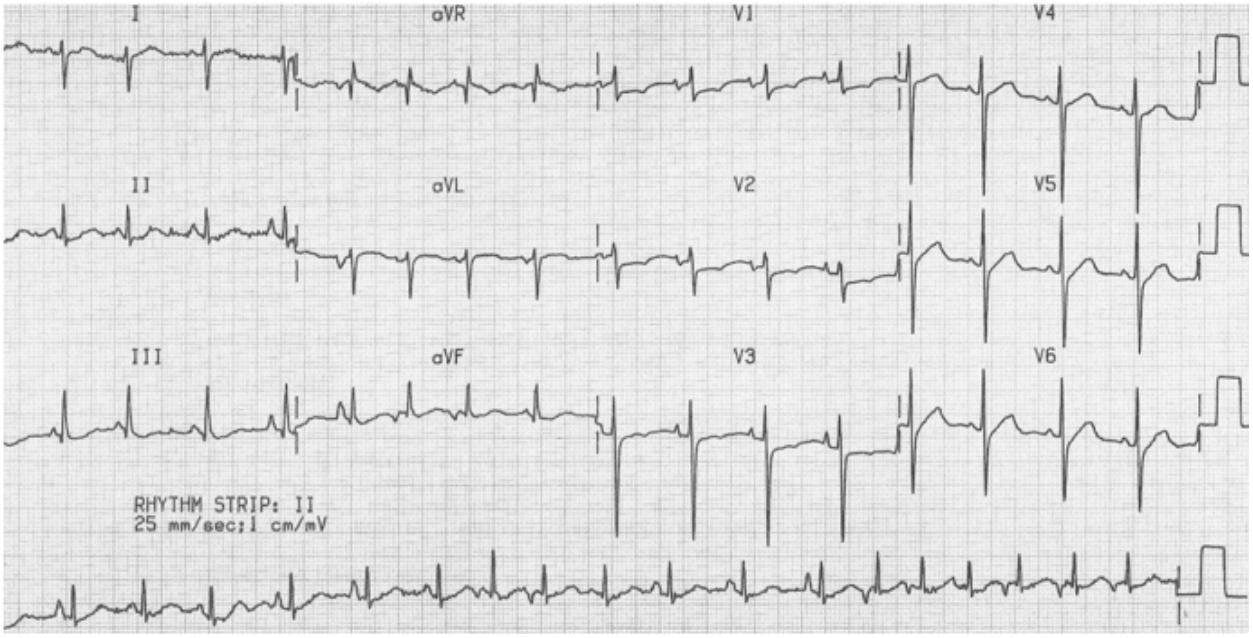
INSTRUCTOR MATERIALS

Results:

Point of care glucose	146mg/dL
Arterial blood gas (ABG)	
pH	7.10
pCO2	>110 mmHg
pO2	79.2 mmHg
$pHCO_3$	34.5 mmol/L
O_2 Sat	87.8 %
Complete blood count (CBC)	
White blood count (WBC)	12.0 x1000/mm^3
Hemoglobin (Hgb)	12.0 g/dL
Hematocrit (HCT)	43.3%
Platelet (Plt)	212 x1000/mm^3
Complete metabolic panel (CMP)	
Sodium	137 mEq/L
Chloride	100 mEq/L
Potassium	4.7 mEq/L
Bicarbonate (HCO_3)	31.5 mEq/L
Blood Urea Nitrogen (BUN)	26 mg/dL
Creatine (Cr)	1.1 mg/dL
Glucose	144 mg/dL
Total bilirubin	1.2 mg/dL
Alkaline phosphatase	62 units/L
Aspartate aminotransferase	40 units/L
Alanine aminotransferase	42 units/L
Albumin	3.1 units/L
Total protein	7.2 units/L
Troponin	<0.012 ng/mL
Lactate	1.8 mmol/L

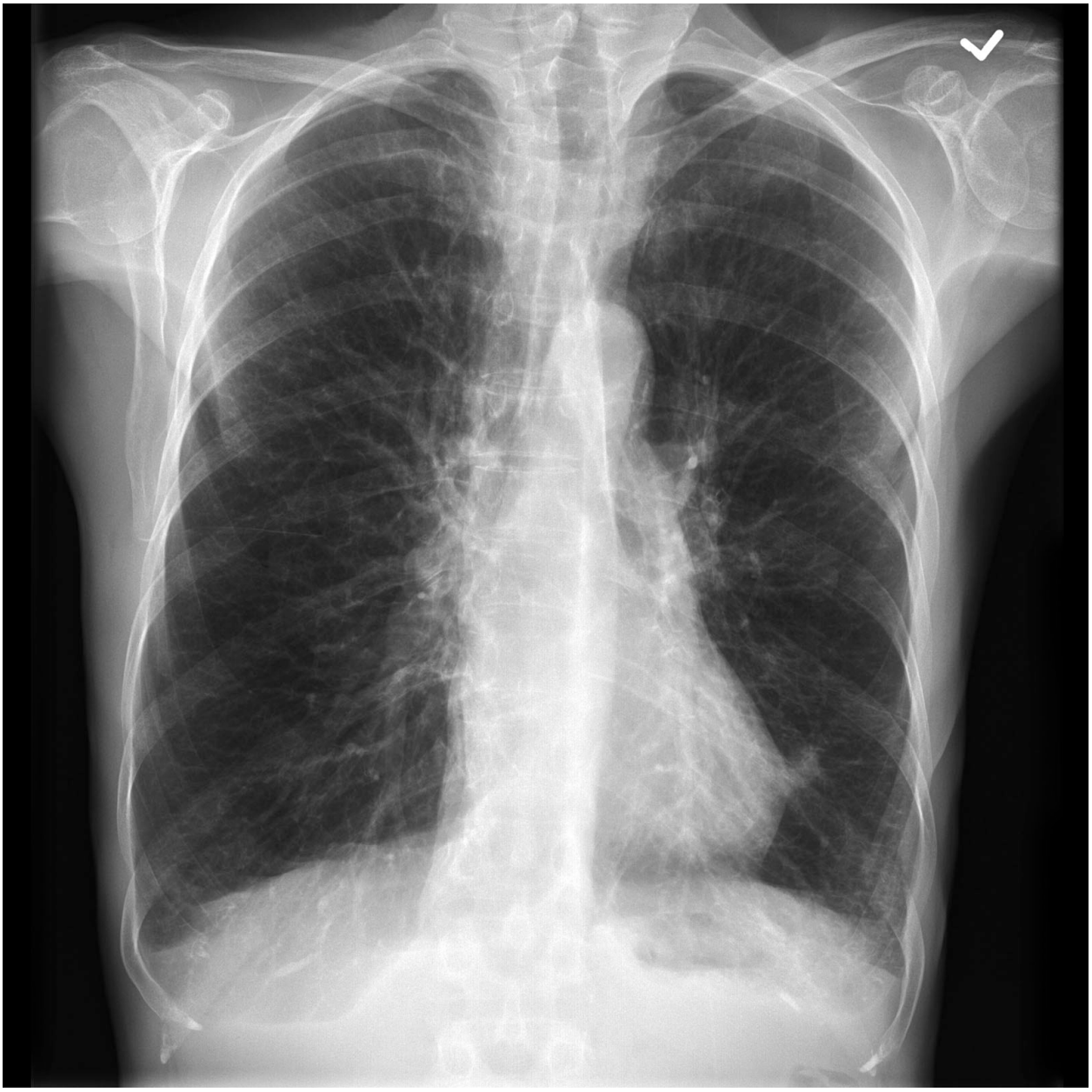
INSTRUCTOR MATERIALS

Electrocardiogram (ECG)
https://litfl.com/multifocal-atrial-tachycardia-mat-ecg-library/



INSTRUCTOR MATERIALS

Chest radiograph
Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 8512
https://radiopaedia.org/cases/chronic-obstructive-pulmonary-disease-marked-hyperinflation?lang=us



OPERATOR MATERIALS

SIMULATION EVENTS TABLE:

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
0:00 (Baseline)	Obtain brief history Obtain vital signs Attach patient to monitor Establish IV access Perform primary survey	Patient will have chief complaint of shortness of breath for 2 days Patient will be trying to sit up in bed, ill-appearing, diaphoretic, with pursed lip breathing, supracostal and infracostal retractions.	T 37.7 °C HR 110 BP 152/106 RR 28 O_2Sat 88% NRB
1:00	Obtain full history and physical exam	Patient speaking in short sentences. He will have history of COPD and ran out of his medications 3 days ago. Physical exam will show signs of respiratory distress.	T 37.7 °C HR 110 BP 152/106 RR 28 O_2Sat 88% NRB
3:00	Start albuterol and ipratropium Give steroid May give antibiotics May give Magnesium	If no intervention, nurse says, "He's really working to breathe; do you want to give him anything right now?" Patient now speaking in one-word sentences. If AECOPD medications not given, progress to Status B (9:00)	T 37.7 °C HR 110 BP 152/106 RR 28 O_2Sat 88% NRB
5:00	Order labs, CXR, EKG Reassess patient after treatment		T 37.7 °C HR 114 BP 152/106 RR 26 O_2Sat 90% NRB
7:00	Recognize declining mental status and decompensation Initiate BiPAP, provide settings	Nurse says, "He looks more altered." Patient GCS 12 (E2V4M4). If BiPAP initiated, proceed to Status A. If BiPAP is not initiated, proceed to Status B.	T 37.7 °C HR 114 BP 152/106 RR 22 O_2Sat 86%

OPERATOR MATERIALS

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
9:00 (Status A)	Interpret labs, EKG, CXR May trial moderate sedation for agitation	Patient becomes more agitated and is pulling off BiPAP mask. If learner trials moderate sedation, patient continues to pull at BiPAP mask.	T 37.7 °C HR 114 BP 152/106 RR 22 O_2Sat 88%
12:00 (Status A)	Identify need for intubation Perform for intubation Ventilator management	Let learners say what they need for intubation, including medications. If participants fail to intubate or BVM is not used for preoxygenation prior to intubation, then proceed to Status B.	T 37.7 °C HR 104 BP 128/86 RR 16 O_2Sat 92
9:00 (Status B)	Follow ACLS Perform CPR Give epinephrine Perform intubation, provide intubation medications Ventilator management	Patient further deteriorates. PEA arrest. Let learners follow ACLS for 2 rounds of CPR and 1 epinephrine; patient will get ROSC.	T 37.7 °C HR 0 BP 0/0 RR 0 O_2Sat 0-50%
13:00	Evaluate high peak pressure on ventilator (DOPES) Auscultate breath sounds May perform bedside	Elevated peak pressure alarms on ventilator. CXR is not available. Nurse, “He’s becoming hypoxic.” No lung sounds on left lung field.	T 37.7 °C HR 125 BP 90/60 RR 14 O_2Sat 72%

OPERATOR MATERIALS

Minute (state)	Participant action/ trigger	Patient status (simulator response) & operator prompts	Monitor display (vital signs)
	pulmonary ultrasound	(No lung sliding on ultrasound.)	
15:00	Identify pneumothorax Perform needle decompression Place chest tube	If pneumothorax is not identified or treated, then patient goes in PEA arrest and does not get ROSC until chest tube is placed.	T 37.7 °C HR 104 BP 128/86 RR 16 O_2Sat 94%
18:00	Consult ICU for admission Case completion		T 37.7 °C HR 104 BP 128/86 RR 16 O_2Sat 96%

Diagnosis:
Hypercapnic and Hypoxic respiratory failure secondary to acute exacerbation of COPD

Disposition:
Admit to intensive care unit

DEBRIEFING AND EVALUATION PEARLS

Acute Exacerbation of COPD

Pearls: In addition to the treatments outlined above, it is important to remember that patients with COPD have chronic mild hypoxia. When assessing and treating these patients, we must avoid excess oxygen because this can cause diffuse pulmonary vasodilation, which leads to worsening ventilation-perfusion mismatching. For patient with AECOPD, inhaled oxygen should be titrated to **target an oxygen saturation of 88-92%.**[4]

General treatment of acute COPD exacerbation:

- Albuterol is a beta-2 adrenergic receptor agonist and acts to relax the bronchial smooth muscle. It also inhibits the release of immediate hypersensitivity mediators from cells, especially mast cells. Albuterol can be given intermittently 2.5-5mg every 20minutes for a total of three dose per hour or may be given in a continuous nebulizer 10-15mg over one hour. [4]
- Ipratropium is an acetylcholine antagonist and facilitates decreased contraction of the smooth muscles as well as decreased airway secretions. Ipratropium is commonly given in conjunction with albuterol. Typical dosing is 0.5mg and maybe given three times per hour. [4]
- Steroids are a mainstay of AECOPD treatment. They reduce treatment failure, shorten hospital length of stay, improve lung function, and reduce dyspnea. The ideal route of administration and dosing of steroids has been debated. Either oral or IV options are available. Typical dosing for an AECOPD includes oral prednisone 40-60mg, 125 methylprednisolone IV. [4]
- Antibiotics should be given to all patients presenting with AECOPD, regardless of whether there is a clear infiltrate on chest radiograph. Patients with COPD are often chronically colonized by a variety of organisms, and therefore the goal of antibiotic therapy is to suppress this bacterial growth situation. For most patients, narrow spectrum antibiotics are fine, such as azithromycin or doxycycline. [1,4]

Optimizing oxygenation: When treating a patient with hypoxemia or respiratory distress, it is important to determine whether they need assistance with ventilation, oxygenation, or both. In general, oxygenation is controlled by PEEP and FiO_2, whereas ventilation is controlled via tidal volume and respiratory rate. As providers in the emergency department, we have multiple modalities at our disposal, but it is imperative that we understand the benefits and limitations of each. [5]

DEBRIEFING AND EVALUATION PEARLS

- Nasal cannula: Typically, nasal cannula is set to a flow rate between 1-6L/min, administering 24-44% fraction of inspired oxygen (FiO_2), assisting with oxygenation. This modality does not offer any positive end expiratory pressure (PEEP) and requires patients to ventilate entirely on their own.[5]
- Non-rebreather mask (NRB): Typically, NRB is set to a flow rate between 10-15L/min, administering 60-95% FiO_2, assisting with oxygenation. NRB is unable to provide 100% FiO_2 secondary to air leak between the patient's face and the mask. This modality does not offer any PEEP and requires patients to ventilate entirely on their own. [5]
- High flow nasal cannula (HFNC): Typically, HFNC is set to a flow rate between 30-60L/min, administering 21-99% FiO_2, assisting with oxygenation. Theoretically, HFNC can provide 100% FiO_2; however, this requires no air entry through the mouth, which will be 21% FiO_2. This modality does offer a small degree of positive end expiratory pressure (PEEP), usually 0-5 cmH_2O. It does not assist with ventilation. [5]
- Non-invasive positive pressure ventilation (NIPPV): There are two main types of NIPPV, Bi-level positive airway pressure (BiPAP) and continuous positive airway pressure (CPAP). As the name implies, BiPAP allows a set inspiratory pressure (IPAP) and a set expiratory pressure (EPAP). The difference between these pressures, the pressure support, helps to assist with tidal volume and improve ventilation. CPAP has one set continuous pressure, which correlates to PEEP, and therefore does not affect ventilation. NIPPV can also provide up to 100% FiO_2, assisting with oxygenation. [3]
  BiPAP can be applied in patients with any of the following: respiratory acidosis with pH < 7.3 despite treatments, severe dyspnea with increased work of breathing and accessory muscle use and persistent hypoxemia with oxygen therapy. Some of the contraindications for BiPAP include respiratory or cardiac arrest, hemodynamic instability, inability to use mask, excessive secretions, high risk of aspiration, altered mental status and uncooperative patient. Initial settings usually begin with IPAP at 8-10cm H_2O and EPAP at 4-5cm H_2O and the settings can be titrated according to the clinical status and patient's response.[3]
  Additionally, continuous nebs may be given when utilizing BIPAP. Unfortunately, as in this case, patients may not tolerate BiPAP secondary to agitation or anxiety. Given its significant impact on decreasing mortality and need for intubation in COPD exacerbations, it is not unreasonable to trial moderate sedation with ketamine or dexmedetomidine in patients not tolerating BiPAP. [3,5]
- Endotracheal tube (ETT): Placement of an ETT serves as a definitive airway. Both oxygenation (PEEP and FiO_2) and ventilation (tidal volume and respiratory rate) can be manipulated to meet the patient's requirements. [3]

DEBRIEFING AND EVALUATION PEARLS

Ventilator settings and high-pressure alarms: Ventilator settings for a patient with an AECOPD should follow a lung protective strategy, being mindful to the risks of lung overinflation and subsequent pneumothorax. Given this, typically ventilator settings for patients intubated for AECOPD are as follows: tidal volume 6-10 ml/kg, respiratory rate 10-14 breaths/minute, PEEP 0-5 cm H_2O, FiO_2 100%. Of greatest importance is the respiratory rate and tidal volume because these variables dictate ventilation, the primary problem in AECOPD. Furthermore, patients with COPD already have hyperinflated lungs due to chronic alveoli distention and air retention. Over-inflation due to a high tidal volume or fast respiratory rate can lead to breath stacking, an extremely dangerous consequence in COPD patients. [3]

Once a patient is placed on a ventilator, the force required to deliver a breath can be thought of in terms of pressure. There are two systems of pressure involved, the pressure to overcome the resistance of the airways and the pressure required to distend the lungs and chest wall, also known as compliance. The sum of these two pressures gives us our total peak pressure. When there are high peak pressures, it is imperative to determine whether the elevated pressure is from the resistance of the airway or the compliance of the lung. To do this, we must measure the plateau pressure, which is measured by performing an inspiratory hold on the ventilator at end inspiration. A high plateau pressure suggests a decrease in compliance and therefore a primary lung problem, whereas a normal plateau pressure suggests an airway resistance problem, which could originate from the anatomical airway of our patient all the way back to the ventilator machine itself. [6-8]

A simple algorithm to follow when assessing high peak pressures is as follows:

1. Is the patient hemodynamically stable?
    a. If yes, disconnect from ventilator and manually bag patient
    b. Assess for tension pneumothorax and determine need for needle decompression
2. Determine plateau pressure
3. Determine difference between peak pressure and plateau pressure
    a. If difference is high (>5cmH_2O) consider increased airway resistance
        i. Bronchospasm, anaphylaxis, ETT obstruction, mucus plugging, ventilator circuit obstruction
    b. If the difference is low consider acute decreases in lung compliance
        i. Tension pneumothorax, evolving pneumonia, pulmonary edema, ARDS, auto-PEEP caused by “breath stacking”[6-8]

DEBRIEFING AND EVALUATION PEARLS

Needle decompression and chest tube thoracostomy: In the setting of a tension pneumothorax, needle decompression is the most immediate way to access the intrathoracic cavity and initiate decompression. This procedure requires placing a large bore IV, usually 12-14 gauge, through the chest wall. It is typically placed in second intercostal place along the midclavicular line or the fourth to fifth intercostal space in the mid axillary line. The needle should be advanced until a rush of air, blood, or fluid is achieved. Needle decompression is not an end point intervention, and therefore requires follow up placement of a chest tube.[8,9]

Chest tube thoracostomy is a procedure that involves placing a hollow plastic tube between the ribs, through the chest wall and into the pleural space in order to drain fluid or air from the thorax. After placement, the distal end of the tube is usually connected to a pleura-evac system to allow drainage. Indications for placing a chest tube include pneumothorax (to remove air), hemothorax (to remove blood), pleural effusion or hydrothorax (to removed fluid) or empyema (to remove purulence) from the intrathoracic space.[8,9] The insertion of a chest tube can be viewed in the instructional video attached below. [9]

Other debriefing points:

In this case, the patient was only able to provide limited history due to severe shortness of breath. EMS personnel are often able to provide additional information when patients are unable to do so. It is an invaluable tool to talk with EMS and glean any additional history. In this case, they would have been able to inform you of the patient's diagnosis of COPD, repeated exacerbations, and recent lapse in refilling his prescription inhalers.

Point of care testing is also a valuable tool, especially in the critically ill patient. In this case, the patient is in respiratory distress and early evaluation of blood gases can give further insight to the severity and expected clinical course of this patient. Additionally, bedside ultrasound can help distinguish pulmonary edema as an etiology by evaluating for the presence or absence of B lines (sensitivity 97% and specificity 98%).[11]

Wrap Up:

To review pharmacologic options for managing acute exacerbation of COPD, we recommend the following articles:

- Stapczynski J, Ma O, Yealy D.M., Meckler G.D., Cline D.M, eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide.* 8th Ed. 2016.

DEBRIEFING AND EVALUATION PEARLS

- Farkas J. Acute exacerbation of COPD (AECOPD). The Internet Book of Critical Care. May 19, 2020. Available at: https://emcrit.org/ibcc/aecopd/#intubation_&_ventilator_management

Here are some excellent videos and articles about managing ventilator settings and high peak pressure alarms:

- Seigel T. Alarms from the ventilator: Troubleshooting high peak pressures. AliEM. July 30, 2013. Available at : https://www.aliem.com/alarms-from-ventilator-troubleshooting-high-peak-pressures/
- Ventilator Management. EM:RAP. (Video) Available at: https://www.emrap.org/episode/january2013/ventilator

To review performing a chest tube thoracostomy, we recommend reviewing the following video:

- Mason, J. EM:RAP. (Video) Available at : https://www.emrap.org/episode/chesttube1/chesttube1

SIMULATION ASSESSMENT

Acute Exacerbation of COPD

Learner: _____

Assessment Timeline

This timeline is to help observers assess their learners. It allows observer to make notes on when learners performed various tasks, which can help guide debriefing discussion.

Critical Actions:	0:00
1. Assess airway, breathing, and circulation 2. Connect patient to cardiopulmonary monitor and obtain large bore IV access 3. Obtain thorough history and perform complete physical exam 4. Assess for causes of shortness of breath 5. Initial pharmacologic therapy for AECOPD 6. Reassess patient's status and recognize clinical signs of decompensation 7. Identify indication for intubation 8. Assess causes of elevated peak airway pressure 9. Recognize indication for chest tube placement 10. Admit patient to intensive care unit	

SIMULATION ASSESSMENT

Acute Exacerbation of COPD

Learner: _____

Critical Actions:

- ☐ Assess airway, breathing, and circulation
- ☐ Connect patient to cardiopulmonary monitor and obtain large bore IV access
- ☐ Obtain thorough history and perform complete physical exam
- ☐ Assess for causes of shortness of breath
- ☐ Initial pharmacologic therapy for AECOPD
- ☐ Reassess patient's status and recognize clinical signs of decompensation
- ☐ Identify indication for intubation
- ☐ Assess causes of elevated peak airway pressure
- ☐ Recognize indication for chest tube placement
- ☐ Admit patient to intensive care unit

Summative and formative comments:

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Pappas D, et al. Acute Exacerbation of COPD. JETem 2023. 8(2):S35-61.
https://doi.org/10.21980/J8V070

SIMULATION ASSESSMENT

Acute Exacerbation of COPD

Learner: _____

Milestones assessment:

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
1	**Emergency Stabilization (PC1)**	☐ Did not achieve Level 1	☐ Recognizes abnormal vital signs	☐ Recognizes an unstable patient, requiring intervention Performs primary assessment Discerns data to formulate a diagnostic impression/plan	☐ Manages and prioritizes critical actions in a critically ill patient Reassesses after implementing a stabilizing intervention
2	**Performance of focused history and physical (PC2)**	☐ Did not achieve Level 1	☐ Performs a reliable, comprehensive history and physical exam	☐ Performs and communicates a focused history and physical exam based on chief complaint and urgent issues	☐ Prioritizes essential components of history and physical exam given dynamic circumstances
3	**Diagnostic studies (PC3)**	☐ Did not achieve Level 1	☐ Determines the necessity of diagnostic studies	☐ Orders appropriate diagnostic studies. Performs appropriate bedside diagnostic studies/procedures	☐ Prioritizes essential testing Interprets results of diagnostic studies Reviews risks, benefits, contraindications, and alternatives to a diagnostic study or procedure
4	**Diagnosis (PC4)**	☐ Did not achieve Level 1	☐ Considers a list of potential diagnoses	☐ Considers an appropriate list of potential diagnosis May or may not make correct diagnosis	☐ Makes the appropriate diagnosis Considers other potential diagnoses, avoiding premature closure

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SIMULATION ASSESSMENT

Acute Exacerbation of COPD

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
5	**Pharmacotherapy (PC5)**	☐ Did not achieve Level 1	☐ Asks patient for drug allergies	☐ Selects an medication for therapeutic intervention, consider potential adverse effects	☐ Selects the most appropriate medication and understands mechanism of action, effect, and potential side effects Considers and recognizes drug-drug interactions
6	**Observation and reassessment (PC6)**	☐ Did not achieve Level 1	☐ Reevaluates patient at least one time during case	☐ Reevaluates patient after most therapeutic interventions	☐ Consistently evaluates the effectiveness of therapies at appropriate intervals
7	**Disposition (PC7)**	☐ Did not achieve Level 1	☐ Appropriately selects whether to admit or discharge the patient	☐ Appropriately selects whether to admit or discharge Involves the expertise of some of the appropriate specialists	☐ Educates the patient appropriately about their disposition Assigns patient to an appropriate level of care (ICU/Tele/Floor) Involves expertise of all appropriate specialists
9	**General Approach to Procedures (PC9)**	☐ Did not achieve Level 1	☐ Identifies pertinent anatomy and physiology for a procedure Uses appropriate Universal Precautions	☐ Obtains informed consent Knows indications, contraindications, anatomic landmarks, equipment, anesthetic and procedural technique, and potential complications for common ED procedures	☐ Determines a back-up strategy if initial attempts are unsuccessful Correctly interprets results of diagnostic procedure

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SIMULATION ASSESSMENT

Acute Exacerbation of COPD

Learner: _____

	Milestone	Did not achieve level 1	Level 1	Level 2	Level 3
20	**Professional Values (PROF1)**	☐ Did not achieve Level 1	☐ Demonstrates caring, honest behavior	☐ Exhibits compassion, respect, sensitivity and responsiveness	☐ Develops alternative care plans when patients' personal beliefs and decisions preclude standard care
22	**Patient centered communication (ICS1)**	☐ Did not achieve level 1	☐ Establishes rapport and demonstrates empathy to patient (and family) Listens effectively	☐ Elicits patient's reason for seeking health care	☐ Manages patient expectations in a manner that minimizes potential for stress, conflict, and misunderstanding. Effectively communicates with vulnerable populations, (at risk patients and families)
23	**Team management (ICS2)**	☐ Did not achieve level 1	☐ Recognizes other members of the patient care team during case (nurse, techs)	☐ Communicates pertinent information to other healthcare colleagues	☐ Communicates a clear, succinct, and appropriate handoff with specialists and other colleagues Communicates effectively with ancillary staff

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