

1. Which intravenous antibiotic choice would not provide adequate coverage in a patient with a newly diagnosed lung abscess most likely caused by aspiration?

- A. Vancomycin
- B. Clindamycin
- C. Meropenem
- D. Ampicillin-sulbactam

Correct: Vancomycin

Clindamycin has good anaerobic coverage and covers oral Streptococcus well. Most lung abscesses due to aspiration are caused by polymicrobial anaerobic bacteria. Although it is no longer a preferred choice for initial antibiotics in lung abscess due to side effects and increasing bacterial resistance, clindamycin is a reasonable choice for treating a lung abscess in patients with a penicillin allergy, particularly when used in combination therapy. Vancomycin Primary lung abscesses are most commonly due to aspiration of upper airway flora. The flora are most commonly polymicrobial, with multiple anaerobic pathogens and oral Streptococcus. Vancomycin has good gram-positive and MRSA coverage, but it is less effective against anaerobic infections. Unlike skin abscesses, MRSA and gram-positive bacteria rarely cause lung abscesses except in cases of superimposed bacterial infection or lung abscesses due to septic emboli. The antibiotic of choice for these abscesses is beta-lactam-beta-lactamase inhibitor or carbapenem antibiotics. Thus, ampicillin-sulbactam or meropenem would be the most appropriate choices. Clindamycin is an alternative option in patients with a penicillin allergy. Clindamycin also treats anaerobic flora and has good lung penetration. Antibiotics are often continued for 3 to 6 weeks in patients with lung abscesses. Meropenem Meropenem is a carbapenem antibiotic with good anaerobic coverage. Most lung abscesses due to aspiration are caused by polymicrobial anaerobic bacteria. Ampicillin-sulbactam Ampicillin-sulbactam is a beta-lactam-beta-lactamase inhibitor antibiotic with good anaerobic coverage. Most lung abscesses due to aspiration are caused by polymicrobial anaerobic bacteria.

2. What is the most significant risk factor for hospital-acquired pneumonia?

- A. Immunocompromise
- B. Chronic lung disease
- C. Mechanical ventilation
- D. Dialysis

Correct: Mechanical ventilation

Patients with chronic lung disease may have an increased risk for HAP, but it is a less significant risk factor than mechanical ventilation. However, underlying lung disease may increase mortality in patients who develop HAP. Immunocompromise Immunocompromised patients are more likely to develop HAP than healthy individuals, but mechanical ventilation is a more significant risk factor than immunocompromise for the development of HAP. However, an immunocompromised state may increase the risk of morbidity and mortality from HAP. Mechanical ventilation Hospital-acquired pneumonia (HAP) is pneumonia that develops more than 48 hours after hospital admission. Mechanical ventilation is the most significant risk factor for HAP. Pneumonia that develops 48 hours or more after endotracheal intubation is known as ventilator-associated pneumonia (VAP). Given the significant morbidity and mortality of VAP, many ICUs have instituted “VAP prevention bundles.” Preventive measures include avoiding intubation when possible, minimizing sedation during intubation as much as possible, preventing aspiration by elevating the head of the bed and draining subglottic secretions, and assessing readiness to extubate daily. Other risk factors for HAP include older age, chronic lung disease, aspiration, multiple trauma, opioid exposure, and paralysis. Dialysis Patients requiring dialysis do not have an increased risk for HAP. However, comorbidities (including renal failure requiring dialysis) may increase mortality in patients who develop HAP.

3. A 17-year-old girl presents with respiratory distress during an acute exacerbation of cystic fibrosis. While being treated with a nebulized beta-agonist, she suddenly arrests. She is pulseless, but some electrical activity is noted on the cardiac monitor. Her airway is controlled, and CPR is in progress. What procedure should be performed next?

- A. Peripheral intravenous line placement
- B. Needle decompression of chest
- C. Cricothyrotomy
- D. Central line placement

Correct: Needle decompression of chest

This patient has pulseless electrical activity (PEA). Given her medical history of cystic fibrosis (CF) and the "H's" and "T's" of PEA, decompression of the bilateral lungs should be performed. There should be a strong suspicion that the cause of the patient's cardiac arrest is respiratory in nature because of the history of CF and the fact that she was being treated for respiratory difficulties prior to the event. Pneumothorax is a common complication of CF (the second most common cause of chest pain in these patients) and occurs much more commonly than in the general public (up to 3.5% of CF patients develop a spontaneous pneumothorax, and there is a 20% recurrence rate). Given the high rate of spontaneous disease, the patient with PEA should be assessed and if found, treated rapidly for a tension pneumothorax. If the patient is already intubated, the mnemonic, DOPE — Displacement of the endotracheal tube, Obstruction within the endotracheal tube, Pneumothorax, and Equipment malfunction — can indicate causes for acute respiratory decompensation. This is especially true in intubated patients who are being moved from one position to another. Peripheral intravenous line placement This patient is in cardiopulmonary arrest. Although a tenet of care is to obtain venous access, the crucial aspect in this case is to quickly address the potential cause for the arrest. Given the patient's clinical presentation, a tension pneumothorax is the likely cause and should be addressed. Cricothyrotomy A cricothyrotomy is unwarranted in this patient since there is no indication of upper airway obstruction (as would be found in a patient with acute anaphylaxis or foreign body obstruction). Patients with cystic fibrosis do have an increase in mucus production, but this causes lower airway obstruction, not upper airway obstruction. Central line placement Although access is an important component of CPR, central line placement would not be a lifesaving procedure for this patient.

4. What are the most likely complications from exposure to a detonated canister of riot control agent?

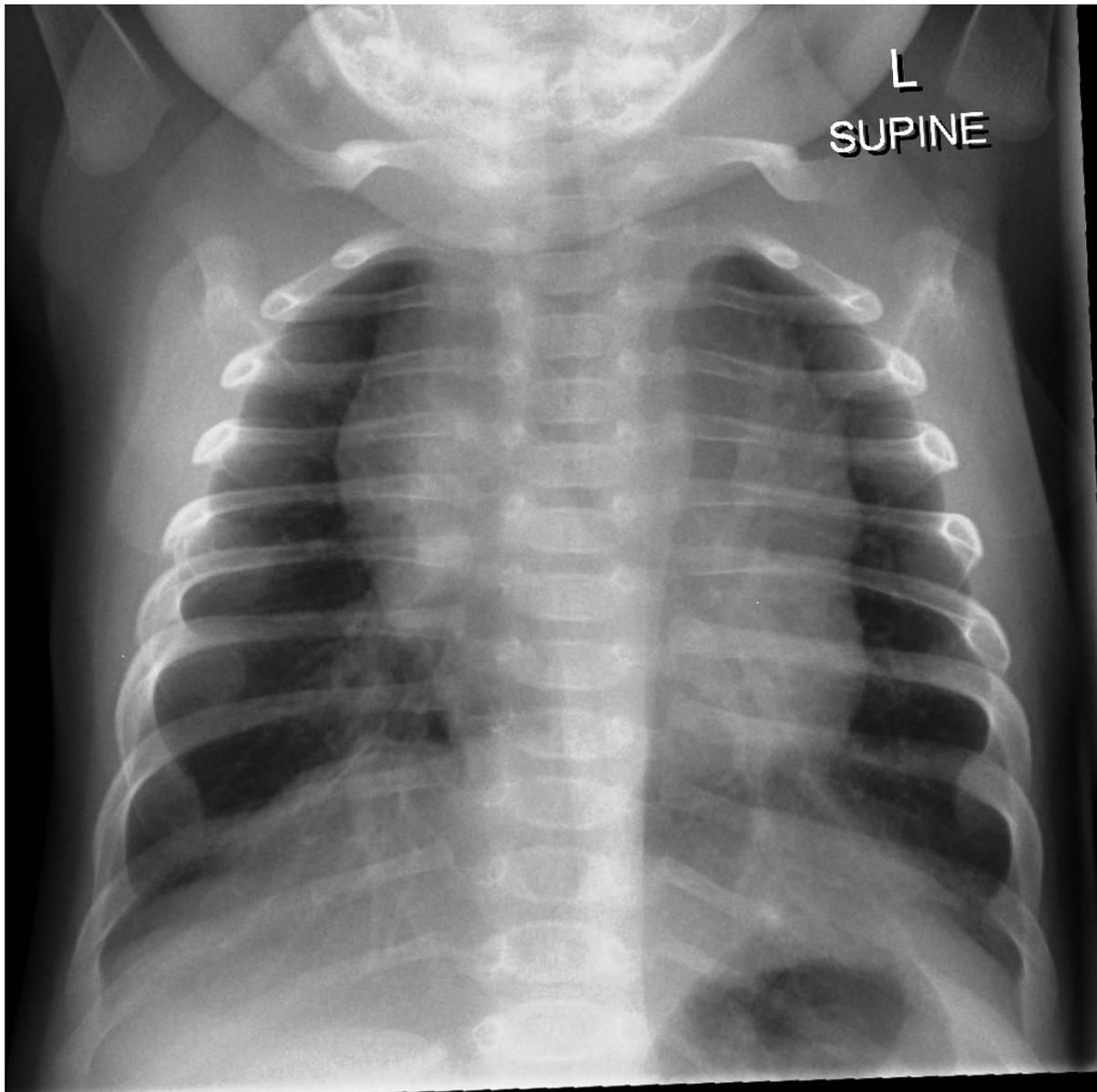
- A. Blistering and irritant contact dermatitis
- B. Nausea, vomiting, and diarrhea
- C. Headache, dizziness, and syncope
- D. Chest pain, dyspnea, and cough

Correct: Chest pain, dyspnea, and cough

Although it is not the most common complication from this exposure, excessive salivation and rhinorrhea resulting from riot control agents may cause patients to swallow contaminated secretions. This could result in epigastric discomfort, nausea, vomiting, and diarrhea. Blistering and irritant contact dermatitis Dermal manifestations are common after exposure to riot control agents but are typically limited to burning sensation and erythema. Blistering, bullae, edema, burns, and contact dermatitis are uncommon complications. Decontamination is an important

preventative measure. Headache, dizziness, and syncope Pain and agitation are common after exposure to riot control agents. Headache, tachycardia, syncope, dizziness, and fever may occur but are uncommon. Chest pain, dyspnea, and cough Riot control agents are nonlethal chemical irritants that rapidly and transiently incapacitate individuals via effects at exposed mucous membranes, specifically at the eyes, GI tract, and respiratory tract. All of the answer choices listed are potential effects of these agents. However, chest pain, dyspnea, and cough are the most common and are likely to occur in many exposed individuals. Following inhalation, typical effects include chest tightness, shortness of breath, cough, burning in the nose and throat, rhinorrhea, and salivation. Symptoms are expected to resolve quickly after removal from the exposure. Patients with a prolonged or high-concentration exposure or underlying reactive airway disease are more likely to have severe respiratory reactions, which may include respiratory distress, bronchospasm, laryngospasm, or pulmonary edema. Care is supportive, including supplemental oxygen, bronchodilators, corticosteroids, and invasive or noninvasive positive-pressure ventilation.

5. A 5-month-old boy is presented for evaluation of fever, decreased feeding, nasal congestion, and "fast breathing" for 2 days. He was born at term and is otherwise healthy. Immunizations are up-to-date. His vital signs include P 170, R 70, and T 38°C (100.4°F); SpO₂ is 95% on room air. Examination reveals copious nasal secretions, scattered wheezes, subcostal retractions, and bulging and injected tympanic membranes bilaterally. Albuterol is given with no change in respiratory status. A chest x-ray is obtained and shown below. What further treatment is most beneficial for this disease process?



- A. Nasal suctioning and supplemental oxygen
- B. Nebulized racemic epinephrine
- C. Steroids and continuous albuterol
- D. Intravenous antibiotics and parenteral hydration

Correct: Nasal suctioning and supplemental oxygen

Nebulized L-epinephrine or racemic epinephrine is used in the treatment of upper airway conditions such as croup, which often presents with stridor and a barking cough. No difference has been found between the two isomers of epinephrine in croup. However, there is no supported benefit of this treatment in bronchiolitis. Nasal suctioning and supplemental oxygen Bronchiolitis is an acute infectious illness that causes inflammation of the small airways. Supportive care with supplemental oxygen remains the keystone of therapy, and nasal suctioning can provide benefit. Beyond that, treatment is controversial. Respiratory syncytial virus (RSV) is the most commonly associated virus (70%) with this disease, but parainfluenza, human metapneumovirus, adenovirus, bocavirus, and rhinovirus are frequently implicated as well. Bronchiolitis typically occurs during the winter in children younger than 2 years old. It classically presents initially with common URI symptoms such as rhinorrhea and cough, which then proceed to increased work of breathing, decreased feeding, and wheezing. It is rarely fatal, but it does frequently contribute to hospitalizations. There is increased risk of death in children with low birth weight, with low initial Apgar scores, first-born children, and those born to young mothers. The most common comorbid complication of bronchiolitis is bacterial otitis media (60%). Apnea can occur in younger infants with RSV as well. Routine laboratory evaluations and imaging are not recommended in straightforward presentations of bronchiolitis. Steroids and continuous albuterol Continuous albuterol and steroids are most beneficial in children with acute asthma exacerbations, not

bronchiolitis. Distinguishing between asthma and bronchiolitis can be challenging because they often present similarly. In a child younger than 2 years with no asthma risk factors who has concurrent URI symptoms and no improvement after a trial of albuterol, the diagnosis of bronchiolitis is more likely, particularly during peak bronchiolitis months. Studies have not supported the benefit of steroids. Intravenous antibiotics and parenteral hydration Intravenous fluids and antibiotics are the treatment of choice in a child with severe pneumonia or some other serious bacterial infection. However, there is no benefit from this approach in a viral process.

6. A patient presents with respiratory distress after sanitizing an enclosed space using a mixture of bleach and another cleaning product. The patient noted a noxious odor and developed severe shortness of breath within minutes. On examination, the patient is wheezing without stridor. After supplemental oxygen and albuterol, what is the next best pharmacologic step in management?

- A. Methylprednisolone
- B. Diphenhydramine
- C. Sodium bicarbonate nebulization
- D. Racemic epinephrine nebulization

Correct: Sodium bicarbonate nebulization

Diphenhydramine is typically given for allergic and anaphylactic reactions. This patient is suffering a chemical/irritant exposure, which would not be expected to improve with administration of diphenhydramine. Methylprednisolone Corticosteroids such as methylprednisolone have not been shown to be of benefit in the treatment of chlorine or chloramine exposures, but corticosteroids are sometimes used given their demonstrated efficacy in other inflammatory conditions. Corticosteroids' effect, if any, will not be observed for hours to days, so they are not required as part of the initial stabilization in a patient presenting with respiratory distress. Sodium bicarbonate nebulization Household bleach (hypochlorite) should not be mixed with acid or ammonia due to the consequent liberation of chlorine or chloramine gas, respectively, which have a corrosive effect on contact with moist tissues (eg, the eyes, mouth and respiratory tract). Particularly in patients with underlying reactive airway disease, these products may induce wheezing, which should be treated with bronchodilators; in refractory cases, sodium bicarbonate nebulization may provide additional benefit. Chlorine and chloramine are acid-forming gasses, and bicarbonate is thought to neutralize some of their effects. A similar approach is not taken with acid ingestions due to the possibility of consequent exothermic reactions. However, it is assumed that any small amount of exothermic reaction that may occur in the lung is rapidly dissipated by large surface area and air movement. Corticosteroids have not been shown to be helpful in chemical pneumonitis resulting from chlorine and chloramine exposure. Severe reactions to inhaled chlorine gas may result in upper airway swelling that progresses to hoarseness, stridor, and a croupy cough, and, ultimately, to airway obstruction. Massive exposures may result in noncardiogenic pulmonary edema, ARDS, and death. Racemic epinephrine nebulization Some patients with chemical or irritant inhalation exposure will develop upper airway swelling and obstruction, and these patients may benefit from administration of racemic epinephrine. However, this patient does not demonstrate any upper airway signs. Signs of upper airway involvement include voice changes, stridor, and croupy cough.

7. A 2-year-old boy is brought in with difficulty breathing that started about an hour ago. According to his mother, he was playing alone in the living room when she heard him start "coughing and choking." He has continued to cough and breathe abnormally since then. Mild supraclavicular and suprasternal retractions and stridor are noted on examination. His chest is clear to auscultation, except for transmitted upper airway noises. His vital signs include P 114, R

42, and T 37°C (98.6°F); SpO₂ is 97% on room air. What is the most likely diagnosis?

- A. Foreign body aspiration
- B. Asthma exacerbation
- C. Epiglottitis
- D. Croup

Correct: Foreign body aspiration

Asthma exacerbation is a common cause of respiratory distress. However, the signs of respiratory distress described in this case are more associated with upper airway illness (stridor, retractions noted at suprasternal and supraclavicular areas) than lower airway. There are no findings of wheeze on examination to further indicate lower airway disease. Although cough is the most common presenting symptom, this child presented with a history of cough and choking, which makes the presence of a foreign body more likely than asthma in a child with no history of asthma or reactive airway disease. Foreign body aspiration This child presents with acute-onset of respiratory distress. The mother's description of the event and his symptoms is consistent with a history of choking, which is the most reliable predictor of foreign body aspiration. Signs and symptoms are related to the location of the obstructing foreign body. If the obstruction is in the upper airway, stridor and respiratory or cardiopulmonary arrest can be expected. If it is in the lower airway, coughing, wheezing, retractions, decreased breath sounds, and cyanosis are likely. More than half of cases of foreign body aspiration are in children 1 to 2 years old, and the vast majority are in children younger than 5 years. The foreign bodies are usually food, coins, marbles, or batteries. Foreign body aspirations are fatal most often in infants younger than 1 year, and balloons are the most commonly fatal aspirated foreign body. In patients who present with suspected partial obstruction, imaging includes AP and lateral x-rays of the upper airway; extending the view from the nasopharynx to the abdomen covers the diaphragm as well. Additional studies, including inspiratory and expiratory chest x-rays and bilateral decubitus views, might be needed. Epiglottitis Epiglottitis is a life-threatening infectious process that was most commonly caused by Haemophilus influenzae type b. Due to increasing use of the Hib vaccine, the incidence of epiglottitis has declined dramatically. There is a rapid deterioration of the upper airway due to the edema of the aryepiglottic folds, potentially leading to respiratory arrest. Unlike croup, there is no seasonal aspect to epiglottitis. Croup This patient's respiratory distress had an acute onset. Although there is a history of URI, his temperature is normal, making croup and epiglottitis less likely. Croup, otherwise known as laryngotracheobronchitis, is associated with a barking or seal-like cough. It can have associated laryngitis, respiratory distress, and even stridor due to upper airway edema. Physical signs and symptoms of croup include fever, malaise, and other influenza-like illnesses. The most common infectious agent is parainfluenza virus, although there are many other infectious agents that can cause croup. Croup is more commonly seen in fall and winter.

8. A 65-year-old woman presents with a 3-day history of progressive fever, shortness of breath, and hypoxia. Chest x-ray shows bilateral diffuse pulmonary opacities. She is diagnosed with pneumonia, but her clinical status deteriorates, requiring intubation while in the emergency department. The initial ventilator settings are PEEP 5, R 12, and FiO₂ 40%. What is the most appropriate tidal volume ventilator setting?

- A. 12 ml/kg total body weight
- B. 8 ml/kg total body weight
- C. 6 ml/kg predicted body weight
- D. 10 ml/kg predicted body weight

Correct: 6 ml/kg predicted body weight

A tidal volume of 8 ml/kg is considered LTVV, but settings should be based on predicted body weight (PBW), not

total body weight (TBW). PBW utilizes sex and height to calculate predicted weight to better estimate lung size and volume, and it was used in meta-analysis and randomized controlled trials for LTVV. TBW refers to a patient's actual weight and can overestimate lung volume, leading to overdistention and lung injury. 12 ml/kg total body weight A tidal volume of 12 ml/kg tidal volumes were "traditional" ventilator settings that are not recommended in the setting of ARDS. Additionally, ARDS tidal volumes should be based on PBW not TBW. Multiple studies comparing 6 ml/kg PBW to 12 ml/kg PBW have shown a mortality benefit and a reduction in the number of ventilator days when using lower tidal volumes, which has led to recommendations for LTVV strategy in patients with ARDS. 6 ml/kg predicted body weight Pneumonia is one of the leading causes of ARDS, and low tidal-volume ventilation (LTVV) has become the recommended ventilation strategy to prevent complications from mechanical ventilation and to maintain adequate oxygenation. LTVV uses 4 to 8 ml/kg predicted body weight (PBW) tidal volume, with most experts suggesting initial settings at 6 ml/kg PBW. LTVV has also been shown to improve mortality in patients diagnosed with ARDS; it is thought that low tidal volumes reduce alveolar overdistention and mitigate additional lung injury that can be caused by mechanical ventilation. 10 ml/kg predicted body weight A tidal volume of 10 ml/kg tidal volumes were "traditional" ventilator settings that are not recommended in the setting of ARDS. Multiple studies comparing 6 ml/kg PBW to 12 ml/kg PBW have shown a mortality benefit and a reduction in the number of ventilator days when using lower tidal volumes, which has led to recommendations for LTVV strategy in ARDS patients.

9. A patient presents with nontraumatic chest pain. They are in no distress, and their vital signs are BP 130/86, P 76, R 12, and T 37°C (96.8°F); SpO₂ is 96% on room air. A chest x-ray demonstrates a 15% pneumothorax. What is the most appropriate treatment?

- A. Provide pain control and discharge the patient home
- B. Perform an emergent needle thoracostomy
- C. Administer 100% oxygen and repeat x-ray in 4 hours
- D. Insert a 32 French chest tube

Correct: Administer 100% oxygen and repeat x-ray in 4 hours

Emergent needle thoracostomy is the treatment for tension pneumothorax, which is diagnosed clinically and can be detected and treated before imaging is obtained. However, this patient is not in acute respiratory distress and does not have abnormal vital signs, which would be present in case of tension pneumothorax. Provide pain control and discharge the patient home It would be imprudent to discharge this patient home without a period of observation and a repeated chest x-ray. Although many patients with primary spontaneous pneumothorax can be discharged, they should first be assessed in the emergency department to verify that they improve on oxygen. Administer 100% oxygen and repeat x-ray in 4 hours In a healthy adult with an uncomplicated small pneumothorax, the most appropriate treatment is administration of supplemental oxygen and observation in the emergency department. A small pneumothorax is typically considered to be one that is less than 20% of lung volume. Size can also be estimated on an x-ray by measuring the distance between the lung apex and the thoracic cupola, which should be less than 3 cm in small pneumothorax. Although this patient did complain of chest pain, they are not in respiratory distress and do not have grossly abnormal vital signs. If the pneumothorax improves over 4 hours with administration of oxygen, this patient can be discharged home and instructed to return to the emergency department in 24 hours for reassessment. Administration of oxygen has been shown to increase the resorption rate of primary spontaneous pneumothorax by up to four times. This is likely because administration of 100% oxygen decreases alveolar nitrogen concentration, causing nitrogen to diffuse from the air-containing pleural space into the alveoli and speeding resolution of the pneumothorax. Although there is no universally accepted treatment algorithm for pneumothorax, most would recommend observation for this patient; however, it would also be reasonable to consider placing a pigtail catheter, depending on local practice patterns. Insert a 32 French chest tube A large-bore chest tube such as a 32 French would be overly aggressive in a stable patient with no history of trauma or concern for hemothorax. Some small pneumothoraces may be treated with aspiration or a pigtail catheter at the clinician's discretion, but initial treatment with oxygen carries the least risk for this patient.

10. A 2-year-old boy is presented after choking on a peanut. Which symptom would indicate that the foreign body is in his bronchus?

- A. Stridor
- B. Wheezing
- C. Hoarseness
- D. Drooling

Correct: Wheezing

Foreign bodies can lodge in any of the anatomic structures in a toddler's pharynx, airway, or esophagus. The presenting symptoms can provide a clue to the location of the foreign body and the urgency of treatment; for instance, a wheezing sound comes from the narrowing of the airways at the level of the bronchus. Most foreign bodies, especially in children, become obstructed at this level because the larynx and trachea are generally larger than the bronchus. A child who is wheezing because of foreign body aspiration but is not cyanotic can be watched in the emergency department or admitted for urgent bronchoscopy. Chest x-rays are generally unhelpful because most foreign bodies are nonopaque food particles; peanuts are the most frequently identified food culprit. Indirect evidence of a foreign body can be seen on a chest x-ray with unilateral air trapping or atelectasis on the affected side. Unobserved foreign body aspiration should be considered a possible etiology in any child with unilateral wheezing. If a foreign body is opaque and flat, the location can be determined based on the direction of the item; a flat foreign body appears on edge if in the trachea on an anteroposterior image or in the esophagus on a lateral view. Stridor Stridor is generally noted with foreign bodies obstructing at the level of the vocal cords or just below in the trachea. This is a much more alarming indication of obstruction, and emergent evaluation — including involvement by a pediatric pulmonologist or otolaryngologist — should be obtained. If the patient is in extremis, the emergency physician can carefully use a laryngoscope to view the larynx and remove a foreign body if it is seen above the vocal cords. If not, intubation can be performed, with the attempt to push the tracheal foreign body into one bronchus. Because children generally have larger trachea distally, the foreign body generally does not get stuck again until it reaches the bronchus. Hoarseness Hoarseness occurs in patients with an obstructing foreign body in the pharynx or larynx generally at or above the level of the vocal cords. An aspirated foreign body can be asymptomatic initially but then lead to increasing swelling or tissue granulation, resulting in interference with the vocal cords and worsening hoarseness over time. In this situation, an otolaryngologist should be consulted. Drooling Drooling can occur from a foreign body obstructing the esophagus or the pharynx. Although there may be no airway obstruction, young children drool rather than spit (as adults do) if they cannot swallow their own secretions due to an esophageal obstruction. If a drooling pediatric patient has no respiratory symptoms, including stridor or tachypnea, then the foreign body is likely in the esophagus, and a pediatric gastroenterologist should be consulted.

11. What is the greatest risk factor for lung abscess?

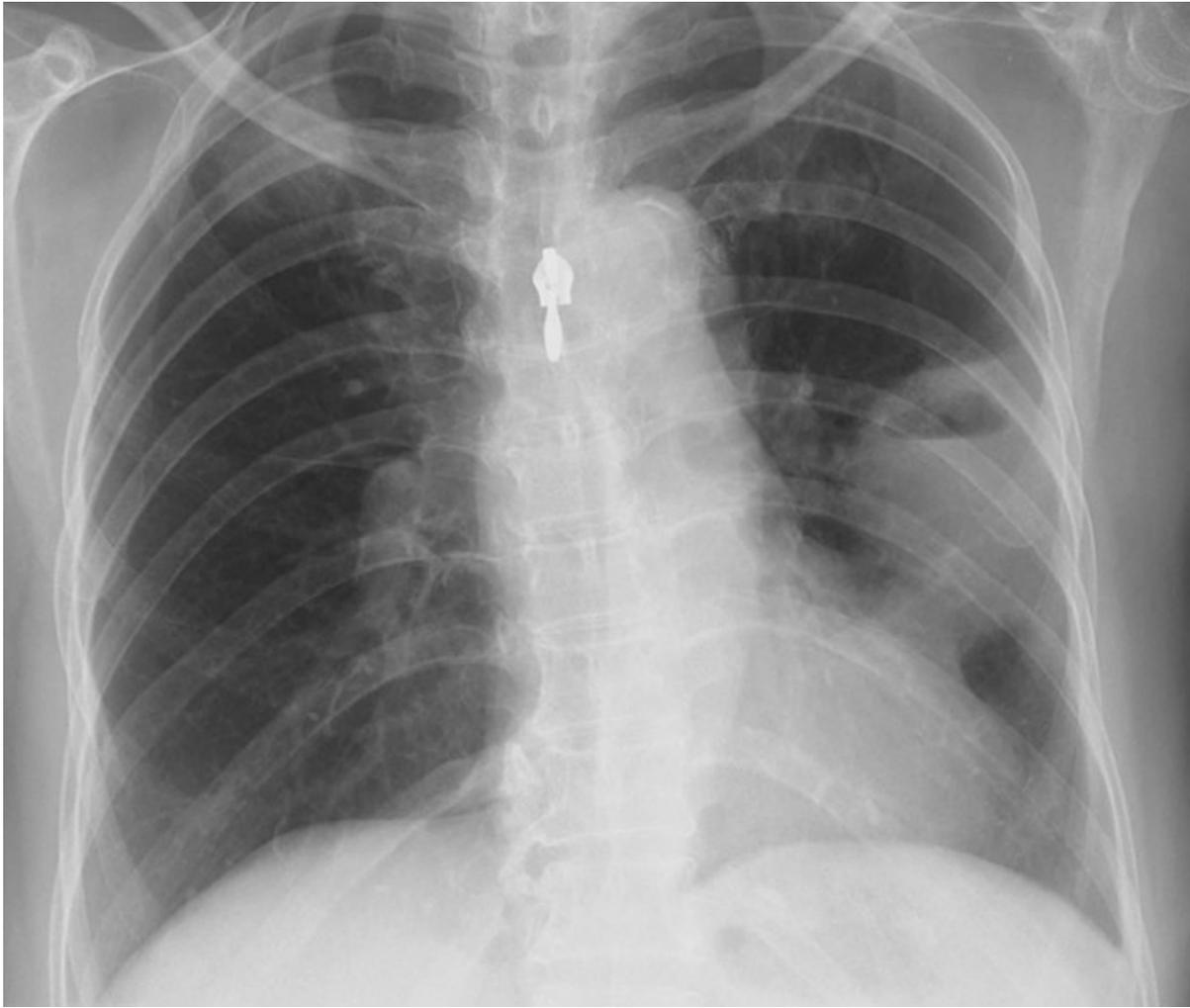
- A. Aortic valve endocarditis
- B. Recent video-assisted thoracoscopic surgery
- C. Stroke with residual dysphagia
- D. Acute respiratory distress syndrome

Correct: Stroke with residual dysphagia

Video-assisted thoracoscopic surgery (VATS) may be complicated by empyema but is unassociated with lung

abscesses. Empyema is purulent material found in the pleural space, while a lung abscess is purulent material in the lung parenchyma. Occasionally, VATS may be used to resect a lung abscess, but this is only performed when other measures have failed. Aortic valve endocarditis A secondary lung abscess due to endocarditis is possible. Right-sided endocarditis (tricuspid or pulmonary valve) poses the highest risk from septic emboli thrown directly into the pulmonary circulation. Left-sided (aortic or mitral valve) endocarditis is unassociated with lung abscesses. Unlike primary lung abscesses, which are found in areas associated with aspiration, secondary lung abscesses from septic emboli are usually multiple and may be found in unrelated segments of the lung. Stroke with residual dysphagia Patients with a history of stroke with residual dysphagia are at a high risk for aspiration. Dysphagia in combination with gingival disease is the most common risk factor for lung abscess. Roughly 80% of lung abscesses are primary and caused by aspiration, subsequent necrosis in the lung parenchyma, and polymicrobial infection. Lung abscesses most commonly develop in the following manner: large-volume aspiration leads to pneumonitis with tissue necrosis in 7 to 14 days, followed by the development of a polymicrobial infection in the area of necrosis. Bacteria that are pathogenic in lung abscesses are the same bacteria that live in the gingival crevices. Risk factors for lung abscess are the same risk factors for aspiration, including recumbent positioning, reduced level of consciousness, esophageal dysmotility, gastric overdistention, large-volume tube feedings, vomiting, and gastric reflux. Acute respiratory distress syndrome ARDS is a diffuse inflammatory lung injury characterized by severe hypoxemia and bilateral infiltrates on chest x-rays. Although ARDS is not a risk factor for lung abscess, bronchoscopic drainage of a lung abscess may cause ARDS due to pus and necrotic materials spilling into other lung segments. Aspiration itself can cause both ARDS and lung abscess, but they are independent conditions.

12. A 47-year-old man with a history of alcohol abuse presents with a 3-week history of cough, fever, weight loss, and night sweats. He also reports pain with deep inspiration. The patient's vital signs include P 86, R 14, and T 37.5°C (99.5°F); SpO₂ is 96% on room air. Laboratory studies reveal a WBC of 14 and an ESR of 25. A chest x-ray is obtained and shown below. What is the most likely diagnosis?



- A. Septic pulmonary emboli
- B. Miliary tuberculosis
- C. Lung abscess
- D. Hiatal hernia

Correct: Lung abscess

Miliary tuberculosis (TB) presents on x-ray with multiple small lesions resembling millet seeds and affects multiple organs due to the hematogenous spread during infection with primary TB. Miliary TB nodules will be distributed in the central and peripheral areas bilaterally in contrast to a lung abscess, which is often unilateral. Septic pulmonary emboli X-ray imaging of septic pulmonary emboli reveals bilateral peripheral nodules with central cavitation. These develop as a result of infected material seeding through the pulmonary vasculature, causing a “feeding vessel sign” on CT where pulmonary vessels can be seen feeding directly to the nodule. Infection is typically introduced through infected venous catheters, pacemaker wires, or indwelling catheters. Lung abscess Pulmonary abscess is most commonly caused by aspiration of anaerobic bacteria in the oral cavity. Patients with alcohol use disorder are at high risk for aspiration, which increases the chance of lung abscess formation. X-ray of a lung abscess reveals air-fluid levels inside a dense cavitory lesion, most commonly in dependent portions of the lung (eg, the right lower lobe in an ambulatory patient). CT chest with contrast reveals the abscess cavity and margins. Patients with a lung abscess will require admission to the hospital and initiation of intravenous antibiotics, followed by continuation of antibiotics for 3 to 6 weeks. Typical treatment includes beta-lactam-beta-lactamase inhibitor or carbapenem antibiotics. Clindamycin and metronidazole may be used as an alternative regimen. Common complications include hemoptysis, contamination of the healthy lung, treatment failure, and empyema formation. Hiatal hernia Patients presenting with hiatal hernia typically complain of abdominal pain, nausea, and vomiting, or they have bowel sounds on chest auscultation. X-ray reveals a large retrocardiac opacity with air-fluid level that represents the stomach bubble, typically on the left side.

13. What is the most common bacterial etiology of septic emboli from infective endocarditis?

- A. Staphylococcus aureus
- B. Polymicrobial infection
- C. Enterococci species
- D. Viridans streptococci

Correct: Staphylococcus aureus

Polymicrobial infections account for only 1% to 3% of infective endocarditis cases. The HACEK organisms (Haemophilus species, Aggregatibacter species, Cardiobacterium hominis, Eikenella corrodens, and Kingella species) are common infective organisms. Another common gram-positive cause of infective endocarditis is coagulase-negative Staphylococcus, which accounts for roughly 11.6% of infections. Staphylococcus aureus Septic emboli are present in 10.52% of patients with infective endocarditis. The most common pathogen is Staphylococcus aureus, which affects 33.6% of all infective endocarditis cases. This percentage rises to 68% in intravenous drug users. Treatment of septic emboli should therefore cover gram-positive organisms; coverage should also include MRSA in patients with risk factors for resistant organisms. Enterococci species Enterococci account for 16.1% of infective endocarditis. This accounts for less septic emboli than S. aureus, which accounts for 33.6% of all infective endocarditis cases. Viridans streptococci Viridans streptococci are common bacteria that cause infective endocarditis. This group, however, causes infective endocarditis less often than S. aureus.

14. Which intervention is indicated for asthmatic patients who require intubation?

- A. Targeting an I:E ratio of 1:2
- B. Administration of propofol as a sedating agent
- C. Maintaining respirations to ensure a pH of 7.35 to 7.45
- D. Starting tidal volume at 10 mL/kg of ideal body weight

Correct: Administration of propofol as a sedating agent

Although various factors affect the intubation of a patient, the preferred route is orotracheal rapid sequence intubation with the use of induction and paralytic agents. Of the answer choices provided, only propofol use for sedation is recommended. Propofol facilitates deep sedation but also possesses bronchodilating properties; thus, it is an ideal agent for asthmatic patients. Ketamine, similarly, has bronchodilatory properties. Benzodiazepines are not recommended for the sedation of asthmatic patients because they increase delirium, time on a ventilator, and length of ICU stay. A small percentage of patients with asthma exacerbations (1% to 2%) require endotracheal intubation, which is commonly indicated by profound hypoxia, depressed mental status, exhaustion, and an inability to continue breathing. Asthmatic patients who require mechanical ventilation frequently develop mucous plugging in addition to significant bronchospasm, which can result in extremely high peak airway pressures and place them at risk for barotrauma. These patients typically require high doses of analgesia and sedation to prevent patient-ventilator dyssynchrony, which can exacerbate the already high peak airway pressures and lead to significant harm. Targeting an I:E ratio of 1:2 Asthma is an obstructive pulmonary process; therefore, after intubation, it is important to allow for prolonged expiratory time after intubation. Normally, during spontaneous breathing, a typical I:E ratio is about 1:2, but in asthma, there is obstruction and need for longer expiration time, especially after intubation. Initial ventilator settings for asthmatics post-intubation include an I:E ratio of 1:3 to 1:5 to allow for increased exhalation time. This can decrease the risk of breath stacking and potential for barotrauma. The ideal management of an intubated asthmatic patient also includes having a relatively low initial respiratory rate (8 to 12 breaths/min); prolonging the expiration phase (an inspiratory-to-expiratory ratio of 1:4 or 1:5) to allow time for full expiration and the reduction of air trapping; increasing the inspiratory flow rate, which is normally at 60 L/min, to 80 to 100 L/min

with a decelerating flow pattern; and ensuring plateau pressures are less than 30 cm H₂O. Maintaining respirations to ensure a pH of 7.35 to 7.45. Airflow obstruction is a hallmark of a severe asthma exacerbation. The tidal volume returned is frequently less than what is delivered by the ventilator, and as a result, patients develop air trapping and high levels of auto-PEEP (positive end-expiratory pressure), which can result in hemodynamic instability due to a decrease in venous return to the heart. To avoid this, a ventilator approach that allows for permissive hypercapnia is recommended. In this approach, a lower respiratory rate and, subsequently, a lower pH (around 7.25 to 7.30) and higher PCO₂, are tolerated until the patient improves. Starting tidal volume at 10 mL/kg of ideal body weight. There is no benefit to high tidal volumes in patients; high tidal volumes can even be harmful, as they can increase peak pressures and predispose patients to the development of ARDS. Patients should receive low tidal volume ventilation, which is defined as a tidal volume of 6 to 8 mL/kg of ideal body weight. The ideal management of an intubated asthmatic patient also includes having a relatively low initial respiratory rate (8 to 12 breaths/min); prolonging the expiration phase (an inspiratory-to-expiratory ratio of 1:4 or 1:5) to allow time for full expiration and the reduction of air trapping; increasing the inspiratory flow rate, which is normally at 60 L/min, to 80 to 100 L/min with a decelerating flow pattern; and ensuring plateau pressures are less than 30 cm H₂O.

15. A pulmonary hypertension patient on a home pulmonary vasodilator infusion presents with a peripherally inserted central catheter (PICC) line malfunction. What should be performed first?

- A. Continue infusion via peripheral IV
- B. Hold infusion until PICC line replacement
- C. Start an oral pulmonary vasodilator
- D. Flush the PICC line

Correct: Continue infusion via peripheral IV

Holding the infusion is contraindicated due to the short half-lives of treprostinil and epoprostenol. The infusion should instead be transitioned to a peripheral line while awaiting PICC replacement. Continue infusion via peripheral IV. Many patients with severe pulmonary hypertension are on home pulmonary vasodilator infusions such as treprostinil and epoprostenol. In the setting of a peripherally inserted central catheter (PICC) line malfunction, a dedicated peripheral IV should be placed immediately, and these infusions should be continued at the home settings on the home pump. Similarly, a home pump malfunction should prompt transition of the infusion to a hospital pump as soon as possible in direct discussion with the patient's pulmonary hypertension specialist to ensure proper settings. Treprostinil and epoprostenol are very short-acting agents, with half-lives of approximately 4 hours and 6 minutes, respectively. Thus, any significant interruption can result in rapid-onset catastrophic rebound pulmonary hypertension and life-threatening circulatory dysfunction. Start an oral pulmonary vasodilator. Oral pulmonary vasodilators are often used for milder pulmonary hypertension but are not a replacement for existing intravenous infusions. Patients presenting with malfunctioning home intravenous infusions cannot be transitioned acutely to oral therapy. Instead, the infusion should be transitioned to a peripheral line while awaiting PICC replacement. Flush the PICC line. Flushing the PICC line would result in a potentially dangerous medication bolus. Thus, this action is contraindicated. The infusion should instead be transitioned to a peripheral line while awaiting PICC replacement.

16. A 6-month-old boy is presented for coughing and wheezing. He was born at 29 weeks' gestation and has a history of bronchopulmonary dysplasia. At home, he is on supplemental oxygen therapy at 0.5 L/min. A chest x-ray is obtained and read as abnormal. Which entry in the patient's medical record would be most helpful in determining the disposition?

- A. History of furosemide administration
- B. Previous chest x-ray
- C. History of total parenteral nutrition
- D. Previous ICU admission

Correct: Previous chest x-ray

Children with bronchopulmonary dysplasia (BPD) typically have abnormal lung examinations (wheezes, rales, rhonchi) and x-ray findings at baseline. Comparing old and new chest x-rays helps to distinguish new infiltrates from chronic lung disease. Bronchopulmonary dysplasia is a chronic lung disease most commonly associated with premature birth. During an acute illness, the baseline work of breathing and lung examination findings are worsened, and patients may require more supplemental oxygen to maintain their saturation levels. The diagnosis of BPD depends on a child's need for supplemental oxygen at specific postconceptual or postnatal age cutoffs. Risk for BPD is increased in more extreme prematurity, in babies requiring a longer duration of supplemental oxygen or positive pressure ventilation and in neonates with inadequate nutrition. As with many chronic lung diseases, BPD puts children at risk for increased severity of acute respiratory illnesses. Respiratory syncytial virus (RSV) infection in children with BPD is particularly worrisome; these babies are at risk for more severe disease, increased need for intensive care, increased need for mechanical ventilation, and increased likelihood of death. In fact, RSV is so concerning in children with BPD that many of them receive periodic RSV prophylaxis. Treatment of acute respiratory illness in children with BPD is supportive. A trial of inhaled beta-agonist therapy is reasonable. Of particular importance for these patients is hydration status; many children with BPD are on long-term diuretic therapy to improve lung mechanics. History of furosemide administration Although children with BPD can be on long-term diuretic therapy to help with lung remodeling, previous furosemide therapy does not predict an acute exacerbation of BPD. History of total parenteral nutrition A history of total parenteral nutrition is not associated with acute exacerbations of BPD. Inadequate nutrition is a risk factor for the development of BPD. Many children with a history of premature birth also have a history of total parenteral nutrition. Previous ICU admission Unlike asthma, a history of a previous ICU admission does not predict severity of a current acute BPD exacerbation.

17. Fluid analysis after a thoracentesis reveals pH 6.96, protein 3.6 g/dL, and glucose 26 mg/dL. What is the most likely cause of this patient's pleural effusion?

- A. Esophageal perforation
- B. Migration of central venous catheter
- C. Heart failure exacerbation
- D. Hepatic hydrothorax

Correct: Esophageal perforation

Extravascular migration of a central venous catheter should cause an effusion with laboratory studies reflective of the nature of the fluid infusing into the pleural space. If saline were infusing, a high protein measurement would not be expected. If parenteral nutrition were infusing, a higher glucose level would be expected. Esophageal perforation Of the available options, esophageal perforation is the most likely cause of an exudative collection of fluid with a low pH (<7.3) and low glucose (<60). Although pneumonia with concomitant empyema and malignant effusion are more common causes of pleural fluid with these laboratory findings, an esophageal perforation may lead to both mediastinitis and an infected exudative pleural effusion. A high pleural fluid amylase level may help confirm the diagnosis in suspected esophageal perforation. Most patients with a new pleural effusion larger than 1 cm in diameter will require a diagnostic thoracentesis to evaluate for the presence of a complicated effusion, which will require drainage for patient improvement. Exceptions to this include a patient with symmetrical pleural effusions in the setting of a clear heart failure exacerbation or a patient with viral pleurisy with a small effusion. In these cases, patients should be carefully monitored for improvement with conservative management. Heart failure exacerbation A heart failure exacerbation may cause a transudative effusion. This should demonstrate a normal glucose, low

LDH, and normal pH. The pleural fluid protein level may be higher than expected in the setting of diuresis. Hepatic hydrothorax A hepatic hydrothorax may occur in patients with liver failure. This is a transudative effusion; similar to ascitic fluid, a transudative effusion would demonstrate a low protein level (<2.5 g/dL) and a normal pH.

18. Fibrinolytic therapy should be considered in a patient with pulmonary embolism and which other finding?

- A. Septal shift to the right
- B. Tricuspid stenosis
- C. Right ventricular hypokinesis
- D. Decreased pulmonary artery pressure

Correct: Right ventricular hypokinesis

Tricuspid stenosis does not require fibrinolytic therapy in PE because it is not a marker for massive PE. Septal shift to the right Septal shift to the right is not an indicator of right ventricular strain. Septal shift to the left is concerning for right ventricular strain in PE. Right ventricular hypokinesis Signs of massive pulmonary embolism (PE) causing right heart dysfunction include right ventricular dilation and hypokinesis, septal shift to the left, tricuspid regurgitation, elevated pulmonary artery pressure, decreased left ventricular filling, and impediment on left ventricular output. Standard treatment for PE is anticoagulation. Low-molecular-weight heparin (LMWH) has become standard therapy, although unfractionated heparin is still a safe and effective treatment. Unfractionated heparin and LMWH do not act to break down an existing thrombus; rather, they decrease thrombus propagation and extension. With a massive PE, more rapid thrombus breakdown is needed, and fibrinolytic therapy is recommended. In a practice guideline statement, the American College of Emergency Physicians recommended fibrinolytic therapy for hemodynamically unstable patients with confirmed PE as a class B recommendation. Catheter-based techniques of thrombus fragmentation, as well as surgical embolectomy, are alternatives to systemic use of fibrinolytics. The FDA-approved on-label use of fibrinolytic therapy for PE is alteplase, 15 mg as an IV bolus and then 85 mg IV over a 2-hour period (heparin infusion should be stopped during alteplase administration). Decreased pulmonary artery pressure Pulmonary artery pressure is increased proportionally with increased obstruction from larger emboli. Increased pulmonary artery vascular resistance is not correlated with the level of hypoxia or obstruction.

19. What is the most appropriate course of action to manage a 15% stable nontraumatic pneumothorax?

- A. Perform needle aspiration
- B. Admit for 24-hour observation
- C. Insert a 36 Fr chest tube
- D. Administer oxygen and repeat x-ray in 4 hours

Correct: Administer oxygen and repeat x-ray in 4 hours

Successful management of a pneumothorax usually requires a therapeutic intervention using thorax drainage. Observation alone is recommended for only those few patients with pneumothorax with minimal clinical symptoms. In the surgical therapy of pneumothorax, VATS (video-assisted thoracic surgery) is the current effective standard treatment. Open posterolateral thoracotomy is the recommended approach in patients with serious illness or complications. The aim is to reduce the recurrence rate of pneumothorax. Perform needle aspiration Studies have shown that needle aspiration has the same outcomes as the placement of a chest tube with less patient discomfort.

However, most patients with a small pneumothorax do not require invasive treatment. Insert a 36 Fr chest tube. Insertion of a large-bore chest tube is the treatment of choice for hemothorax to encourage drainage; a 28 to 32 Fr chest tube is used in most instances. Smokers have a higher risk of developing pneumothorax. Administer oxygen and repeat x-ray in 4 hours. Traditionally, small pneumothoraces were defined as those occupying less than 20% of one hemithorax. Supplemental oxygen increases the rate of resorption of the pneumothorax by a factor of 4 over 3 to 6 hours, so while patients with small pneumothoraces do not require hospitalization, most physicians choose to observe them until repeat films demonstrate improvement of the pneumothorax. Most pneumothoraces estimated at smaller than 15% are regarded as safe to treat with observation only. In small pneumothoraces, there is less likelihood of persistent air leak and less likelihood of recurrence in those managed with observation alone than in those treated with chest tube insertion. Guidelines for the management of primary spontaneous pneumothorax continue to evolve, and there are many and different systems used to estimate pneumothorax volume, such as the analysis of plain PA chest x-rays. Recently, the British Thoracic Society published guidelines regarding the differentiation between large and small pneumothoraces to avoid incorrect estimations of size percentages.

20. Which symptom is reliably found in patients who develop clinical signs of pneumoconiosis?

- A. Sputum production
- B. Chest pain
- C. Gradual onset dyspnea
- D. Acute wheezing

Correct: Gradual onset dyspnea

Chest pain can be caused by numerous pulmonary diseases, but pneumoconiosis is generally not associated with pain. Acute shortness of breath with chest pain in patients with pneumoconiosis might be associated with spontaneous pneumothorax or associated pneumonia. Sputum production Productive cough and sputum production can be seen in patients with pneumoconiosis who are smokers and have concomitant chronic bronchitis. Coughing does not distinguish one disease process from another. Gradual onset dyspnea Pneumoconiosis is a restrictive lung disease that generally results from inhaling toxic substances, including coal dust (a condition known as coal miner's lung, coal workers' pneumoconiosis, or black lung disease) and silica. It results in pulmonary fibrosis, which limits total lung volume and decreases oxygen perfusion across the alveoli. Obstructive lung diseases, in distinction, cause symptoms due to increased airway resistance. Patients often have symptoms of dyspnea, but wheezing is heard less often due to the nature of restrictive lung disease. Chest x-ray reveals numerous nodules larger than 1 cm, generally in the upper part of the lung lobes. Interstitial lung findings (a fine reticular pattern) can appear similar to interstitial pulmonary edema on initial imaging. Treatment is generally based around steroids to prevent further inflammatory response. Acute wheezing Wheezing is not a classic symptom for patients with chronic pneumoconiosis. It can be seen in patients with pneumoconiosis, especially smokers, who generally have worsening disease with a combination of symptoms from COPD and fibrosis.

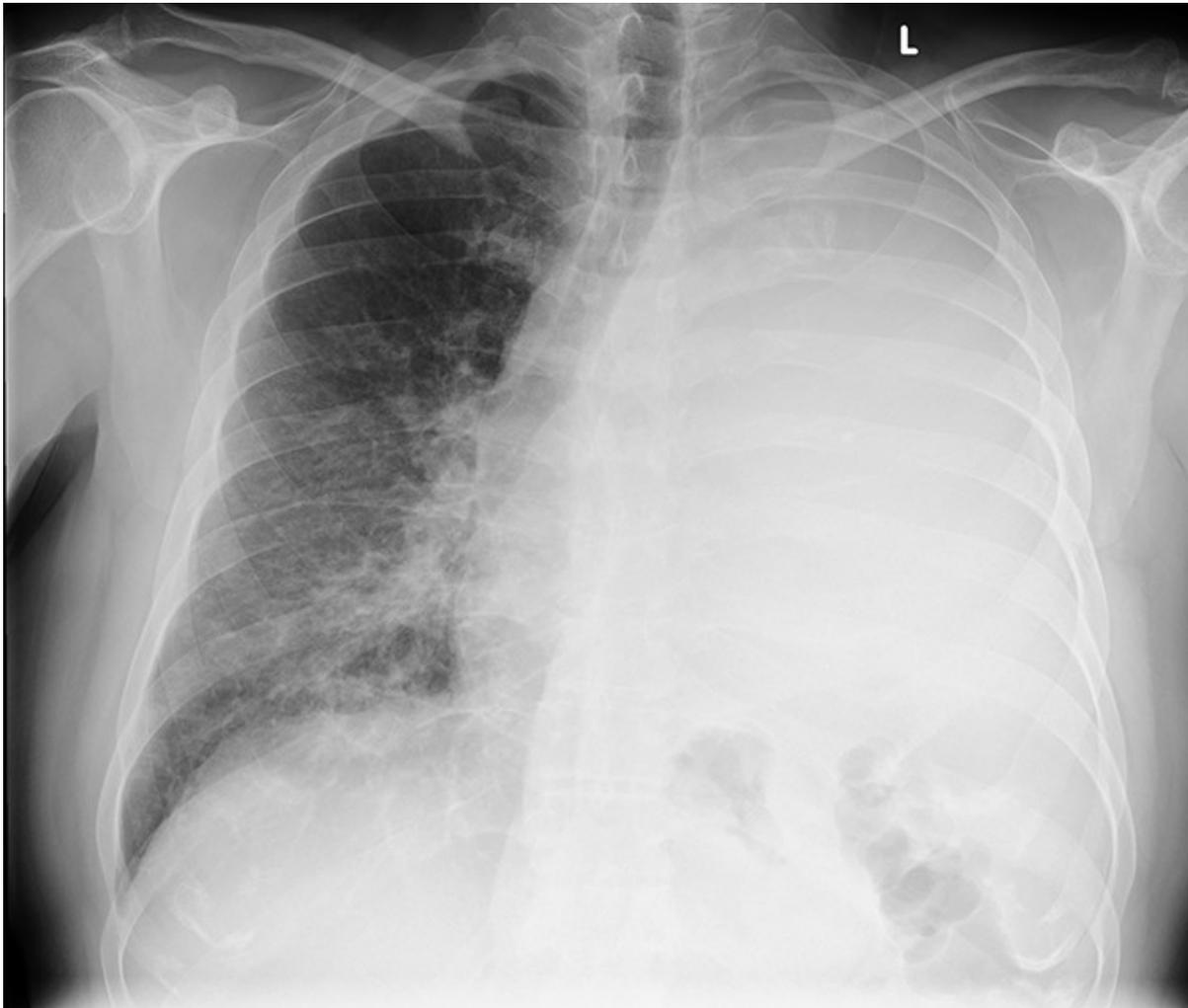
21. Chest tube drainage of a pleural effusion should be avoided in a patient with which diagnosis?

- A. Hepatic hydrothorax
- B. Empyema
- C. Malignant effusion
- D. Chylothorax

Correct: Hepatic hydrothorax

Empyema requires chest tube drainage for control of the source of the infection. Some simple parapneumonic effusions may not need drainage, but pleural fluid that has evidence of bacterial infection must be drained. Hepatic hydrothorax Although most pleural effusions may be initially managed with thoracentesis or chest tube drainage, tube thoracostomy is associated with increased mortality in patients with hepatic hydrothorax. This type of transudative effusion occurs in patients with cirrhosis, similar to ascites. Chest tube drainage may become necessary in the setting of infected pleural fluid but should be avoided if possible. Hepatic hydrothorax should be managed with intermittent thoracentesis along with diuretics and a sodium-restricted diet. Patients should be advised to avoid alcohol intake. If the patient is a good candidate, follow-up with hepatology and referral to a liver transplant center is warranted. Malignant effusion Malignant pleural effusions are often managed with chest tube drainage. Sometimes, patients with this condition have indwelling pleural catheters placed as an option for outpatient management. Chylothorax Chylothorax is often initially managed with chest tube drainage. Dietary modification is also necessary.

22. An alert patient presents with severe respiratory distress and hypercapnic respiratory failure improving with noninvasive positive-pressure ventilation. Their chest x-ray is shown. What is the next best step in management?



- A. Continuous albuterol nebulization
- B. Rapid sequence intubation
- C. Thoracentesis
- D. Needle decompression

Correct: Thoracentesis

Rapid sequence intubation is an invasive procedure that is not immediately necessary in an alert patient improving on noninvasive positive-pressure ventilation. This patient's respiratory function is likely to improve further with thoracentesis, and respiratory support may be de-escalated at that time, avoiding intubation entirely. Continuous albuterol nebulization Continuous albuterol nebulization is unlikely to help a patient in respiratory distress due to a large pleural effusion. Continuous albuterol nebulization would be indicated if hypercapnia or respiratory distress were caused by an obstructive lung disease, such as asthma or COPD. Thoracentesis Respiratory distress or failure is an indication for emergent thoracentesis in the setting of a moderate to large pleural effusion, as seen in the chest x-ray above. This patient is likely to improve clinically with reexpansion of their left lung after drainage of the fluid. Coagulopathy is not an absolute contraindication to thoracentesis in this situation, and positive-pressure ventilation is also not considered to be a contraindication. Another indication for emergent thoracentesis is suspected empyema. The fluid obtained during the procedure should be sent for laboratory analysis for cell count and differential, protein, LDH, and glucose along with Gram stain and culture if infection is suspected. These tests will help differentiate the cause of the effusion and guide further management. Needle decompression Needle decompression of the thorax is not indicated for a pleural effusion. This may be helpful in the setting of hemodynamic compromise from a tension pneumothorax, but there is no evidence of pneumothorax in the imaging above.

23. What best defines the classification of massive pulmonary embolism?

- A. Systolic blood pressure <90 mmHg for >15 minutes
- B. Shock index <1.0
- C. Elevated cardiac troponin
- D. Right ventricular dilation on bedside ultrasound

Correct: Systolic blood pressure <90 mmHg for >15 minutes

Shock index is defined as heart rate divided by systolic blood pressure. A shock index of <1.0 on its own is indicative of less severe PE. However, a shock index >1.0 can be associated with either massive or submassive PE. Systolic blood pressure <90 mmHg for >15 minutes Pulmonary embolism (PE) is an obstruction of blood flow into the pulmonary arteries that is most commonly caused by thrombus. A patient's overall clinical picture is often not directly correlated to clot burden, as patients with similar thrombus burden can have symptoms varying from minimal to sudden cardiac arrest. Thus, the clinical severity of PE is based on hemodynamic stability. Massive pulmonary embolism is defined as systolic blood pressure <90 mm Hg for >15 minutes, a 40% reduction in baseline systolic blood pressure for >15 minutes, or hypotension requiring vasopressor support without other cause. Patients with massive PE have been shown to benefit from fibrinolysis. Patients with submassive PE have normal blood pressure but show signs of cardiopulmonary dysfunction, including right ventricular dilation and strain on ultrasonography, elevated cardiac biomarkers (including Troponin I or T or BNP), or a shock index (ie, heart rate divided by systolic blood pressure) >1.0. Patients with submassive PE should be considered for fibrinolysis although may have a higher bleeding risk. All other cases are "less severe" PE and should not receive thrombolysis. Elevated cardiac troponin Acute PE can cause elevations in cardiac troponin. This is caused by acute subendothelial ischemia in the right ventricle. Troponin elevation in PE is indicative of right ventricular dysfunction and can indicate submassive PE. Right ventricular dilation on bedside ultrasound Right ventricular (RV) dilation and hypokinesia on ultrasound can indicate RV dysfunction and can be seen in cases of acute PE, pulmonary hypertension, and ischemic heart disease. RV dilation can be suggested by a right ventricle:left ventricle ratio greater than 1:1 in the apical 4-view on echocardiography. RV dysfunction alone indicates submassive PE, not massive PE.

24. Pleural fluid analysis after thoracentesis demonstrates a milky fluid with a lymphocytic predominance. What is the most likely underlying diagnosis?

- A. Diminished left ventricular function
- B. Laceration of the thoracic duct
- C. Bacterial pneumonia
- D. Pancreatitis

Correct: Laceration of the thoracic duct

Laceration of the thoracic duct may cause a chylothorax through leakage of chyle into the pleural space, characterized by milky white fluid on thoracentesis. Laboratory analysis may reveal elevated triglycerides and a lymphocytic predominance. The list of conditions resulting in chylothorax is extensive, including spinal trauma, iatrogenic trauma during a procedure, and malignancy. Chylothorax is often treated with chest tube drainage and dietary modification (often parenteral nutrition), but it may require operative intervention. Diminished left ventricular function Diminished left ventricular function would typically cause a transudative effusion. This would classically appear serous or watery and should not have a milky appearance. Other causes of transudates include CSF leaks into the pleural space, hepatic hydrothorax, nephrotic syndrome, and peritoneal dialysis. Bacterial pneumonia Bacterial pneumonia may be associated with a parapneumonic effusion, but this would not usually present as a milky fluid with a lymphocytic predominance. There may be an uncomplicated exudate with a normal glucose level and pH or an empyema with a low glucose level and pH along with a neutrophilic predominance. Pancreatitis Pleural effusion is a known complication of pancreatitis, but this often presents as a hemorrhagic rather than milky fluid. It may have a lymphocytic predominance and often demonstrates a high pleural fluid amylase measurement.

25. A 2-year-old boy presents with a cough and tachypnea following a choking episode. Symptoms began while the child was sitting on the floor playing. On examination, he is afebrile and is noted to have right-sided wheezing. What is the most likely diagnosis?

- A. Epiglottitis
- B. Retropharyngeal abscess
- C. Bacterial tracheitis
- D. Foreign body aspiration

Correct: Foreign body aspiration

Retropharyngeal abscesses may present in this age group but are often preceded by local trauma or URI. Localized wheezing is unlikely to be present, although stridor is common. Epiglottitis Since the patient is afebrile and has a cough, he is unlikely to have epiglottitis. The presentation of epiglottitis is usually fever, sore throat, and respiratory distress. Cough is rarely present. Bacterial tracheitis Bacterial tracheitis may present in this age group but is usually preceded by URI, often influenza. Symptoms worsen rapidly over the course of 8 to 12 hours. Foreign body aspiration Foreign body aspiration should be suspected in all children with a history of cough after a choking episode. However, the diagnosis may be difficult since ingestion of the foreign body may not be witnessed by the caregiver. Foreign body aspiration should be considered regardless of symptom duration; presentation within the first 24 hours only occurs in about 50% of cases. Patients with foreign body aspiration may present with a broad spectrum of symptoms, ranging from mild cough in cases of partial airway obstruction to severe respiratory distress in patients with complete airway obstruction. Patients commonly have tachypnea, stridor, and may have focal wheezing. In a stable patient, a chest x-ray should be obtained. Hyperinflation of one lung, atelectasis, mediastinal shift, or pneumonia may be noted. However, the chest x-ray is normal in approximately 30% of cases. If there is clinical suspicion for foreign body aspiration, a CT of the thorax should be performed. If foreign body aspiration is strongly suspected or if it has been diagnosed radiographically, rigid bronchoscopy should be done to remove the object.

26. Which finding is more likely to be present in an elderly patient who has primary tuberculosis than in a young patient?

- A. Pleural effusion
- B. Ghon complex
- C. Hilar adenopathy
- D. Miliary pattern

Correct: Pleural effusion

The Ghon complex is a lung lesion that represents a calcified focus of healed infection. Patients who are immunocompromised often lack the immune response to create a Ghon complex. Pleural effusion The number of different chest x-ray manifestations of primary tuberculosis (TB) is large, and they vary based on patient age, presence of comorbidities (particularly HIV), and stage of disease. The most common chest x-ray finding in patients with primary pulmonary TB, regardless of age, is a single lobar infiltrate with associated hilar adenopathy. In elderly patients with primary TB, chest x-ray typically exhibits an isolated pleural effusion. Primary refers to the initial infection of TB in a host. Patients are typically asymptomatic; primary TB is often detected either on a chest x-ray or with a tuberculin skin test. Populations at higher risk for TB include people from Asia, Africa, and other Latin American countries; those with recent contact with a known, active TB patient; persons with HIV/AIDS; the elderly; medically underserved, low-income populations; and residents of long-term care facilities. According to the CDC, most US cases among foreign-born individuals are in people from seven countries: Mexico, the Philippines, Vietnam, India, China, Haiti, and Guatemala. Hilar adenopathy Hilar adenopathy is most commonly found in pediatric patients rather than in adults. In fact, hilar adenopathy is considered the hallmark of TB in younger patients. Miliary pattern The other pulmonary pattern of TB, miliary, is seen at the extremes of age and in immunocompromised patients. It is characterized by the presence of countless noncalcified nodules with a basilar predominance.

27. Which characteristic of a breast mass is most likely to represent fibrocystic changes?

- A. Skin thickening
- B. Fluctuance
- C. Nodularity
- D. Nipple retraction

Correct: Nodularity

A fluctuant breast mass likely represents an abscess; it can be identified using ultrasonography or mammography. Although the label fibrocystic might imply fluctuance of a mass due to its cystic nature, the small size of the cysts and more prominent dense stromal tissue create the classic bumpy, nonfluctuant feel on palpation of the characteristic fibrocystic changes. Skin thickening Breast cancer also can cause skin changes, including discoloration, thickening, and dimpling. Classic characteristics of the skin changes in inflammatory breast cancer are skin thickening and an erythema called peau d'orange (orange peel). Some abscesses can cause erythema, but fibrocystic disease does not cause this particular change in the appearance of the skin. Nodularity Fibrocystic changes are the most common cause of breast lesions in women. These noncancerous lesions are described as nodular, mobile, and smooth. As the name describes, the breast tissue develops numerous cystic structures from dilatation of the ducts that are mixed with excessive fibrous tissue. A breast that has undergone these changes can become tender with menstrual cycle changes. Several radiologic imaging techniques have been used to make sure that changes noted on physical examination are not indicative of cancer, including ultrasonography, mammography,

and MRI. These changes occur in at least one third of women of child-bearing age. In contrast, cancerous lesions are generally firmer and more irregular in shape. Enlarged lymph nodes associated with breast cancer initially are described as rubbery; they become matted and fixed when found in association with breast cancer. Nipple retraction is a sign found in cancer and not found in fibrocystic changes. The retraction is a result of fibrosis that can pull the nipple toward the breast and chest wall. Bloody, unilateral nipple discharge is another concerning sign that can indicate the presence of a breast carcinoma.

28. Which pathogen most commonly causes pneumonia in young children with cystic fibrosis?

- A. *Staphylococcus aureus*
- B. *Pseudomonas aeruginosa*
- C. *Streptococcus pneumoniae*
- D. *Burkholderia cepacia*

Correct: *Staphylococcus aureus*

By age 18 years, 80% of patients with cystic fibrosis have been colonized with *P. aeruginosa*. Empiric antibiotics generally include a penicillin and aminoglycoside. Typically, an emergency physician should consider expert consultation before treating cystic fibrosis. Investigation of the patient's history and evaluation of prior sputum cultures are warranted. *Staphylococcus aureus* and *Haemophilus influenzae* are the most common pathogens of childhood pneumonia in patients with cystic fibrosis. Cystic fibrosis is caused by defects in chloride transport in the cellular membranes, which results in reduced ciliary clearance of mucus, thicker mucus, and ultimately, enhanced bacterial adherence to the airway. Patients with cystic fibrosis frequently have pneumonia. An important component of the treatment of pneumonia includes aggressive pulmonary toilet, aerosolized treatments, and mucolytics. Although *S. pneumoniae* is the most common cause of pneumonia overall in both immunocompetent and immunocompromised patients, *S. aureus* and *H. influenzae* are the most common pathogens that cause pneumonia in children with cystic fibrosis. It is important to remember the specific pathogens associated with disease processes like cystic fibrosis. *Burkholderia cepacia* is a common pathogen that causes pneumonia in cystic fibrosis patients. Although not the most common cause of pneumonia, infection with this organism is related to increased morbidity and mortality rates.

29. Which characteristic is more commonly seen with atypical pneumonia than with other causes of pneumonia?

- A. Chest pain
- B. Dry cough
- C. Dyspnea
- D. Fever

Correct: Dry cough

Atypical pneumonias are generally characterized as those caused by *Legionella pneumophila*, *Chlamydia pneumoniae*, and *Mycoplasma pneumoniae*, in addition to viruses. The symptoms include fever, dyspnea, and cough. Patients who have atypical pneumonia tend to describe the cough as “dry”; this nonproductive cough is unlike the cough associated with other bacterial illnesses, which produces sputum. The symptom of dry cough should be considered when selecting an empiric antibiotic, especially if the patient is to be treated as an outpatient. Because *M. pneumoniae* is one of the most common etiologies of pneumonia in healthy persons, antibiotic coverage for it should

be considered. Generally, a macrolide is recommended. Chest pain Chest pain, often described as pleuritic pain, is present in up to 50% of patients with pneumonia. This can be caused by inflammation of the parietal pleura by the infiltrate. In addition, 25% of patients with *Streptococcus pneumoniae* infection have a pleural effusion, which can also be symptomatic. Dyspnea Dyspnea is a more common complaint in patients with pneumonia caused by classic bacterial pathogens, including *Streptococcus pneumoniae* and *Staphylococcus aureus*. It also is common in elderly and immunocompromised patients at high risk for pneumonia caused by *Pseudomonas aeruginosa* and *Haemophilus influenzae*. Fever Fever, in addition to cough and fatigue, is the one of most common symptoms in patients with all types of pneumonia (75%). It does not help make the distinction between atypical pneumonia and other etiologies. Rigors, the shaking and cold feeling associated with spiking a fever, is a typical symptom found in patients with the most common pneumonia, *Streptococcus pneumoniae*. It can also be common in patients with *Klebsiella pneumoniae*.

30. For a pediatric patient, which history or physical examination finding is associated with an increased incidence of a simple spontaneous pneumothorax?

- A. Ehlers-Danlos syndrome
- B. Female gender
- C. Short stature
- D. Smoke exposure

Correct: Ehlers-Danlos syndrome

As for adults with a spontaneous pneumothorax, there is a male, not female, predominance in children. Boys are twice as likely as girls to develop spontaneous pneumothoraces. The reasons for this gender difference are unclear. Ehlers-Danlos syndrome Children with connective tissue disorders such as Ehlers-Danlos or Marfan syndrome are at an increased risk for developing spontaneous pneumothoraces. Other conditions that predispose children to pneumothoraces include chronic lung disease (eg, asthma or cystic fibrosis) and chronic inflammatory conditions such as juvenile idiopathic arthritis. Foreign body aspirations have also been associated with the development of a pneumothorax. A simple pneumothorax is defined as a pneumothorax that does not communicate with the atmosphere and does not cause a shift of the mediastinum or hemidiaphragm. A spontaneous pneumothorax is generally characterized as either primary (no clinically apparent lung disease) or secondary (with underlying lung disease). Children with pneumothoraces can be asymptomatic or may present with chest pain and dyspnea. Vital signs can be normal or may reveal tachycardia, tachypnea, and hypoxia. The diagnosis is often made using chest x-rays. Treatment options for pneumothoraces in children are the same as for adults: observation, supplemental oxygen, needle aspiration, pigtail catheter placement, or open tube thoracostomy. The treatment decision is guided by the size of the pneumothorax, underlying disease, and availability of appropriate follow-up care. Children with underlying lung disease or recurrent pneumothoraces may need to see a pediatric surgeon for video-assisted thoracoscopic surgery (VATS). Short stature A spontaneous pneumothorax tends to occur in persons who are taller than average in height, not shorter. It is thought that the shape of the thorax in taller persons contributes to the increased risk of a spontaneous pneumothorax. Smoke exposure Smoking, both tobacco and cannabis, is associated with an increased risk of a spontaneous pneumothorax. Secondhand smoke exposure, however, has not been associated with the development of a pneumothorax.

31. A 2-month-old girl is presented with a 3-day history of cough, nasal congestion, wheezing, and fever. Her vital signs include BP 78/50, P 132, and T 38.5°C (101.3°F); SpO₂ is 99% on room air. She is awake and well-appearing. Lung sounds reveal mild symmetric wheezing. Viral testing is positive for respiratory syncytial virus. What study is most likely to change the clinical

management?

- A. Chest x-ray
- B. Blood culture
- C. Urinalysis
- D. CBC with differential

Correct: Urinalysis

The risk for bacteremia is so low that blood culture is unnecessary. Chest x-ray X-rays are not routinely needed in the evaluation of bronchiolitis, much less in a child with a normal SpO₂ level who is in no distress. The risk of infiltrates seems to increase in patients with SpO₂ levels below 92%, but this concern should be weighed against the risks of unnecessary imaging. There is support in the literature that a child with respiratory syncytial virus and an infiltrate on x-ray has no difference in outcome when antibiotics are used. Urinalysis A 2-month-old with a UTI would be an indication for antibiotics; this would be a significant change in management because an infant with bronchiolitis does not receive antibiotics, but an infant with bronchiolitis as well as a UTI would get antibiotics. The American Academy of Pediatrics characterizes bronchiolitis as rhinitis, tachypnea, wheezing, cough, crackles, use of accessory muscles, or nasal flaring in a child younger than 24 months. This patient presents with a classic history of bronchiolitis but also has fever. Although the risk of bacteremia is low (<1%) in this age group (younger than 3 months), the continued risk of UTI warrants consideration. The studies indicate that there is an approximately 3% chance of a concomitant UTI in infants with respiratory syncytial virus bronchiolitis. The evaluation of a patient with bronchiolitis is based on a complete evaluation of medical history, specifically, any issue with gestational age or perinatal complications, immunodeficiency, or history of cardiac or lung disease. CBC with differential Blood work, including CBC with differential, is not advised in this clinical scenario.

32. What is the most common location for septic emboli from infective endocarditis?

- A. Extremities
- B. Brain
- C. Lungs
- D. Kidney

Correct: Brain

Approximately 44% of patients with infective endocarditis will suffer a major embolic event, and the highest percentage of these will be to the brain (26%). Although many patients with septic emboli to the brain will have clinical manifestations similar to an ischemic stroke, other patients will have clinically silent septic emboli, with up to 48% subclinical emboli found on MRI. Other complications from cerebral septic emboli can be intracerebral hemorrhage and abscess formation. Other areas of septic embolization include the spleen (which presents with splenic infarction) and the coronary arteries and mesentery (which will present with myocardial ischemia and mesenteric ischemia, respectively). Extremities Only approximately 2.2% of septic emboli will be to the peripheral extremities. These patients will present with acute limb ischemia, which can vary in severity. Some patients may experience transient ischemia that responds to antibiotics and anticoagulants, while others may require limb amputation. Lungs Lung involvement from septic emboli accounts for only 6.1% of all septic emboli. These septic pulmonary emboli can cause fever, dyspnea, pleuritic chest pain, cough, and hemoptysis. Unlike other septic emboli, pulmonary septic emboli occurs in right-heart infective endocarditis (ie, from the tricuspid valve). Kidney Septic emboli to the kidneys only account for 2.9% of all septic emboli. This can present with renal infarctions or hemorrhages, which can lead to renal failure.

33. A 72-year-old obese patient is diagnosed with a recurrent right femoral DVT. What is the most likely sequela of this patient's DVT?

- A. Arterial thromboembolism
- B. Intermittent claudication
- C. Post-thrombotic syndrome
- D. Phlegmasia cerulea dolens

Correct: Post-thrombotic syndrome

Intermittent claudication, which is defined as leg pain with local physical exertion that improves with rest, is a finding associated with chronic arterial insufficiency. Intermittent claudication should not occur due to venous obstruction, except in the unlikely event the venous obstruction is severe enough to obstruct arterial outflow. Intermittent claudication is the result of muscle ischemia from a perfusion-demand mismatch in the setting of muscle activation. Patients with PTS may have chronic local pain due to venous congestion, but this pain should not present with ischemic-like muscular pain. PTS, which occurs in up to 50% of DVTs, is the more likely result of inadequate DVT treatment. Arterial thromboembolism following untreated DVT is uncommon because it would require a right-to-left shunt (such as a patent foramen ovale) to allow the thromboembolism to travel from venous to arterial circulation. PTS, which occurs in up to 50% of DVTs, is the more likely result of inadequate DVT treatment. Post-thrombotic syndrome (PTS) is a common sequela of DVT, occurring in up to 50% of DVT cases. Risk factors for PTS include proximal DVT location, previous, recurrent, or persistent DVT in the same location, venous insufficiency, older age, obesity, and inadequate treatment. PTS is thought to be the result of local venous hypertension caused by residual obstruction and damage to venous valves by the DVT. It presents with a range of symptoms, including local swelling, pain, cramping, a feeling of "heaviness," paresthesias, and itch. The skin can appear thickened, hyperpigmented, edematous, indurated, and erythematous, with a dusky cyanotic coloring when dependent. Varicose veins may be present. The leg may be tender to palpation, in particular to calf squeeze. Chronic skin ulcers may form in more severe cases or following minor trauma. It is important to note that these symptoms can occur weeks to months after DVT. Emergency department management of PTS includes ruling out recurrent acute DVT, ensuring adherence to anticoagulation treatment if still prescribed (including checking INR if on warfarin), and screening for ulcerations to ensure proper wound care and to evaluate for infection. Symptoms of PTS can improve with leg elevation, weight loss, exercise, and use of elastic compression stockings. PTS is not treated with anticoagulation unless otherwise indicated for treatment of DVT. Phlegmasia cerulea dolens is an uncommon manifestation of proximal DVT that results in severe venous outflow obstruction. Generally, this occurs at the point of single venous outflow for a limb, such as the external iliac vein. Although an untreated proximal femoral vein DVT could propagate into the common femoral or external iliac veins (resulting in the risk of phlegmasia cerulea dolens), this is an uncommon occurrence and is much less likely than the development of PTS.

34. What is the most important protective mechanical ventilation strategy in ARDS?

- A. Low respiratory rate
- B. Low inspiratory/expiratory ratio
- C. Low tidal volume
- D. Low positive end-expiratory pressure

Correct: Low tidal volume

Low inspiratory/expiratory (I/E) ratio is incorrect; increased I/E ratio (>1) has been suggested as a treatment strategy in severe ARDS. An increased I/E ratio is thought to increase alveolar recruitment and intrinsic PEEP to improve

oxygenation while reducing volutrauma and barotrauma. Low respiratory rate Low respiratory rate is incorrect; respiratory rate should be set to maintain adequate minute ventilation. Given the low tidal volume (6 ml/kg predicted body weight) recommended in ARDS, an increased respiratory rate of 14 to 22 is typically indicated to maintain ventilation, but it should not exceed 35 breaths per minute. Low tidal volume One of the most important ventilation strategies when treating ARDS is low tidal-volume ventilation (LTVV). Lower tidal volumes during mechanical ventilation are thought to reduce barotrauma and overdistention of alveoli. Multiple studies have shown a mortality benefit in patients with ARDS when this protective ventilation strategy is implemented. Maintaining reduced peak plateau pressures (<30 cm H₂O), increasing positive end-expiratory pressure (PEEP) to maximize alveolar recruitment, and reducing FiO₂ are also key ventilation strategies in the treatment of ARDS. Low positive end-expiratory pressure Low PEEP is incorrect; increased PEEP is one of the strategies implemented in LTVV. PEEP is utilized to maintain alveolar recruitment to improve oxygenation. Increasing PEEP and FiO₂ are strategies outlined in the ARDS Network to increase oxygenation.

35. Which treatment for acute asthma in the emergency department reduces the relapse rate?

- A. Oxygen via nasal cannula
- B. Heliox
- C. Long-acting beta₂-adrenergic receptor agonists
- D. Oral corticosteroids

Correct: Oral corticosteroids

Heliox is a combined gas mixture (roughly 80% helium and 20% oxygen) used to lower effort in patients with critical bronchospasm due to the properties of the inert helium gas. There are no large studies that indicate whether this improves asthma outcomes, such as decreased relapse or intubation rates. Oxygen via nasal cannula There have been no studies of the use of just oxygen without other treatment modalities to show that oxygen itself can decrease rate of relapse in acute asthma. Use of oxygen via nasal cannula is recommended to keep SaO₂ greater than 90% in patients with severe asthma. Hypoxia has been shown to be a factor in death resulting from severe asthma, so oxygenation is important. Additionally, the studies show that use of oxygen with nebulized beta₂-adrenergic receptor agonists improves outcomes compared to the use of air for nebulization. Long-acting beta₂-adrenergic receptor agonists Long-acting beta₂-adrenergic receptor agonists are not effective for acute asthma symptoms and have a black box warning against their use for acute symptoms. These medications are intended to be used in conjunction with inhaled corticosteroids for long-term control of symptoms. Short-acting beta₂-adrenergic receptor agonists are the key to treatment of acute asthma in the emergency department. Providing repeated treatments by nebulizer or inhaler with a spacer has been shown to provide bronchodilation. Studies have shown that intravenous and subcutaneous short-acting beta₂-agonists (epinephrine and terbutaline) do not provide any improvement in outcomes compared to inhaled beta₂-adrenergic receptor agonists. Oral corticosteroids Several studies have demonstrated that the prompt use of corticosteroids in asthma patients in the emergency department can improve air flow, thus decreasing both relapse rate and hospital admission rate in both adults and children. The glucocorticoids decrease inflammation of the airways; the type of corticosteroid (short acting or long acting) and the mode (oral, inhaled, IM, IV) all seem to provide the positive response to treatment. Effects of corticosteroids can be seen as rapidly as 2 hours after administration, so administering them early in the emergency department course is important.

36. A 24-year-old woman presents via ambulance with headache, dizziness, and mild shortness of breath after a house fire. She has no burns on her skin and no soot in her mouth or nares, and she is not in respiratory distress. ABG analysis with co-oximetry reveals a carbon monoxide level of 30%. Her vital signs include BP 119/74, P 95, R 15, and T 36.9°C (98.4°F). Which additional

finding, if present, makes hyperbaric oxygen therapy the correct intervention?

- A. SpO₂ of 94% on room air
- B. Pregnancy
- C. Repeated nausea and vomiting
- D. History of asthma

Correct: Pregnancy

Pregnancy is considered an indication for hyperbaric oxygen (HBO) therapy after carbon monoxide (CO) exposure if the mother has signs of ischemic injury, neurologic deficits, or a carboxyhemoglobin (COHb) level greater than 15%. High levels of maternal COHb can lead to significant fetal hypoxia and death or permanent neurologic or developmental injury if the CO is not displaced by oxygen. Other indications for HBO therapy include COHb levels over 40% (some institutions go as low as levels >25%) and signs of tissue ischemia, such as altered mental status, neurologic deficits, myocardial ischemia, cardiac dysrhythmias, and syncope. CO poisoning is known to cause delayed neurologic deficits, which is the primary reason for considering HBO therapy for patients with elevated COHb levels. SpO₂ of 94% on room air A low SpO₂ level can be managed with supplemental oxygen and observation. A chest x-ray may be warranted to assess for other lung injury from smoke inhalation, but low SpO₂ alone is not an indicator for HBO therapy. Supplemental oxygen at 100% can reduce the half-life of COHb to 1 hour from the normal 5 hours at room air; HBO therapy decreases that half-life even further, to 30 minutes. Repeated nausea and vomiting Nausea and vomiting are common symptoms after smoke and CO exposure. However, HBO therapy or airway control is not indicated if the nausea and vomiting can be controlled or if they have resolved. History of asthma Underlying asthma does not increase the likelihood of delayed neurologic sequelae from CO exposure. Asthma can cause the patient to present with some bronchospasm from the inhaled irritant gas and smoke, but asthma is not an indication for HBO therapy.

37. A 22-year-old man presents with sudden-onset shortness of breath. A chest x-ray reveals a 10% right-sided pneumothorax. The patient has no history of underlying lung disease or trauma and does not smoke. His vital signs and SpO₂ are within normal limits. Without any intervention, approximately how long will it take for the pneumothorax to resolve on its own?

- A. 12 hours
- B. 24 hours
- C. 3 weeks
- D. 1 week

Correct: 1 week

At 24 hours, the expansion would have been only 1% to 2% of the total lung volume. 12 hours If a typical primary spontaneous pneumothorax reabsorbs at approximately 1% to 2% of the total lung volume per day, then an expansion of only 0.5% to 1% of the total lung would have occurred at 12 hours. 3 weeks If the pneumothorax reabsorbs at approximately 1% to 2% of the total lung volume per day, the right lung would have completely expanded much sooner than 3 weeks. 1 week The intrinsic reabsorption rate of intrapleural air is in the range of 1% to 2% of total lung volume per day. In this case, without any intervention, the patient would then reabsorb his 10% pneumothorax in 5 to 10 days, or approximately 1 week. Administration of 100% oxygen increases the resorption rate three- to fourfold. Supplemental oxygen lowers the alveolar partial pressure of nitrogen; as a result, the rate at which air diffuses across the pleural-alveolar barrier is accelerated. Because there was no precipitating event and this patient has no known underlying lung disease, the diagnosis in this case is a primary spontaneous pneumothorax. A pneumothorax is considered small if the distance from the apex to the cupola is less than 3 cm or the interpleural space from the hilum is less than 2 cm. An otherwise healthy patient with normal vital signs and minimal symptoms

can be safely managed conservatively and discharged home if prompt follow-up care can be arranged. Most physicians observe such patients for more than 3 hours and obtain a repeat chest x-ray before discharge to ensure that the pneumothorax has not increased in size. This management plan does not apply to patients with a secondary spontaneous pneumothorax (an unprovoked pneumothorax in patients with known underlying lung disease) because this type of pneumothorax rarely resolves without intervention. Patients also should be instructed to avoid air travel and underwater diving until the pneumothorax has completely resolved.

38. A 57-year-old woman with metastatic breast cancer presents with progressive chest heaviness and shortness of breath that worsens when she lies down. Her vital signs are BP 100/55, P 135, R 28, and T 37.0°C (98.6°F); SpO₂ is 82% on room air. A lung examination reveals decreased breath sounds on the right side with dullness to percussion in the lower two thirds. Chest x-ray confirms a large, right-sided pleural effusion. After supplemental oxygen, what is the most appropriate next therapy?

- A. Administer an intravenous fluid bolus and antibiotics
- B. Perform a right thoracentesis
- C. Administer nitroglycerin and furosemide
- D. Administer subcutaneous enoxaparin

Correct: Perform a right thoracentesis

This patient's presentation and history of metastatic breast cancer, which can spread to the pleura, suggest a massive pleural effusion, which is confirmed on chest x-ray. Given the hypoxia, the appropriate course of action is to administer oxygen, identify the presence of fluid with ultrasound, and consider thoracentesis drainage. Fluid collection in the pleural space limits the lungs' ability to expand during inspiration, which can result in tachypnea, tachycardia, and hypoxemia. In most patients, thoracentesis can be deferred from the emergency department because emergent drainage is unnecessary. However, in cases of massive effusion (around 1.5-2 L), an urgent thoracentesis is warranted because of acute hypoxia. Administer an intravenous fluid bolus and antibiotics If the likely diagnosis were pneumonia, fluids and antibiotics would be appropriate initial therapies. Pneumonia typically presents with gradual-onset fever and cough in addition to hypoxemia. Chest x-rays should demonstrate infiltrates in the involved lobes. In this case, however, the history and physical examination make pneumonia less likely than a pleural effusion. Administer nitroglycerin and furosemide Oxygen, nitroglycerin, and furosemide are indicated for the treatment of congestive heart failure (CHF), which can present with hypoxia, tachypnea, and orthopnea. Patients with CHF can also have small pleural effusions, but these are typically bilateral. An asymmetric finding of a large effusion is much less likely in acute CHF. Administer subcutaneous enoxaparin Patients with cancer have an increased risk of pulmonary embolism (PE), and subcutaneous enoxaparin is an appropriate treatment option for that condition. However, patients with PE typically have sudden worsening of breathing, pleuritic chest pain, and clear lungs on examination. In many cases, PE can be diagnosed with a chest CT scan or a ventilation-perfusion scan. It would be inappropriate to administer anticoagulants without a diagnosis of PE in the setting of an alternative diagnosis, as in this case. In this patient, the large pleural effusion is more likely contributing to acute hypoxia.

39. In a patient who presents with presumed *Pneumocystis jirovecii* pneumonia, what is an indication for steroid administration?

- A. Elevated lactate dehydrogenase level
- B. PaO₂ less than 70 mm Hg

- C. A-a O₂ gradient greater than 10 mm Hg
- D. CD4 count less than 200 cells/mm³

Correct: PaO₂ less than 70 mm Hg

Pneumocystis jirovecii pneumonia (PCP) (formerly known as Pneumocystis carinii pneumonia) is a fungal disease that affects immunosuppressed patients and is the most common opportunistic infection in patients with HIV. While trimethoprim-sulfamethoxazole is the mainstay of treatment, steroids should be given for moderate to severe disease, defined as a partial pressure of oxygen (PaO₂) less than 70 mm Hg or an alveolar-arterial (A-a) O₂ gradient greater than 35 mm Hg on room air. PCP typically presents with dyspnea, fever, and a dry cough. With the progression of PCP, hypoxia worsens, and more than 90% of patients have a widened A-a O₂ gradient. Within 2 to 3 days of initiating treatment for PCP, respiratory status can worsen as a result of increased lung inflammation caused by Pneumocystis particles. Steroids given in conjunction with antimicrobial therapy can blunt the inflammatory process, decrease the mortality associated with PCP, and decrease the need for mechanical ventilation. Elevated lactate dehydrogenase level Serum LDH levels are elevated in more than 90% of patients with PCP and can aid in the diagnosis of PCP, but they are not an indication for steroid initiation. LDH levels typically decrease with recovery; a rising LDH level despite treatment is associated with a poor prognosis. A-a O₂ gradient greater than 10 mm Hg An A-a O₂ gradient greater than 10 mm Hg in a patient with PCP is not an indication for steroids. However, an A-a O₂ gradient greater than 35 mm Hg indicates moderate to severe PCP, which is an indication for steroids. CD4 count less than 200 cells/mm³ PCP is an AIDS-defining illness that typically occurs in patients with low CD4 counts who are not receiving antiretroviral therapy or prophylaxis. However, a CD4 count less than 200 cells/mm³ alone is not an indication for steroids.

40. A 58-year-old woman with a history of mitral valve prolapse presents with fever and fatigue. On examination, she is febrile and confused with a systolic ejection murmur. A CT head is performed and representative images are pictured. Which test will most likely identify the source of her problem?





- A. CT angiogram chest, abdomen, and pelvis
- B. Blood cultures
- C. MRI brain
- D. Echocardiogram

Correct: Echocardiogram

This patient most likely has septic emboli from infective endocarditis. Blood cultures will help identify bacteremia and the culprit bacteria; three sets should be obtained. Although positive blood cultures will prove the patient has bacteremia, they will not identify the source of the bacteremia. An echocardiogram is necessary to make the definitive diagnosis of infective endocarditis and to identify the source of the bacteremia. CT angiogram chest, abdomen, and pelvis Although CT imaging is useful for identifying other septic emboli, it will not identify the source of the septic emboli seen in this patient, which is infective endocarditis. Infective endocarditis requires an echocardiogram to visualize valvular vegetations. CT angiograms can be used to identify mycotic aneurysms which are caused by seeding of a septic emboli into the vessel wall. These are prone to rupture. MRI brain In this case, the CT demonstrates multiple septic emboli. An MRI is more sensitive than a CT and may uncover other “silent” septic

emboli, but it would not help identify the source of these septic emboli. This patient's septic emboli is from infective endocarditis, which is best identified by echocardiogram. Echocardiogram This patient is probably suffering from septic emboli to the brain, most likely from infective endocarditis. These emboli have caused hemorrhagic conversion of her infarcts. The cerebral vasculature is the most common site of septic embolization from infective endocarditis, and the mitral valve is the most common source of septic emboli from infective endocarditis. To diagnose infective endocarditis, an echocardiogram is necessary to evaluate for valvular vegetations. The workup can begin with transthoracic echocardiogram, although it has lower sensitivity than transesophageal echocardiogram. In cases with high index of suspicion, transesophageal echocardiogram should be pursued if the transthoracic echocardiogram is nondiagnostic.

41. What is the most common cause of death in patients diagnosed with ARDS?

- A. Refractory hypoxic respiratory failure
- B. Hemorrhagic shock
- C. Cardiovascular failure
- D. Sepsis and multiorgan dysfunction

Correct: Sepsis and multiorgan dysfunction

Hemorrhage is a rare cause of death in patients diagnosed with ARDS. It accounts for approximately 2% to 5% of deaths in patients diagnosed with ARDS. Trauma-related ARDS has a significantly lower mortality rate when compared to non-trauma-related ARDS. Refractory hypoxic respiratory failure Refractory hypoxic respiratory failure is a rare cause of death in patients diagnosed with ARDS. It accounts for approximately 10% to 20% of deaths from ARDS, with multiorgan dysfunction causing around 50% to 70% of deaths. Cardiovascular failure Cardiovascular failure is a rare cause of death from ARDS, accounting for only 5% to 10% of deaths. Although many patients with ARDS show evidence of cardiovascular failure late in their course, it is often accompanied with multiorgan failure, with increasing numbers of organ failures relating to increasing mortality. Sepsis and multiorgan dysfunction ARDS has an overall in-hospital mortality rate of around 40%. The highest cause of death in patients diagnosed with ARDS is sepsis with multiorgan failure; death is rarely caused by respiratory failure alone. Studies have shown decreasing mortality over time, likely related to improved supportive care and mechanical ventilation strategies. Underlying factors — including patient age, comorbidities, and the underlying etiology of ARDS — are predictors of mortality. Infection and multiorgan dysfunction are better predictors of mortality compared to respiratory parameters, indicating that treatment and recognition of underlying etiology of ARDS is a key component in its treatment.

42. What is the most common presenting symptom in pulmonary embolism?

- A. Dyspnea
- B. Hypotension
- C. Chest pain
- D. Hypoxia

Correct: Dyspnea

Hypotension is a physical examination finding, not a symptom. It is not likely to occur except in patients with very large hemodynamically compromising pulmonary emboli. Dyspnea Although patients with pulmonary embolism (PE) can present in many ways, the most common uniting feature is dyspnea. Dyspnea is present in more than 90%

of patients with PE without infarction. Some patients present with dyspnea while at rest, but most have exertional dyspnea, both of which are due to irregular pulmonary blood flow from the occluded vessel. Pleuritic chest pain is a common presenting symptom as well but not as common as dyspnea. The Pulmonary Embolism Ruleout Criteria (the PERC rule) are used to exclude the diagnosis of PE and avoid additional testing. These criteria rule out any patient with an SpO₂ level above 94% on room air. Chest pain is more likely with distal pulmonary emboli and is the second most common PE symptom, after dyspnea. Hypoxia can occur, but it is not considered the most common finding. It is a sign, not a symptom.

43. Which factor predicts the highest risk for sudden death in an adult asthma patient?

- A. Self-reported symptom severity
- B. Inhaled corticosteroid use
- C. History of smoking
- D. Increased use of beta agonists

Correct: Increased use of beta agonists

The use of inhaled corticosteroids has been shown to control patients' asthma symptoms. One study revealed that the use of an average of one or more canisters of inhaled corticosteroids over the prior 3 months decreased the incidence of fatal asthma. Another showed that premature cessation of inhaled corticosteroids increased the risk of fatal asthma. Self-reported symptom severity Patients' reports of the severity of their asthma are highly unreliable. Those who report severe asthma are not more likely to die from asthma, and those who do not accurately perceive the severity of their disease are more likely to die from asthma. History of smoking In several studies, smoking was not found to have increased the risk of death in fatal asthma, possibly because the patients were more likely to have the diagnosis of COPD as a cause of death than asthma. One small study in 1996 reported a risk in adult male athletes who were smokers, but this has not been found in more recent studies with larger cohorts. Increased use of beta agonists Numerous factors forecast an increased risk of sudden death due to asthma. One of the most-studied risk factors is increased use of beta agonists via metered-dose inhaler or nebulizer. The increase is likely secondary to delayed formal evaluation of asthma exacerbation in patients using beta-agonists. Researchers recently have found that frequent use of short-acting beta-agonists results in tolerance to the medication as well as increased lung reactivity to stimuli. Poor self-perception or physician perception of a patient's asthma and a lack of having or following a formal care plan are also risk factors for asthma-related death. Use of illicit drugs, including heroin and cocaine, has been found to increase the risk for hospitalization, intubation, and fatal asthma. More severe asthma (as indicated by current or recent use of steroids, hospitalization, and intubation within the past year) is also a risk factor for asthma-related death. Finally, recent studies indicate that sensitization to mold is a risk factor for increased asthma severity and death. It is important for emergency physicians to ask patients about these risk factors to educate them and improve treatment plans when needed.

44. A 24-year-old patient at 34 weeks' gestation presents with shortness of breath, unilateral leg swelling, and chest pain. Their vital signs are BP 120/80, P 95, R 16, and T 37°C (98.6°F); SpO₂ is 95% on room air. What would be the best treatment?

- A. Low-molecular-weight heparin
- B. Warfarin
- C. Alteplase
- D. Unfractionated heparin

Correct: Low-molecular-weight heparin

Warfarin is a vitamin K antagonist and is pregnancy category D. Warfarin crosses the placenta and has been linked with congenital malformation, microcephaly, and hydrocephalus. Although warfarin should be avoided in pregnancy, it is safe to use while breastfeeding. Low-molecular-weight heparin This patient has an acute pulmonary embolism. Low-molecular-weight heparin (LMWH) such as enoxaparin is an indirect thrombin inhibitor and is the preferred treatment for venous thromboembolism during pregnancy. LMWH is pregnancy category B, does not cross the placenta, and is safe for the fetus. Although LMWH has been shown to have better efficacy than unfractionated heparin, unfractionated heparin is preferred in patients with renal failure or need for acute surgery. Alteplase Alteplase is a thrombolytic agent used to treat life-threatening massive PE. Although there have been no reports of teratogenicity and alteplase is pregnancy category C, alteplase does have a higher risk of maternal bleeding. This patient does not have evidence of a massive or submassive PE, so thrombolysis is not indicated. Unfractionated heparin Unfractionated heparin is pregnancy category C. It is safe for the fetus and does not cross the placenta; however, it is considered a second-line treatment to LMWH in most cases, given the risk of heparin-induced thrombocytopenia. In patients with renal failure, hypotension, or need for acute surgical intervention, unfractionated heparin may be the preferred anticoagulation method due to its shorter half-life and its reversibility with protamine.

45. For children with stridor, which finding can differentiate croup from bacterial tracheitis?

- A. Hot potato voice
- B. Abnormal chest x-ray
- C. Rhinorrhea prodrome
- D. Productive cough

Correct: Productive cough

Imaging is unnecessary for the diagnosis of either croup or bacterial tracheitis. Furthermore, chest x-rays are expected to be normal because both conditions are upper airway disorders that do not involve the lungs. In croup, a neck x-ray may show the classic “steeple sign” indicating subglottic narrowing, but the presence or absence of this alone does not confirm or eliminate the diagnosis. In bacterial tracheitis, a neck x-ray may show nonspecific tracheal irregularities. Bronchoscopy is used for diagnosis instead. Hot potato voice Hot potato voice is a classic finding of epiglottitis, where there is swelling of the epiglottis and surrounding airway structures. This swelling causes a characteristic muffled voice. Voice change in croup and bacterial tracheitis is typically hoarseness. Drooling is also typically seen in epiglottitis. Rhinorrhea prodrome Rhinorrhea and other URI symptoms are known to be precursors of both croup and bacterial tracheitis. This is often also accompanied by congestion and a cough, which then progresses to croup or bacterial tracheitis. Productive cough Croup, or viral laryngotracheitis, is a condition affecting children between 6 months and 3 years of age that is usually mild without an associated productive cough. These children typically present after a URI that progresses to a barking cough, fever, and stridor. The associated cough is not typically productive. The severity of croup can vary depending on the amount of airway edema and inflammation present. Thus, treatments are targeted at decreasing these signs. Important factors contributing to worsening severity include tachypnea, oxygen desaturations, stridor at rest, cyanosis, retractions, and altered mental status. Croup is typically treated with nebulized epinephrine and steroids. Bacterial tracheitis is a bacterial infection that is often preceded by a viral infection, such as croup. Typical organisms are *Staphylococcus aureus* or polymicrobial. These patients appear much sicker than children with croup, with a rapid decline exhibiting respiratory distress, fevers, and productive cough with thick secretions. Patients with bacterial tracheitis have been known to have copious purulent secretions in the trachea causing potential airway obstruction. The diagnosis is confirmed with bronchoscopy, and most patients require intubation.

46. A nonimmunized 7-year-old patient presents with sudden-onset stridor, dysphagia, high fever, and drooling. What is the most likely diagnosis?

- A. Croup
- B. Epiglottitis
- C. Retropharyngeal abscess
- D. Bacterial tracheitis

Correct: Epiglottitis

Acute epiglottitis typically presents with acute-onset sore throat, high fever, stridor, dysphagia, drooling, and tender manipulation of the hypoid. Classically, epiglottitis was considered a pediatric illness, but acute epiglottitis is now more prevalent in adults (mean age 46) since the introduction of routine childhood *Haemophilus influenzae* vaccination. Despite immunization, patients may still develop acute epiglottitis, most likely caused by gram-positive organisms. Because adult airways are larger, they may better tolerate epiglottitis with less dramatic findings, but rapid airway evaluation and intervention remain essential for any concern for imminent complete airway obstruction by the swollen epiglottis. For stable patients, lateral neck x-rays during inspiration and with the neck in extension may identify the classic “thumb sign” of an edematous epiglottis ballooning hypopharynx with loss of the vallecular space. Air flow may be promoted by humidified oxygen, racemic nebulized epinephrine, or heliox. Prompt antibiotic coverage with intravenous cefuroxime — ceftriaxone, cefotaxime or ampicillin-sulbactam can be used alternatively — will treat the causative organisms, but intubation to avert complete airway obstruction is essential and should not be delayed if there is an immediate concern. To limit further epiglottic edema leading to this complication, intubation should be performed by the most experienced intubator in order to minimize provocative manipulation. Using an endotracheal tube one size smaller than usual may aid passage and may also help prevent postextubation stridor. Needle jet ventilation may temporize an obstructed airway in children younger than 8; cricothyrotomy is indicated for older patients. Circumstances allowing airway intervention may optimally be performed in an operating room with a double setup for both laryngoscopic and surgical airway procedures. Croup Croup is the most common cause of pediatric stridor with inflammation and edema in the subglottic area. However, croup often presents in pediatric patients aged 6 months to 3 years with a 1 to 5 day prodrome of cough, runny nose, and the classic barking or seal-like cough. X-rays are unnecessary but may show a steeple sign. Management includes dexamethasone 0.6 mg/kg PO or IM, racemic nebulized epinephrine, and consideration of heliox and intubation, if indicated.

Retropharyngeal abscess Retropharyngeal abscess is rare but occurs most commonly in pediatric patients aged 6 months to 4 years old. Patients present toxic, drooling, febrile, and with inspiratory stridor. On examination, a pharyngeal mass may be noted; use caution with palpation because rupture of the pocket can cause rapid and fatal airway obstruction. Early airway management with otolaryngologist consultation is the priority, and broad-spectrum antibiotics with ampicillin-sulbactam (or a third-generation cephalosporin if allergic) or clindamycin should be started. Bacterial tracheitis Bacterial tracheitis is a superimposed bacterial infection on a preceding viral URI (often croup) that is most commonly seen in patients younger than 3 years of age. Bacterial tracheitis is less likely than epiglottitis in this 7-year-old patient. Bacterial tracheitis’ presentation is more consistent with respiratory distress than croup and is similar to epiglottitis, including stridor, possible sputum, and hoarse voice but not dysphagia. The majority of bacterial tracheitis patients require intubation, ideally in the operating room. Vancomycin with a third-generation cephalosporin should be started promptly after cultures are obtained.

47. What is required for the diagnosis of ARDS?

- A. Bilateral pulmonary opacifications not due to heart failure
- B. Progressive symptoms over 1 to 2 weeks
- C. High ventilation/perfusion (V/Q) ratio
- D. PaO₂/FiO₂ greater than 300 mm Hg

Correct: Bilateral pulmonary opacifications not due to heart failure

Progressive respiratory symptoms over 1 to 2 weeks is incorrect; ARDS is an acute process that is defined by presentation of worsening respiratory symptoms acutely over a period of less than 7 days from the insult. This presentation is outlined in the Berlin Definition, which is the standard definition for ARDS. Bilateral pulmonary opacifications not due to heart failure Bilateral pulmonary opacifications on chest imaging that are not due to heart failure is one component of the Berlin Definition, which is the current standard for defining ARDS. The Berlin Definition requires that all of the following must be met: the patient must have an acute process, with respiratory symptoms beginning within 1 week of insult; a PaO₂/FiO₂ ratio <300 mm Hg on positive end-expiratory pressure (PEEP) ≥5 cm H₂O; bilateral pulmonary opacifications on chest imaging that are not explained by lung collapse or nodules; and respiratory failure that is not explained by heart failure or volume overload. A key clinical aspect of defining ARDS is ruling out cardiac etiology for lung infiltrates, which can be done by physical examination, lab markers, or echocardiogram. High ventilation/perfusion (V/Q) ratio High ventilation/perfusion (V/Q) ratio is incorrect because ARDS causes a low V/Q ratio due to the damage to lung parenchyma and the decreased ventilation and oxygenation of lung tissue. This leads to shunting within the lung tissue, increasing hypoxia. Pulmonary embolism is a disease that causes a high V/Q ratio. PaO₂/FiO₂ greater than 300 mm Hg PaO₂/FiO₂ >300 mm Hg is incorrect because ARDS is defined by a PaO₂/FiO₂ ratio <300 mm Hg on PEEP ≥5 cm H₂O. ARDS is further defined by mild ARDS (PaO₂/FiO₂ ratio <300 mm Hg), moderate ARDS (PaO₂/FiO₂ ratio <200 mm Hg), and severe ARDS (PaO₂/FiO₂ ratio <100 mm Hg). Mortality increases with the severity of ARDS based on PaO₂/FiO₂ ratio.

48. A 64-year-old woman presents with a 4-day history of pleuritic chest pain and shortness of breath. She is currently undergoing chemotherapy for lung cancer. Her vital signs are BP 110/70, P 115, R 26, and T 36.6°C (97.9°F); SpO₂ is 94% on room air. She appears to be in moderate distress from respiratory compromise. Her right leg is edematous with calf tenderness. Chest x-ray demonstrates only the lung mass, which is unchanged compared to those in her records. What is an appropriate management strategy?

- A. Administer a fibrinolytic agent if CT angiography is positive for PE
- B. Infuse unfractionated heparin while waiting for results of CT angiography
- C. Refer the patient for surgical embolectomy if CT angiography is positive for PE
- D. Order a D-dimer, and if it is positive, order CT angiography to evaluate for PE

Correct: Infuse unfractionated heparin while waiting for results of CT angiography

This patient's symptoms of pleuritic chest pain and shortness of breath raise concern for pulmonary embolism (PE). Applying the Wells criteria puts her in the high-risk category for PE — alternative diagnosis less likely than PE, 3 points; heart rate over 100, 1.5 points; suspected DVT, 3 points; and active malignancy, 1 point; for a total of 8.5. Given this high pretest probability for PE, initiating empiric treatment with heparin while waiting for confirmation of the diagnosis is a reasonable approach. She has no major contraindications to anticoagulation, and the delay for CT angiography can be several hours in a busy emergency department. Studies have shown that unfractionated heparin and low-molecular-weight heparin have the same efficacy. Low-molecular-weight heparin has fewer bleeding complications but should not be used in patients with renal insufficiency or those at the extremes of weight. The Wells criteria are as follows: Suspected deep vein thrombosis = 3 points Alternative diagnosis less likely than PE = 3 points Heart rate higher than 100 bpm = 1.5 point Prior venous thromboembolism = 1.5 points Immobilization within prior 4 weeks = 1.5 point Active malignancy = 1 point Hemoptysis = 1 point A score greater than 6 is high risk for PE, a score of 2 to 6 reflects moderate risk, and a score less than 2 is low risk. Administer a fibrinolytic agent if CT angiography is positive for PE Fibrinolytic agents are indicated for hemodynamically unstable patients or patients with a large clot burden, but this patient is normotensive and not hypoxic. Fibrinolysis is potentially indicated in hemodynamically unstable patients with known PE. If PE is suspected but not yet diagnosed,

there is insufficient data to support the empiric use of fibrinolytic agents. Refer the patient for surgical embolectomy if CT angiography is positive for PE. Surgical embolectomy is indicated for patients with severe refractory hypotension or with very large clot burden, which this patient does not have. Order a D-dimer, and if it is positive, order CT angiography to evaluate for PE. This patient has a high pretest probability for PE, and the D-dimer is not useful in ruling out PE in this situation. A D-dimer can be used to rule out PE in patients with a low pretest probability for PE. In patients who have had symptoms longer than 3 days, the sensitivity of the D-dimer can decrease because the half-life is less than 8 hours.

49. A vaccinated 4-month-old boy is presented for evaluation of "cold symptoms" that he has had for 2 days. His vital signs are BP 72/56, P 113, R 65, and T 37.3°C (99.1°F); SpO₂ is 94% on room air. An examination of the chest reveals transmitted upper airway noises with a few end-expiratory wheezes, but the rest of the examination and history is unremarkable. His parents report that he is eating normally. What is the best next step in management?

- A. Start oral antibiotics in the emergency department
- B. Discharge with instructions for nasal suctioning and supportive care
- C. Order a CBC and absolute neutrophil count
- D. Admit him to the hospital for monitoring and reassessment

Correct: Discharge with instructions for nasal suctioning and supportive care

This patient appears to have bronchiolitis, and the most likely underlying cause is respiratory syncytial virus (RSV), which can be confirmed with point-of-care testing. Appropriate treatment is supportive; he has no fever, and his vital signs are normal for his age given his present illness. Since he is eating normally, he is likely able to maintain hydration. Children younger than 6 months are obligate nose breathers and have issues with feeding and sleeping when their nasal passages are obstructed. Therefore, the best approach in this case is to teach the father how to perform nasal suctioning and tell him to do it before the baby eats or sleeps to help maintain homeostasis. Supportive care is the key to treatment of the bronchiolitic child. The only other issue to address with the father is apnea. As this child is 4 months old, the likelihood of central apnea is low; this is more common in a neonate 4 weeks old or younger due to the immaturity of the respiratory center. It is important to ask about apnea in any child who appears to have RSV. Start oral antibiotics in the emergency department. Antibiotics are unwarranted. If the child were febrile, then other infections should be considered, specifically UTI. If he were younger than 1 month, evaluation for significant bacterial infections should be strongly considered. Order a CBC and absolute neutrophil count. Blood work is not warranted in this case because the patient is afebrile, has otherwise normal vital signs, and can maintain hydration. There is likely little relevant information to be gleaned from blood testing. Admit him to the hospital for monitoring and reassessment. Admission is unwarranted in this case. The patient has no fever, his vital signs are normal, and he is able to maintain hydration. Admission consideration is only warranted if he has a history of apnea.

50. What is the best initial imaging test for evaluating suspected pulmonary hypertension?

- A. High-resolution chest CT
- B. Transthoracic echocardiography
- C. Pulmonary angiography
- D. Chest x-ray

Correct: Transthoracic echocardiography

Patients with suspected pulmonary hypertension should have a transthoracic echocardiogram (TTE) performed. TTE can evaluate multiple aspects of ventricular and valvular function that estimate pulmonary artery pressure and demonstrate associated right heart findings, such as hypertrophy or strain. Similarly, TTE can evaluate for left ventricular dysfunction, which is the most common cause of pulmonary hypertension. Pulmonary hypertension is caused from high pulmonary vascular resistance that leads to increased pulmonary artery pressures. Patients with pulmonary hypertension most commonly present with dyspnea, chest pain, and fatigue; additional symptoms are dependent on the underlying cause of the pulmonary hypertension. Symptoms of presyncope or syncope could indicate more severe disease, so the suspicion of pulmonary hypertension should prompt further workup with a TTE. High-resolution chest CT High-resolution chest CT is generally not performed in the emergency department or as an inpatient, but it is used as an outpatient study for situations requiring detailed lung evaluation, such as interstitial lung disease or evaluation of pulmonary nodules. In the setting of pulmonary hypertension, a high-resolution chest CT scan would likely reveal similar findings to chest x-ray. Pulmonary angiography Pulmonary angiography, which is generally performed by CT angiography (CTPA) in the modern era, can reveal findings suggestive of pulmonary hypertension, such as enlargement of the pulmonary arteries and right ventricular enlargement. CTPA can also be used to evaluate underlying causes, such as pulmonary embolism. However, CTPA is an overall more limited study compared with TTE and is generally used in an adjunctive capacity; it can be used as a primary evaluation tool for patients with poor TTE visualization, but it yields comparatively less diagnostic and functional information. Thus, TTE is a better initial test for the evaluation of pulmonary hypertension specifically. Chest x-ray A chest x-ray should be obtained to evaluate dyspnea, but its value for pulmonary hypertension is limited. At most, a chest x-ray will show pulmonary artery enlargement and right-sided cardiac border changes associated with right atrial and ventricular enlargement. TTE is the preferred initial imaging test for evaluation of pulmonary hypertension.

51. A toddler presents after a witnessed ingestion of charcoal lighter fluid. The toddler is agitated and crying with tachycardia and tachypnea. What is the most important first diagnostic test?

- A. Electrocardiogram
- B. Chest x-ray
- C. Complete metabolic panel
- D. Venous blood gas

Correct: Chest x-ray

This patient has ingested a liquid hydrocarbon, the most likely complication of which is pulmonary toxicity. Pulmonary toxicity can manifest anywhere along the spectrum from mild pneumonitis to severe ARDS. A chest x-ray should be obtained immediately in any patient who demonstrates signs or symptoms of pulmonary toxicity, such as coughing, wheezing, gasping, grunting, or retractions. Hypoxia, tachycardia, and tachypnea are other concerning clinical indicators. Charcoal lighter fluid may contain naphtha, butane, propane, and other predominantly aliphatic hydrocarbons. Ingested hydrocarbons produce pulmonary toxicity by secondary aspiration events. Several qualities of an ingested hydrocarbon increase the likelihood of pulmonary toxicity: low viscosity (ie, flows easily), highly volatile substances with low surface tension (Van der Waals forces) tend to produce worse injury. Injury is thought to result from both direct toxicity to lung tissue and from disruption of surfactant. Treatment is supportive, with supplemental oxygen and invasive or noninvasive positive-pressure ventilation. Inhaled beta agonists could be considered, particularly in patients who demonstrate wheezing. However, the evidence does not support the use of prophylactic antibiotics or steroids. Patients are expected to develop fevers and leukocytosis early after these events, which are manifestations of a generalized inflammatory state. Additionally, any patients with a hydrocarbon exposure to skin or clothing should be decontaminated. Severely ill patients may be candidates for extracorporeal membrane oxygenation (ECMO). Electrocardiogram Some hydrocarbons (aromatic and halogenated) are likely to produce cardiac toxicity resulting in arrhythmias. Charcoal lighter fluid contains mostly aliphatic hydrocarbons, and cardiac toxicity is less likely following this exposure. Thus, an ECG is not the most important initial step in

evaluation. Complete metabolic panel A complete metabolic panel (CMP) may be obtained in the routine workup of patients presenting with an ingestion and respiratory distress. However, there is no specific metabolic disturbance that would be expected from this patient's ingestion. Thus, a CMP does not need to be prioritized in the patient's workup. Venous blood gas This patient is more likely to experience hypoxic rather than hypercarbic respiratory failure, so an ABG would be of more utility than a venous blood gas. Pulse oximetry would be a good first step in evaluating this patient's oxygenation, and a chest x-ray should be obtained once initial stabilization has been performed.

52. A 59-year-old man presents with progressive shortness of breath, dyspnea on exertion, weight loss, and cough over the past several months. He worked in a stone quarry for 15 years. Chest x-ray shows multiple 1 to 3 mm rounded upper lobe opacities. What is the next best step in management?

- A. Outpatient referral to pulmonology
- B. Admission for malignancy workup
- C. Corticosteroid burst and discharge
- D. Azithromycin prescription

Correct: Outpatient referral to pulmonology

Silicosis is linked to several kinds of cancer, including lung, esophageal, and stomach. This patient may ultimately require evaluation for malignancy. However, there are no clinical or social indicators given that suggest the patient requires this workup on an emergent or inpatient basis. Outpatient referral to pulmonology This patient has an occupational exposure to silica, and his symptoms and chest x-ray findings are consistent with chronic silicosis. His emergency department evaluation is reassuring, so the next best step in his management is outpatient referral to pulmonology for pulmonary function testing. Silicosis typically results after long-term (>10 years) exposure to silica dusts via occupational exposures, such as hard rock mining, sandblasting, foundry work, and stone cutting. Inhalation of silica dusts results in free radical formation, injury to pulmonary cells (eg, alveolar macrophages), and an inflammatory cascade that ultimately produces pulmonary fibrosis. Patients with silicosis will present with chronic cough, which may be productive, and dyspnea on exertion. Pulmonary function testing may show decreased compliance, FEV1, FEV1/FVC, and DLCO. Lung biopsy is not required for the diagnosis and is expected to show fibrotic changes. Patients with silicosis are at increased risk of developing pulmonary tuberculosis for unknown reasons. Removal from exposure and smoking cessation will help prevent disease progression. Treatments may include supplemental oxygen, vaccination against influenza and pneumococcus, bronchodilators, corticosteroids, and, rarely, lung transplantation. Notably, there may be an association between silicosis and pulmonary malignancy for which this patient may need further evaluation, especially given his history of weight loss. Less often, silicosis may occur in an accelerated form after short periods of very high exposure to silica-containing dusts. The World Trade Center (WTC) collapse produced a dense cloud of dust and debris containing heavy metals, silica, asbestos, and wood fibers. Some WTC responders, many of whom worked for months recovering remains and clearing debris, have gone on to develop pulmonary fibrosis that could be related to silica exposure. Corticosteroid burst and discharge The evidence in support of using corticosteroid therapy to treat silicosis is limited, so this should not be first-line therapy. Additionally, the patient requires follow-up with pulmonology for pulmonary function testing and definitive diagnosis. Azithromycin prescription Azithromycin may be used to treat pneumonia. However, this patient's presentation is inconsistent with acute bacterial pneumonia. His chronic persistent symptoms are more consistent with malignancy, pneumoconiosis, or tuberculosis.

53. What is the most common ECG finding in acute pulmonary embolism?

- A. Sinus tachycardia
- B. Normal ECG
- C. Left bundle branch block
- D. S1Q3T3 pattern

Correct: Sinus tachycardia

A normal ECG can be found in approximately 10% to 20% of patients presenting with PE. However it is much more common to have some ECG abnormality in the setting of acute PE, such as the most common finding of sinus tachycardia. Sinus tachycardia ECG is an important diagnostic tool in the workup of pulmonary embolism (PE). The most common ECG finding in PE is sinus tachycardia. In severe cases, the ECG may also have the classic S1Q3T3 pattern, T wave inversions in the anterior leads, or a right bundle branch block. These additional findings suggest acute cor pulmonale. Although an ECG is not sensitive for the diagnosis of PE, it can provide information about alternative diagnosis and prognosis. Evidence of right heart strain on an ECG doubles the probability of PE in a symptomatic patient. Left bundle branch block Left bundle branch block is not associated with PE. Instead, signs of acute right heart strain such as incomplete or complete right bundle branch block (RBBB) are much more common. RBBB can be used to aid in the prognosis of PE, with ECG signs of right heart strain indicating worse outcomes. S1Q3T3 pattern An S1Q3T3 (S wave in lead I, Q wave in lead III, and inverted T wave in lead III) is a “classic” pattern taught to be associated with PE. It was first described in 1935 and is associated with cor pulmonale. Although an S1Q3T3 pattern is a sign of right heart strain and found in PE, studies have shown a prevalence of 10% to 50%, making it less common than T wave changes or sinus tachycardia.

54. An unvaccinated 5-year-old boy presents in acute respiratory distress. Earlier in the day, he complained of a sore throat. On arrival, he is sitting in the tripod position, has stridor, and is drooling and febrile. He is currently maintaining his airway. What is the next best step?

- A. Perform cricothyrotomy
- B. Consult anesthesiology and ENT
- C. Obtain anteroposterior soft tissue neck x-ray
- D. Obtain CT scan of the neck

Correct: Consult anesthesiology and ENT

Epiglottitis often presents with fever and sore throat followed rapidly by signs of respiratory distress. Patients with impending airway compromise should be kept in a position that does not agitate them while rapid ENT and anesthesia consultations are arranged. Children younger than 5 often present with stridor and drooling. They are generally uncomfortable lying down, preferring to sit in the tripod or sniffing position. Thanks to vaccination for Haemophilus influenzae, epiglottitis is rarely seen, but it is most common in children 2 to 8 years of age. If epiglottitis is suspected, any actions that may agitate the patient should be avoided. Oxygen may be given along with nebulized epinephrine if it does not agitate the child. CT scan is not indicated, as the patient may be unable to lie flat, but portable lateral soft tissue x-ray of the neck may be considered. Definitive airway management should be performed in patients who are at high risk of airway deterioration. If the patient is not maintaining their airway, the most experienced physician should make a single attempt at endotracheal intubation while another individual prepares equipment for a cricothyrotomy. If the patient is maintaining their airway and personnel are available, arrangements should be made with anesthesiology and ENT to attempt definitive airway management in a controlled setting, such as the operating room. Perform cricothyrotomy In patients with severe epiglottitis, the most experienced physician should make a single attempt at endotracheal intubation. At the same time, another individual should be preparing equipment for cricothyrotomy, if needed. However, cricothyrotomy is contraindicated in children younger than 10 to 12 years old due to the anatomy of the neck; there is less potential for complications in

older children because their laryngeal structures are larger. Obtain anteroposterior soft tissue neck x-ray In severe epiglottitis, definitive airway management should precede lateral soft tissue x-ray of the neck. In this case, there is no indication for an anteroposterior soft tissue x-ray of the neck. A lateral soft tissue x-ray of the neck should be considered in patients with mild or moderate symptoms when epiglottitis is suspected. Obtain CT scan of the neck CT scans of the neck should not play a primary role in the diagnosis of severe epiglottitis. A patient with severe epiglottitis might be unable to lie flat for CT. If symptoms are mild or moderate, a lateral soft tissue x-ray of the neck may be considered.

55. A 3-year-old boy is presented for evaluation of a runny nose, fever, and 2-day progressive nonproductive cough. His vital signs include P 105, R 26, and T 37.6°C (99.7°F); SpO₂ is 95% on room air. On examination, he has inspiratory stridor, moderate intercostal retractions, and a seal-like barking cough. After treatment with systemic corticosteroids and nebulized racemic epinephrine, he has no further stridor, retractions, or cough. What is the best next step in management?

- A. Discharge home
- B. Monitor for 3 hours in the emergency department
- C. Start nebulized albuterol treatment
- D. Arrange admission to the hospital

Correct: Monitor for 3 hours in the emergency department

Emergency department treatment of laryngotracheobronchitis (croup), as described in the case, includes administration of nebulized epinephrine and corticosteroids. Discharge home after treatment has been demonstrated to be safe in well-appearing patients with normal vital signs and no stridor, no retractions, no hypoxia, and access to close follow-up. Because the effects of inhaled epinephrine on respiratory vasoconstriction persist for 2 to 3 hours, investigators recommend at least 3 hours of observation to ensure no recurrence of stridor. Use of racemic epinephrine or L-epinephrine is safe and efficacious. Discharge home immediately following inhaled epinephrine therapy is inappropriate; epinephrine's effects last for about 2 hours, so monitoring the patient for at least this long — 3 hours is often recommended — is necessary to ensure no recurrence of symptoms. Discharge home after corticosteroids, inhaled epinephrine, and an appropriate emergency department monitoring period is appropriate in a well-appearing patient with none of the following: hypoxia, tachycardia, tachypnea, retractions, or stridor. Start nebulized albuterol treatment Albuterol has no role in the treatment of croup and can worsen airway edema through its beta-mediated vasodilatory effects on the respiratory mucosa. Arrange admission to the hospital Hospitalization for treatment of croup is infrequently needed. After administration of corticosteroids and inhaled epinephrine in the emergency department, factors that support the need for admission include persistence of stridor at rest, persistence of respiratory distress, hypoxia, young age (<6 months), high fever, and poor access to close follow-up.

56. What is the most common cause of death from complications of a *Bordetella pertussis* infection?

- A. Diaphragm rupture
- B. Pneumothorax
- C. Seizures
- D. Pneumonia

Correct: Pneumonia

Pneumothorax is also a complication of patients with pertussis, but it is not the most common cause of death either. This diagnosis should be considered if a patient's respiratory effort suddenly increases. Diaphragm rupture
Diaphragm rupture is certainly a complication of pertussis, secondary to coughing and increased intrathoracic and intra-abdominal pressure. However, it is not the most common cause of death. Seizures Seizure and encephalopathy are among the CNS complications of pertussis, but neither is the most common cause of death. Pneumonia
Pneumonia remains the most common cause of death due to complications from B. pertussis infections, especially in infants and young children. The complications from B. pertussis infections include pneumonia superinfection, CNS complications, subconjunctival hemorrhage, petechiae (particularly above the nipple line), epistaxis, hemoptysis, subcutaneous emphysema, pneumothorax, pneumomediastinum, diaphragmatic rupture, umbilical and inguinal hernias, and rectal prolapse. Many of these complications are secondary to the paroxysms of cough and increased intrathoracic and intra-abdominal pressure. Bradycardia, hypotension, and cardiac arrest can occur in neonates and young infants with pertussis. Severe pulmonary hypertension has also shown increased prevalence in this age group and can lead to systemic hypotension, worsened hypoxia, and increased mortality rates. Antibiotic treatments do not seem to reduce the severity or duration of illness. The primary goal of antibiotic therapy is to reduce infectivity and carriage. Macrolide antibiotics, including erythromycin, azithromycin, or clarithromycin, are the primary choices for therapy. Sulfamethoxazole/trimethoprim is a possible secondary choice for macrolide-allergic patients, but its efficacy is unproven. Corticosteroids can reduce the severity and course of illness, especially in young, critically ill children. Beta-agonists can be effective in patients with reactive airway disease. However, there is no evidence to support the use of pertussis immunoglobulin. Standard cough suppressants and antihistamines are also ineffective. Postexposure prophylaxis is recommended for infants younger than 6 months who have household contacts with confirmed pertussis infection because these infants have not yet completed the recommended immunization regimen.

57. Which condition is the most likely cause of widened mediastinum in a patient who has been experiencing weight loss and fatigue for several weeks?

- A. Inhalation anthrax
- B. Boerhaave syndrome
- C. Chest lymphoma
- D. Descending necrotizing mediastinitis

Correct: Chest lymphoma

Pneumomediastinum is a potential complication of Boerhaave syndrome and tracheobronchial injury that results in a widened mediastinum in 20% of patients. It can cause a crackling sound (known as the "Hamman crunch") that is typically heard on chest auscultation coincident with each heartbeat and can be mistaken for a pericardial friction rub. Esophageal rupture in Boerhaave syndrome likely results from a sudden rise in intraluminal esophageal pressure produced during vomiting due to neuromuscular incoordination, which causes the cricopharyngeus muscle to fail to relax. Although these conditions can be associated with a widened mediastinum, they are uncommon and do not typically present with the same symptoms as lymphoma. Inhalation anthrax Although inhalation anthrax can cause a widened mediastinum, it is incredibly rare. Anthrax results in a prodromal viral respiratory illness that lasts about 1 week. This stage is followed by acute hypoxia, dyspnea, or acute respiratory distress with resulting cyanosis. In some patients, mediastinal widening and hilar adenopathy are seen on x-ray, but patients generally do not complain of weight loss. Chest lymphoma If a posterior-anterior standing chest x-ray has been taken with good inspiration and no rotation, then any widening of the mediastinum is likely to be genuine; thus, the main pathological causes to consider include masses and widening of vessels. Of the choices listed, chest lymphoma is the most common cause of widened mediastinum, making the diagnosis particularly likely in a patient who reports weight loss and fatigue. The mediastinum is composed of anterior, middle, and posterior compartments. The anterior causes of a widened mediastinum include the "four T's:" (terrible) lymphoma, thymoma, teratoma/germ-cell tumor, and thyroid tissue.

The middle causes of widened mediastinum, in order of decreasing occurrence, are lymphadenopathy secondary to lymphoma, sarcoid, and metastatic lung cancer. Neurogenic tumors are the most common posterior causes of widened mediastinum. Descending necrotizing mediastinitis Descending necrotizing mediastinitis is a rare and potentially fatal cause of widened mediastinum. It is caused by the spreading of a head or neck infection to the mediastinum from tonsillitis, dental abscess, or sinusitis. These infections are often polymicrobial and produce gas, which contributes to the widening of the mediastinum.

58. Clinical observation without a diagnostic thoracentesis is a reasonable option in a stable patient presenting with new pleural effusions in which clinical scenario?

- A. A history of a previously excised melanoma
- B. Heart failure with pulmonary edema and leg swelling
- C. A history of alcoholic liver disease with ascites
- D. Cough and fever with shortness of breath

Correct: Heart failure with pulmonary edema and leg swelling

Diagnostic thoracentesis is necessary in the workup of most new pleural effusions. Thoracentesis may be reasonably deferred in a stable patient with known heart failure presenting with clear signs of a heart failure exacerbation and symmetrical effusions or in a patient with a small pleural effusion secondary to suspected viral pleuritis. These patients should be carefully monitored to ensure improvement with conservative management. Indications for diagnostic thoracentesis in a patient with heart failure include atypical presentation, asymmetrical effusions, or infectious symptoms. Additionally, therapeutic thoracentesis is warranted for patients that are significantly symptomatic or in respiratory distress. Ultrasound-guided thoracentesis may be safely performed at the bedside, avoiding costs and delays associated with interventional radiology referral. This procedure should be avoided when the largest pocket of pleural fluid is less than 1 cm in diameter or if there is an active soft tissue infection overlying the insertion site. In cases of severe coagulopathy, the risk of bleeding with immediate thoracentesis must be weighed against the risks of delaying the procedure while correcting the coagulopathy. A history of a previously excised melanoma In a patient with a previous melanoma or other malignancy, a diagnostic thoracentesis is important for diagnosis of potential malignant effusion and prognostication. This also helps rule out other treatable causes of pleural effusion. A history of alcoholic liver disease with ascites Hepatic hydrothorax may occur in patients with cirrhosis, suggested by a history of alcoholic liver disease with ascites. Typically, this is initially treated noninvasively, but diagnostic thoracentesis is warranted to rule out other causes of pleural effusion. Cough and fever with shortness of breath A new pleural effusion in a patient with cough and fever is suggestive of a parapneumonic effusion. The effusion may be an uncomplicated parapneumonic effusion that does not require chest tube placement, but empyema must be ruled out with a diagnostic thoracentesis.

59. Which criterion is included in the PERC rule but not the Wells score?

- A. Clinical signs and symptoms of DVT
- B. Hormone replacement therapy
- C. Heart rate greater than 100 bpm
- D. Immobilization for 3 or more consecutive days

Correct: Hormone replacement therapy

A patient's use of hormone therapy is taken into consideration in the pulmonary embolism rule-out criteria (PERC

rule) but not in calculating the pretest probability for DVT or pulmonary embolism (PE) using the Wells score. Hormone therapy includes the use of oral contraceptives, hormone replacement, or estrogenic hormones in men or women. The Wells score is a clinical prediction rule first published in 1995 to help determine the pretest probability of a patient having a DVT or PE by assigning points to each criterion as follows: Clinical signs and symptoms of DVT (3 points) Alternative diagnosis less likely than PE (3 points) Heart rate greater than 100 bpm (1.5 points) Immobilization for 3 or more consecutive days or surgery in the previous 4 weeks (1.5 points) Prior diagnosis of PE or DVT (1.5 points) Hemoptysis (1 point) Malignancy (on treatment, treated in the past 6 months, or on palliative care) (1 point) Low-risk patients (score <2 points; 40% of total patients) have a mean probability of 3.6% for PE. Moderate-risk patients (score 2-6 points; 53% of total patients) have a mean probability of 20.5% for PE. High-risk patients (score >6 points; 7% of total patients) have a mean probability of 66.7% for PE. The PERC rule takes the analysis further. These criteria were first published in 2004 and are intended to help rule out PE clinically if a patient is scored as low risk and to prevent unnecessary diagnostic testing. Such a patient, for example, would have a Wells score less than 3 (or the risk by gestalt thought to be less than 15%) and “no” answers to all of these PERC rule-out questions: Is the patient age 50 years or older? Is the heart rate 100 beats per minute or higher? Is oxygen saturation less than 95%? Does the patient have hemoptysis? Is there unilateral leg swelling? Is the patient on hormone therapy (including oral contraceptives, hormone replacement, or estrogenic hormones in men or women)? Has the patient had surgery or trauma requiring general anesthesia within the past 4 weeks? Has the patient had PE or DVT before? Patients who do not have any of the PERC criteria and are at low risk for PE have a less than 2% chance of having PE; thus, additional imaging or diagnostic testing is not recommended. The PERC rule was validated by a large study with 7,527 patients, in which only 0.9% had PE when they were PERC negative, with no deaths. Clinical signs and symptoms of DVT Clinical signs and symptoms of DVT are a criterion explicitly stated in the Wells criteria that have a value of 3 points. Clinical signs and symptoms of DVT are indirectly stated as unilateral leg swelling in the PERC rule. Heart rate greater than 100 bpm A heart rate of 100 bpm or higher is a consideration in both the Wells score and the PERC rule. In most studies, sinus tachycardia is the most common ECG finding in patients with PE. Immobilization for 3 or more consecutive days Immobilization for 3 or more consecutive days is not found directly in the PERC questions, but it is one of the criteria to determine the pretest probability of PE in a patient using the Wells score. Using this tool, a patient who has been immobilized for 3 or more days is given 1.5 points, but the patient could still be low risk if no other criteria are positive.

60. Which intervention should be performed with extreme caution in pulmonary hypertension patients with associated right ventricular dysfunction?

- A. Inhaled nitric oxide
- B. Dobutamine infusion
- C. Endotracheal intubation
- D. Norepinephrine infusion

Correct: Endotracheal intubation

Dobutamine is a beta receptor agonist used primarily as an inotropic agent in patients with severe heart failure. In pulmonary hypertension patients with right ventricular failure, a dobutamine infusion can augment right ventricular function and improve symptoms. However, dobutamine infusions should be avoided in patients who are hypotensive because it can worsen hypotension through beta-2 receptor agonism. Overall, dobutamine infusion is much safer than endotracheal intubation in the setting of severe pulmonary hypertension. Inhaled nitric oxide Inhaled nitric oxide is used as an acute pulmonary vasodilator for right ventricular afterload reduction. Patients with acutely exacerbated pulmonary hypertension may benefit from administrations of inhaled nitric oxide or other rapidly acting inhaled pulmonary vasodilators (eg, epoprostenol). Notably, these inhaled pulmonary vasodilators may worsen cardiogenic pulmonary edema in patients with concomitant left ventricular dysfunction due to rapidly increased left ventricular preload, so it should be used cautiously in these populations. Overall, nitric oxide use is much safer than endotracheal intubation in the setting of severe pulmonary hypertension. Endotracheal intubation Patients with pulmonary hypertension often have right ventricular dysfunction that creates a brittle, preload-dependent cardiac

physiology. Endotracheal intubation and the resulting positive-pressure ventilation can reduce preload, resulting in worsening right ventricular failure, poor left ventricular filling, and, ultimately, life-threatening hypotension. When intubation is required, settings should be placed at the minimum necessary to adequately ventilate, including low tidal-volume ventilation (at most 6-8 ml/kg ideal body weight), positive end-expiratory pressure (PEEP) with a target plateau pressure of less than 30 cm H₂O, oxygen saturation of 90% or greater, and normocapnia.

Norepinephrine infusion Norepinephrine is a beta-1 and alpha-1 receptor agonist that is the expert-consensus first-line vasopressor for use in hypotensive patients with pulmonary hypertension. Although high doses should be avoided due to a risk of worsening pulmonary vasoconstriction, lower doses can improve systemic blood pressure and right coronary artery blood flow, which improves right ventricular function and general cardiac output. Although it is counter to the management of most other causes of hypotension, hypotensive pulmonary hypertension patients should receive norepinephrine first, and fluids should be used very cautiously only in patients who appear hypovolemic; overzealous fluid use can cause a paradoxical reduction of cardiac output due to reduction in left ventricular size from iatrogenic enlargement of the failing right ventricle. As a result, norepinephrine use is significantly safer than endotracheal intubation in this population.

61. In the community emergency department setting, what is the correct disposition for a patient with a newly diagnosed lung abscess on CT scan?

- A. Admit to inpatient care for intravenous antibiotics
- B. Transfer to a tertiary care center for immediate bronchoscopy
- C. Discharge home with outpatient pulmonary follow-up
- D. Consult interventional radiology for abscess drainage

Correct: Admit to inpatient care for intravenous antibiotics

Transfer for bronchoscopy is unnecessary until the patient has had a trial of intravenous antibiotics. In rare cases, lung abscesses may be related to postobstructive pathology, but bronchoscopies are reserved for patients who have failed to improve with intravenous antibiotics. Admit to inpatient care for intravenous antibiotics Lung abscesses (ie, purulent infections in the lung parenchyma) are initially managed with intravenous antibiotics, preferably a beta-lactam-beta-lactamase inhibitor or carbapenem. Roughly 80% of lung abscesses will respond to intravenous antibiotics, and a 3- to 6-week course is often curative. Because lung abscesses usually self-drain through communication with the tracheobronchial tree, drainage is usually unnecessary. Drainage is reserved for patients who show no improvement with intravenous antibiotics. Notably, treatment for a lung abscess differs from treatment for empyema. Empyema (ie, a purulent infection in the pleural space) is often treated with drainage through chest tube thoracostomy. Discharge home with outpatient pulmonary follow-up Discharge with outpatient follow-up is inappropriate because patients with a newly diagnosed lung abscess require intravenous antibiotic therapy. Most sources suggest that patients require 3 to 6 weeks of treatment, so discharge with a peripherally inserted central catheter (PICC) line and outpatient antibiotic therapy may be appropriate after the patient has defervesced and is improving. Usually, this requires 4 to 5 days of intravenous antibiotics in the hospital. Consult interventional radiology for abscess drainage Unlike empyema, the majority of lung abscesses (80%) respond well to intravenous antibiotics alone. Because lung abscesses usually self-drain through communication with the tracheobronchial tree, drainage is usually unnecessary. Thus, consultation for drainage is premature; it may be required later if the patient does not respond to antibiotics.

62. What is the most prevalent precipitating factor for a primary spontaneous pneumothorax (PSP)?

- A. Cigarette smoking
- B. COPD
- C. Marfan syndrome
- D. Physical exertion

Correct: Cigarette smoking

Secondary spontaneous pneumothoraces (SSPs) occur in patients who have underlying pulmonary disease processes, such as COPD, cystic fibrosis, emphysema, and asthma. They account for one-third of spontaneous pneumothoraces. Of these underlying conditions, COPD is the one most commonly associated with SSPs. It is present in over 50% of cases. Cigarette smoking Spontaneous pneumothoraces can be classified as either primary or secondary based on the absence (primary) or presence (secondary) of a known underlying lung pathology. PSPs comprise two-thirds of cases of spontaneous pneumothoraces. They typically occur in thin, male smokers of taller-than-average height. The biggest risk factor for the development of a PSP is cigarette smoking; it often results in persistent airway inflammation, which can then lead to pneumothoraces. Research shows that the risk of developing a spontaneous pneumothorax is dependent on the amount of cigarette smoking: Light smokers have a relative risk seven times higher than nonsmokers. Moderate smokers have a risk 21 times higher than nonsmokers. Heavy smokers have a risk 102 times higher than nonsmokers. Heavy smokers have a 12% lifetime risk of developing a PSP compared to 0.1% for nonsmokers. Other risk factors associated with PSPs include changes in ambient atmospheric pressure, mitral valve prolapse, and Marfan syndrome. Marfan syndrome Marfan syndrome is one of the most common inherited connective disorders in the world, with an estimated annual incidence of 1 per 3,000 to 1 per 5,000 people. Approximately 10% of people with Marfan syndrome have either apical blebs or bullae on chest imaging. Apical blebs and bullae predispose patients to spontaneous pneumothoraces. An estimated 4% of patients with Marfan syndrome develop a spontaneous pneumothorax, which is less than the percentage of smokers who develop a spontaneous pneumothorax. Physical exertion Physical exertion is not usually a precipitating factor for a PSP. Contrary to common belief, only a small percentage of cases are associated with physical exertion. Onset of a pneumothorax is as likely to occur with physical activity as it is with no activity. The exception is any activity that results in changes in air pressure, such as flying in an airplane or deep-sea diving.

63. An 18-year-old man presents with a sore throat for the past week that is associated with fever, progressive shortness of breath, and neck pain. Imaging is obtained and shown below. What is the appropriate next step in management?



- A. Anticoagulants
- B. Antibiotics
- C. Internal jugular ligation and resection
- D. Thrombectomy

Correct: Antibiotics

This patient is suffering from septic emboli from an infected thrombophlebitis of the internal jugular vein (Lemierre syndrome). Antibiotics are the mainstay of treatment for Lemierre syndrome. Antibiotic regimens should cover gram-negative anaerobes. Some regimens that are cited are piperacillin-tazobactam, imipenem, or ceftriaxone with metronidazole. Antibiotic treatment should be initiated as soon as possible. Anticoagulants are often used to treat venous thrombosis, although their role in Lemierre syndrome remains controversial. There have been equivocal results in studies, with most patients having improvement in their thrombi in 3 months regardless of anticoagulant use. Internal jugular ligation and resection Surgical ligation and excision of the internal jugular vein has been described in the literature as a treatment for Lemierre syndrome; however, this is only recommended as a last resort. Other surgical interventions may be indicated for cases of abscess formation, empyema, or necrotic tissue requiring debridement. Thrombectomy This patient is suffering from infected thrombophlebitis of the internal jugular vein (ie, Lemierre syndrome). Mechanical thrombectomy by interventional radiology (IR) to remove the infected thrombus has only been rarely described in the literature. Currently, there is no published mortality benefit or guideline for IR-guided thrombectomy.

64. What is the most common symptom of pulmonary hypertension?

- A. Orthopnea
- B. Exertional lightheadedness
- C. Chest pain
- D. Dyspnea

Correct: Dyspnea

Exertional presyncopal symptoms (eg, lightheadedness) and syncope are uncommon but are highly concerning findings in pulmonary hypertension, revealing a decreased cardiac output in response to exertion. This reduction in cardiac output can eventually become severe enough to cause these symptoms at rest. Patients presenting with presyncopal symptoms or syncope as a result of pulmonary hypertension likely have severe disease and require emergent evaluation and aggressive management. However, this situation is uncommon relative to the presence of dyspnea, which is present in the majority of pulmonary hypertension cases. Orthopnea Orthopnea is an unusual finding in pulmonary hypertension alone, and its presence usually indicates symptomatic left ventricular dysfunction. Although left ventricular dysfunction is the most common cause of pulmonary hypertension, orthopnea is not as common as dyspnea, which presents in at least half of pulmonary hypertension cases. This also applies to other signs of left ventricular dysfunction, such as paroxysmal nocturnal dyspnea and pulmonary edema. Chest pain Chest pain is an uncommon finding in pulmonary hypertension, occurring in fewer than one-quarter of patients in one study. On the other hand, dyspnea presents in at least half of pulmonary hypertension cases, making it the most common symptom. Dyspnea Dyspnea is the most common pulmonary hypertension symptom. Overall, the symptomatology of pulmonary hypertension, especially early in the disease process, is nonspecific. Chest pain, fatigue, exertional presyncope or syncope, and signs of right ventricular failure (eg, abdominal distention, early satiety, and lower extremity edema) are all prominent findings in pulmonary hypertension but are ultimately uncommon features; since no single symptom is consistently present, delayed diagnosis is common. Ultimately, persistent dyspnea alone should prompt concern for occult pulmonary hypertension and trigger expedited evaluation.

65. A patient is evaluated at low risk for pulmonary embolism with a Wells score of less than 2. What is the next best step to rule out pulmonary embolism?

- A. CT pulmonary angiography
- B. D-dimer
- C. Bilateral lower-extremity venous ultrasound
- D. Pulmonary Embolism Rule-Out Criteria

Correct: Pulmonary Embolism Rule-Out Criteria

D-dimer is a fibrin degradation product that is commonly used to rule-out venous thromboembolism. It has a sensitivity of 94% to 96% and a specificity of 50% to 60% in the diagnosis of PE and DVT. D-dimer should not be used as the initial evaluation of low-risk PE patients given the high rate of false positives that may lead to unnecessary testing. Instead, D-dimer testing should be used in patients who are PERC(+) or moderate risk for PE with Wells score 2 to 4 or clinical gestalt between 15% to 40%. CT pulmonary angiography CT pulmonary angiography (CTPA) identifies PE by directly visualizing a filling defect within the pulmonary arteries. CTPA has a sensitivity and specificity of approximately 90% for detecting PE, depending on correct timing of the contrast bolus. CTPA also has the benefit of identifying other pulmonary pathology (eg, pneumonia, malignancy, etc) that may be causing similar symptoms in patients with suspected PE. Bilateral lower-extremity venous ultrasound Venous ultrasound is primarily used in the diagnosis of DVT. Compression ultrasonography performed by sonographers has a sensitivity and specificity of 96% for DVT, which is similar to that when performed by trained emergency medicine physicians. However, the sensitivity as a marker for PE is only 40%. Ultrasound can be used to evaluate pregnant patients with suspected PE to aid in diagnostic workup. Pulmonary Embolism Rule-Out Criteria The initial workup for pulmonary embolism (PE) should include clinical probability with a structured score (Wells Score) or clinical gestalt. The Pulmonary Embolism Rule-Out Criteria rule (PERC rule) was developed to avoid unnecessary

testing in patients who were deemed low risk for PE with a Wells score <2 or low suspicion with clinical gestalt $<15\%$. The PERC rule includes eight criteria: age <50 , pulse <100 , SpO₂ $\geq 95\%$, no hemoptysis, no estrogen use, no surgery or trauma with hospitalization within 4 weeks, no prior venous thromboembolism, and no unilateral leg swelling. If low clinical suspicion and all eight parameters are met, then the probability of PE is $<2\%$, and the patient should not undergo further diagnostic testing.

66. What is the most common cause of pulmonary hypertension in adults in the United States?

- A. Left ventricular dysfunction
- B. Pulmonary embolism
- C. COPD
- D. Asthma

Correct: Left ventricular dysfunction

Pulmonary embolism (PE) is an uncommon but well-established cause of pulmonary hypertension. The mechanism is direct pulmonary arterial obstruction. PE-related pulmonary hypertension (known as chronic thromboembolic pulmonary hypertension [CTEPH]) is the primary cause of WHO Group IV pulmonary hypertension. However, left ventricular dysfunction is a more common cause of pulmonary hypertension overall. Left ventricular dysfunction is generally considered the most common cause of pulmonary hypertension in adults in the United States; broadly speaking, this group is known as WHO Group II pulmonary hypertension. Although Group II includes any cause of left ventricular dysfunction (eg, diastolic, systolic, valvular, and congenital), diastolic dysfunction (otherwise known as heart failure with preserved ejection fraction [HFPEF]) is dominant. High rates of hypertension and metabolic disease are thought to be the major underlying contributors to the prevalence of left ventricular dysfunction (HFPEF in particular) and Group II pulmonary hypertension. Left ventricular dysfunction causes pulmonary hypertension via chronically elevated pressures and remodeling. Increased left-sided filling pressures affect the pulmonary vasculature and result in elevated pulmonary arterial pressures. Long-term exposure to high pressures results in maladaptive pulmonary vascular remodeling, producing chronic pulmonary hypertension. In the end-stage form of this process, right-sided heart failure occurs due to progressive right ventricular dilation and ischemic injury from poor coronary artery perfusion. COPD COPD is a common and well-established cause of pulmonary hypertension. The mechanism is not well understood but is thought to be due primarily to chronic hypoxic pulmonary vasoconstriction. COPD is a major part of WHO Group III, which includes all primary lung causes of pulmonary hypertension. Despite being a common cause of pulmonary hypertension, left ventricular dysfunction is considered more common. Asthma Although asthma is a common overall disease, it is rarely associated with pulmonary hypertension. Left ventricular dysfunction is a far more common cause. Pulmonary hypertension due to asthma is a part of WHO Group III, along with all other primary lung causes of pulmonary hypertension.

67. An employee of a plastics manufacturing company presents with chest tightness and shortness of breath after an occupational exposure. She reports seeing a white gas and then smelling something like “freshly mowed grass.” Her SpO₂ is 92% on room air. What is the next best step in management?

- A. Discharge with home oxygen
- B. Admission and N-acetylcysteine IV
- C. Admit for observation

D. Transfer for hyperbaric oxygen

Correct: Admit for observation

Phosgene exposure is a rare event, so guidelines for treatment are based on data from animal models and case reports. Recommended therapies include early corticosteroids, nebulized beta-agonists, nebulized (not intravenous) N-acetylcysteine, and NSAIDs. Discharge with home oxygen This patient has only mild symptoms with an SpO₂ of 92% on room air, so she does not require supplemental oxygen at this time. There is some thought that oxidative damage is at least partially responsible for pulmonary injury in phosgene exposure. Thus, unnecessary supplementary oxygen is potentially harmful. This patient requires admission for observation. Admit for observation This patient was likely exposed to phosgene, a chemical precursor that smells of freshly cut hay or grass. Patients exposed to lower concentrations of this gas may experience only mild or moderate symptoms initially, but they require observation for at least 24 hours from the time of exposure due to the risk of delayed noncardiogenic pulmonary edema and ARDS. Phosgene was used in chemical warfare (as a “choking” agent) during World War I and was responsible for approximately 80% of all chemical gas fatalities. Phosgene is a chemical precursor that is used extensively in the manufacture of plastics, pharmaceuticals, polyurethane, and pesticides, so the risk of appropriation and use as a terrorist weapon remains. Phosgene is poorly water-soluble gas at room temperature, and it penetrates deep into the lung before producing toxicity. Hydrolysis in the lungs produces hydrochloric acid, and cellular injury results from cross-linking of cell components. Due to poor water solubility, symptoms may be mild initially, particularly with low-concentration exposures. At higher concentrations, immediate dyspnea with ocular and mucous membrane irritation may occur. Evolving tissue injury results in capillary leak and noncardiogenic pulmonary edema, which may be delayed up to 24 hours after exposure. Thus, prolonged observation is required. Transfer for hyperbaric oxygen There is no role for hyperbaric oxygen in the treatment of phosgene exposure. Patients with respiratory distress and hypoxia should have supplemental oxygen administered. Patients who experience respiratory failure may require mechanical ventilation and a lung-protective strategy using low-tidal volume, low plateau pressures, and high positive end-expiratory pressure.

68. A 56-year-old woman presents after an episode of near syncope. Her vital signs are BP 93/40, P 104, R 20, and T 36.1°C (97°F); SpO₂ is 95% on room air and blood glucose is 94. She recently received a diagnosis of idiopathic pulmonary hypertension; an ECG is unchanged from her most recent one. She denies fever, chest pain, and recent illness. Her dyspnea is slightly increased from baseline. Auscultation of the chest yields a loud split S1 but no murmurs. There is no jugular venous distention, hepatomegaly, or lower extremity swelling. Lungs are clear. Chest x-ray shows moderate cardiomegaly. After placing the patient on supplemental oxygen, what is the next treatment goal?

- A. Decrease pulmonary artery pressures
- B. Maintain adequate right ventricular filling pressure
- C. Maintain pulmonary vascular resistance
- D. Decrease left ventricular afterload

Correct: Maintain adequate right ventricular filling pressure

Maintaining high right ventricular filling pressures by ensuring adequate intravascular volume status is the mainstay of emergency therapy for pulmonary hypertension; parenteral fluid hydration with normal saline is recommended. Primary, or idiopathic, pulmonary hypertension is rare. It often presents as exercise intolerance, syncope or near syncope, dyspnea on exertion, and shortness of breath, making it difficult to distinguish from a variety of other more common cardiopulmonary disease processes such as asthma, COPD, left ventricular heart failure, and pulmonary embolism. Syncope occurs in up to half of patients with pulmonary hypertension and is typically related to dysrhythmia. There are many secondary causes of pulmonary hypertension, most notably congenital heart disease

with unrepaired cardiac shunt. Decrease pulmonary artery pressures Medications such as prostacyclin analogues and phosphodiesterase inhibitors can decrease pulmonary artery pressure; however, this should be initiated and managed by or in collaboration with a cardiologist. The initial management of pulmonary hypertension should focus on intravascular volume resuscitation to maintain right ventricular filling pressure and ensure adequate cardiac output. Maintain pulmonary vascular resistance There are no benefits to maintaining pulmonary artery resistance, and the emergency physician should focus on maintaining adequate cardiac output by maintaining preload. Decrease left ventricular afterload Decreasing afterload through diuresis is beneficial in left-sided heart failure and, judiciously, in right-sided heart failure. In this patient without clear evidence of right-sided heart failure and pulmonary hypertension, however, fluid resuscitation is indicated.

69. A 62-year-old man presents with a cough, producing foul-smelling sputum streaked with blood. He has had the cough for 1 week, along with night sweats and pain in his chest when he coughs; he reports that his fever "just came on." He is a smoker and an alcoholic but denies drug use, recent travel, and other medical problems. His vital signs are BP 110/54, P 108, R 16, and T 39.3°C (102.7°F); SpO₂ is 94% on room air. A chest x-ray is obtained and shown below. What is the most likely underlying cause?



- A. Influenza virus
- B. Mixed anaerobic bacterial infection
- C. Streptococcus pneumoniae infection
- D. Tuberculosis

Correct: Mixed anaerobic bacterial infection

This chest x-ray reveals an abscess in the left lung field, likely due to aspiration. Abscesses are most commonly caused by aspiration of mixed oropharyngeal anaerobic bacteria. The patient's alcoholism predisposes him to aspiration, and aspiration is the condition that most commonly leads to a lung abscess in the United States. Other risk factors include dental caries, malignancy, malnutrition, immunosuppression, debilitation, and advanced age. Typical treatment of a pulmonary abscess includes intravenous broad-spectrum antibiotic therapy using penicillin and metronidazole or clindamycin. If there is concern for gram-negative bacillus, such as with alcoholic patients, treatment should include metronidazole plus ceftriaxone/piperacillin-tazobactam/ticarcillin-clavulanate. Influenza virus The influenza virus rarely, if ever, causes an abscess. A viral infection can precede a worsening respiratory infection from aspiration and a bacterial source, so this possibility should be considered. It would not, however, be the cause of an abscess. Streptococcus pneumoniae infection Streptococcus pneumoniae infection is the most likely cause of pneumonia, but it is unlikely to cause an abscess alone. It is the most common cause of an empyema, or pleural-based collection of exudate, as a complication of pneumonia. Tuberculosis Tuberculosis (TB) can cause an

abscess in advanced disease but is less likely given the patient's symptoms. Typically, a patient with TB has lesions involving more than one lobe, mediastinal adenopathy, or parenchymal disease. Typical symptoms found in a patient with TB include hemoptysis, night sweats, fatigue, and weight loss. Abscesses are found in patients with reactivation of TB, rarely in primary or latent disease. This patient's symptoms came on abruptly, but he is otherwise immunocompetent. Nothing in his history suggests travel to an endemic area for TB or a fungal infection.

70. A patient with a history of COPD presents with progressive dyspnea and productive cough for the past 2 days. On examination, the patient is noted to be tachypneic with increased respiratory effort. Coarse breath sounds and wheezing are noted in all lung fields, and ABG shows respiratory acidosis. In addition to bronchodilators, what is the best first step in management?

- A. Noninvasive positive-pressure ventilation
- B. Methylprednisolone administration
- C. Azithromycin administration
- D. High-flow supplemental oxygen

Correct: Noninvasive positive-pressure ventilation

Steroids such as methylprednisolone, like antibiotics, are clinically beneficial and are recommended for COPD exacerbations. Specifically, steroids are intended to reduce the relapse rate. However, steroids will not acutely treat this patient's respiratory distress, which is better addressed with NIPPV. Noninvasive positive-pressure ventilation For COPD exacerbations resulting in respiratory difficulties and hypercapnic respiratory failure (as in this case), noninvasive positive-pressure ventilation (NIPPV) is the best first management step. A 2017 Cochrane Review revealed that using NIPPV for COPD exacerbations with hypercapnic respiratory failure decreased mortality risk by 46% and decreased the intubation rate by 65%. NIPPV was also associated with improved oxygenation, improved hypercapnia, reduced complications, and reduced hospital length of stay. Bilevel NIPPV has the best evidence for use, although other modes such as continuous positive airway pressure (CPAP) can be used if bilevel NIPPV is unavailable. Azithromycin administration This patient has a productive cough in the setting of a more severe COPD exacerbation, which is an indication for use of antibiotics, such as azithromycin. Generally, antibiotics are indicated in the setting of moderate to severe COPD exacerbations with any two of the following symptoms: increased dyspnea, sputum volume, or sputum purulence. Azithromycin is preferred due to evidence of anti-inflammatory and antimicrobial effects. Other potential antibiotic options include clarithromycin, second- or third-generation cephalosporins, or respiratory fluoroquinolones (eg, levofloxacin); if known to be colonized with *Pseudomonas* species, an antipseudomonal antibiotic such as ciprofloxacin is recommended. However, antibiotics will not acutely treat this patient's respiratory distress, which is better addressed with NIPPV. High-flow supplemental oxygen In general, high-flow supplemental oxygen should not be necessary with pure COPD exacerbations, as in this case; in fact, it may be harmful. Hypoxia with COPD is usually not profound or refractory to low-flow supplementation, such as by nasal cannula. Supplemental oxygen is generally only necessary if the SpO₂ is less than 90%, with a goal SpO₂ of around 92%. In the acute setting of a moderate to severe COPD exacerbation (as in this case), NIPPV is the superior modality and is the best management choice, not high-flow supplemental oxygen.

71. What is a potential source of nitrogen dioxide gas?

- A. Explosive military weapons
- B. Heated refrigerator chemicals
- C. Swimming pool maintenance agents

D. Household cleaning products

Correct: Explosive military weapons

Heating of chlorinated fluorocarbons, such as those found in refrigerators or air conditioners, can lead to the release of phosgene gas. Inhalation of phosgene gas causes burns to the lower airways. Explosive military weapons Nitrogen dioxide (also known as silo gas or silo-filler gas) is often found in agricultural settings, industrial arenas, and explosive military weapons. Nitrogen dioxide is often produced from combustion or fermentation. Exposure to nitrogen dioxide causes a respiratory pathology known as silo-filler's disease. This chemical pneumonitis typically affects the bronchi and bronchioles, causing airway inflammation from an eosinophil-mediated response. Silo-filler's disease is considered a triphasic condition. The initial symptoms are shortness of breath and generalized malaise. Symptoms tend to be delayed from the initial inhalation exposure; nitrogen dioxide is first converted to nitric acid, which then leads to lung inflammation and irritation. After the initial onset of symptoms, there may be a period of symptom resolution. This is followed by worsening inflammation, which can lead to pulmonary edema and respiratory failure. Treatment is typically supportive. Data on the use of steroids are limited, but there may be some benefit. Swimming pool maintenance agents Chlorine gas is found in multiple industries. These include swimming pool maintenance, drinking water treatment, and some manufacturing. Exposure causes mucous membrane irritation and can lead to respiratory distress. Household cleaning products Household cleaning products can cause inadvertent exposure to ammonia gas. Ammonia gas can also be released from fertilizers. Inhalation of ammonia gas causes significant airway inflammation. Inappropriate combinations of household cleaning products, such as ammonia with bleach, can also react to produce other toxic gases.

72. Which pathogen most commonly causes pneumonia in HIV-infected persons?

- A. *Pneumocystis jirovecii*
- B. *Staphylococcus aureus*
- C. *Pseudomonas aeruginosa*
- D. *Streptococcus pneumoniae*

Correct: Streptococcus pneumoniae

S. aureus can be a common cause of pneumonia, but it is a less common cause of community-acquired pneumonia than *S. pneumoniae*. *Pneumocystis jirovecii* *Pneumocystis pneumonia* (PCP) is caused by infection with *P. jirovecii* and is a serious cause of pneumonia for HIV-infected patients. However, it is still less common than infection with *S. pneumoniae* and is usually present only when the CD4 count drops below 200. PCP is considered an AIDS-defining illness. *Pseudomonas aeruginosa* *Pseudomonas* infection is a concern among immunocompromised patients and recently hospitalized patients, particularly those who are in a hospital setting for more than 48 to 72 hours. However, *P. aeruginosa* is decidedly less common than *S. pneumoniae* as a cause of community-acquired pneumonia. *Streptococcus pneumoniae* Patients with HIV are prone to contracting pneumonia from uncommon pathogens due to their immunocompromised status, but they are also more likely to get the common types and have severe disease as a result. *S. pneumoniae* is the most common cause of community-acquired pneumonia among both immunocompetent and HIV-positive patients. Pulmonary infections are the most common cause of serious illness and death among patients with HIV, and while upper tract infections are most common, the incidence of lower tract infection increases as the CD4 count decreases.

73. Which patient is at the highest risk of death from asthma?

- A. 24-year-old Black man who has a history of childhood asthma
- B. 42-year-old Caucasian woman who used one canister of an inhaled, short-acting beta2-agonist this month
- C. 36-year-old Hispanic man who has been hospitalized once for asthma within the past year
- D. 28-year-old Black woman who is currently using systemic corticosteroids

Correct: 28-year-old Black woman who is currently using systemic corticosteroids

Regular use of short-acting beta2-agonist inhalers is a risk factor for death in asthmatic individuals; however, patients who use more than two canisters per month (not one) are at a high risk of death from asthma. 24-year-old Black man who has a history of childhood asthma Childhood asthma is not a risk factor for death in those with asthma. Black individuals do have higher rates of mortality (24 cases per million) than Hispanics (6 cases per million) and non-Hispanic whites (10 cases per million). Ethnicity alone, however, is insufficient to determine that the 24-year-old man has the highest risk of death from asthma. 36-year-old Hispanic man who has been hospitalized once for asthma within the past year This man has been hospitalized only once for asthma within the past year; a single admission for asthma is not associated with an increased risk of death from asthma. Multiple admissions for asthma in the prior year, however, represent a well-recognized risk factor for death from asthma. 28-year-old Black woman who is currently using systemic corticosteroids If this patient is using systemic corticosteroids, she likely has poorly controlled asthma. Patients who have multiple severe asthma attacks are at the highest risk of death from asthma exacerbations. Interestingly, patients with slow-onset asthma, which occurs over days to weeks, are much more likely to die, rather than patients with rapid-onset asthma, which occurs over a few hours. Autopsies typically reveal thick, tenacious mucous plugs, a finding that develops over days, not hours. Well-described risk factors for death include: A history of a severe asthma exacerbation, including prior intubation for asthma, prior admission to the ICU for asthma, or two or more hospitalizations for asthma in the past year Poorly controlled asthma, including the current use of or recent withdrawal from systemic corticosteroids, nocturnal dyspnea, dependence on the emergency department for asthma care, hospitalization or an emergency department visit for asthma within the past month, or use of more than two inhaled, short-acting beta2-agonist canisters per month Certain comorbidities, including cardiovascular disease, pulmonary disease, or other systemic problems; serious psychiatric disease; or psychosocial problems Illicit drug use, especially inhaled cocaine or heroin Low socioeconomic status, particularly in urban areas

74. What is a contraindication to a trial of noninvasive ventilation prior to intubation in a patient with a COPD exacerbation?

- A. Hypercapnia
- B. Acute respiratory acidosis
- C. Facial fractures
- D. GCS score of 14

Correct: Facial fractures

Acidosis, defined as a pH less than 7.36, is an indication for positive-pressure ventilation, but it can be corrected with either noninvasive ventilation (NIV) or intubation. Patients with acute respiratory acidosis due to a COPD exacerbation are the most likely subgroup to benefit from NIV. There is no specific degree of acidosis that mandates intubation. Intubation should be considered when respiratory acidosis fails to improve despite NIV. Hypercapnia Significant hypercapnia ($\text{PaCO}_2 > 50$ mm Hg) and hypoxia ($\text{PaCO}_2 > 50$ mm Hg or $\text{SaO}_2 < 90\%$) are also selection criteria for either noninvasive ventilation (NIV) or intubation. Intubation should be considered if hypoxemia or respiratory acidosis worsens despite NIV. Facial fractures Facial fractures are a contraindication to noninvasive ventilation (NIV) because of the need for a proper mask fit. NIV in the setting of facial fractures may lead to poor mask fit, discomfort, worsening of the fractures, and pneumocephalus. Other indications for intubation without an initial trial of NIV include inability to protect the airway (GCS score < 10 , inability to handle secretions), and significant airway obstruction. NIV has revolutionized the management of COPD exacerbations, reducing mortality

and often preventing intubations. Bilevel NIV should be initiated with inspiratory positive airway pressure of 8 to 12 cm H₂O and expiratory positive airway pressure of 3 to 5 cm H₂O. GCS score of 14 Although altered mental status due to many other conditions is a contraindication to noninvasive ventilation (NIV), altered mental status in the setting of a COPD exacerbation is most likely due to hypercapnia. NIV is the treatment for this cause of the altered mental status. Such patients should be observed closely and intubated if their mental status does not improve within 1 or 2 hours.

75. What is the most common etiology of ARDS?

- A. Trauma
- B. Aspiration pneumonitis
- C. Sepsis
- D. Pancreatitis

Correct: Sepsis

Aspiration pneumonitis is a direct cause of ARDS that is much less common than sepsis, accounting for 10% to 30% of cases overall in observational studies. In the case of aspiration pneumonitis, ARDS is caused by direct injury to the lung parenchyma by gastric enzymes and food particles. Some studies suggest that one-third of patients who are diagnosed with aspiration pneumonitis will go on to develop ARDS. Trauma Approximately 10% of ARDS develops after severe trauma. Predisposing risk factors include bilateral pulmonary contusions, fat emboli, and massive transfusion. ARDS does not appear to independently increase the risk of mortality in trauma patients, and trauma-related ARDS has a significantly better prognosis than other causes. Sepsis ARDS is an acute diffuse inflammatory lung injury that can result from direct and indirect causes. Sepsis is the most common cause, found in 30% to 70% of ARDS cases; sepsis should be considered when a patient presents with ARDS and is predisposed to infection or has a fever. Direct injury to the alveolar space is most frequently caused by pneumonia, aspiration of gastric contents, or fat emboli. Indirect causes of ARDS are systemic disorders that diffusely damage the vascular endothelium, often caused by inflammation. Common indirect causes of ARDS are sepsis and septic shock, pancreatitis, and severe trauma. Determining the etiology of ARDS and focusing treatment toward the underlying cause is one of the most important steps in management. Pancreatitis Pancreatitis is associated with the development of ARDS at a much lower rate than patients presenting with sepsis. Patients with severe pancreatitis can develop respiratory distress due to diaphragmatic irritation and develop pleural effusions and inflammatory lung pathology that can lead to ARDS.

76. What is the next best step in a patient diagnosed with a new lung abscess?

- A. Consult infectious disease for recommendations regarding empiric antibiotic therapy
- B. Consult interventional radiology for thoracostomy tube placement
- C. Consult pulmonology for bronchoscopic drainage
- D. Consult thoracic surgery for video-assisted thoracoscopic surgery

Correct: Consult infectious disease for recommendations regarding empiric antibiotic therapy

Tube thoracostomy is contraindicated for a lung abscess because placement of a chest tube is unlikely to drain the area of lung abscess in the lung parenchyma. Most lung abscesses self-drain through communication with the tracheobronchial tree. Consult infectious disease for recommendations regarding empiric antibiotic therapy A lung abscess is purulence of the lung parenchyma and is most commonly associated with large-volume aspiration and

necrosis. Polymicrobial infections with anaerobic or mixed pathogens are most common. The mainstay of treatment for lung abscesses is appropriate intravenous antibiotics. Most lung abscesses self-drain via communication with the tracheobronchial tree, so external drainage is rarely required. Empiric antibiotics may include a beta-lactam-beta-lactamase inhibitor (eg, ampicillin-sulbactam) or a carbapenem antibiotic. Infectious disease may be helpful in guiding antibiotic therapy. Consult pulmonology for bronchoscopic drainage. Bronchoscopic drainage is of limited benefit in lung abscesses, and it risks spillage of the necrotic contents of the lung abscess. Thus, bronchoscopic drainage is reserved for patients who do not resolve with intravenous antibiotics. Consult thoracic surgery for video-assisted thoracoscopic surgery. Video-assisted thoracoscopic surgery (VATS) is useful in patients with lung abscess that fail to resolve with antibiotics and other conservative treatment. However, VATS should not be first-line therapy for patients with a newly diagnosed lung abscess.

77. What is considered a significant risk factor for venous thromboembolism?

- A. Remote, inactive solid-organ malignancy
- B. Multiple myeloma
- C. Age >40
- D. Long-distance continuous travel >2 hours

Correct: Multiple myeloma

The term venous thromboembolism (VTE) includes pulmonary embolism (PE) and DVT. Both disease processes carry similar risk factors since most PE events are caused by DVTs in the legs, arms, or pelvis. Hematologic malignancies are considered risk factors for venous thromboembolism, and the highest risk is among patients with acute leukemia and multiple myeloma. Multiple myeloma is thought to place patients at higher risk for VTE by multiple mechanisms, including increased activity of the coagulation cascade and decreased fibrinolytic activity. Remote, inactive solid-organ malignancy Active solid-organ tumors are significant risk factors for VTE, with the highest risk being among adenocarcinomas and metastatic diseases. However, remote, inactive malignancies do not appear to confer increased risk for PE or DVT. Age >40 Advanced age is known to be a risk factor for PE and DVT. However, most evidence suggests that a significant increase in risk becomes apparent at ages greater than 50 and increases each year until the age of 80. Hence, the Pulmonary Embolism Rule-Out Criteria Rule (PERC Rule) includes age less than 50 as one of its rule-out factors. Long-distance continuous travel >2 hours Long-distance travel and immobilization are significant risk factors for VTE. However, it is thought that continuous travel for more than 6 or 8 hours is a significant risk factor for VTE.

78. A 20-year-old man presents with a 1-week history of sore throat, fever, and malaise. Over the past 3 days, he has developed facial swelling and pleuritic chest pain. His chest imaging is shown below. What is the most common bacterial etiology of this disease process?



- A. Bacteroides
- B. Fusobacterium
- C. Staphylococcus
- D. Streptococcus

Correct: Fusobacterium

This patient is suffering from Lemierre syndrome, which is a rare complication of pharyngitis or tonsillitis. *Fusobacterium necrophorum* is the most common anaerobe to cause Lemierre syndrome. The bacterial infection extends from the pharyngeal space and causes a subsequent septic thrombophlebitis of the internal jugular vein. This septic thrombophlebitis is complicated by a septic embolism. *F. necrophorum* is a gram-negative bacillus that is an obligate anaerobe. Because *F. necrophorum* is a beta-lactamase producer, empiric treatment regimens, such as piperacillin-tazobactam or a carbapenem, should be utilized. Once cultures have speciated *Fusobacterium*, metronidazole can be used for treatment.

Bacteroides This patient is suffering from Lemierre syndrome, which is most commonly caused by *Fusobacterium*. *Bacteroides* is an aerobic gram-negative organism that is part of the normal human gut flora. *Bacteroides* species have been reported to cause Lemierre syndrome, but *Fusobacterium* is more common.

Staphylococcus *Staphylococcus*, a gram-positive organism, can be recovered in deep facial infections but is only rarely recovered in Lemierre syndrome. Both methicillin-sensitive and methicillin-resistant *Staphylococcus aureus* have been reported to cause Lemierre syndrome, although less commonly than *Fusobacterium*. If the patient has risk factors for resistant bacteria or hemodynamic instability, empiric antibiotic coverage should include MRSA coverage (ie, vancomycin). Other organisms that are rarely recovered are *Eikenella*, *Peptostreptococcus*, and *Enterobacter*.

Streptococcus *Streptococcus* is a gram-positive organism that has been recovered from deep facial infections and mastoiditis. However, *Streptococcus* is rarely recovered in Lemierre syndrome and is often recovered in conjunction with *Fusobacterium*.

79. A 52-year-old man presents via ambulance with shortness of breath and hoarseness, following a fire in an industrial plant. The physical examination reveals a very hoarse voice, difficulty speaking, occasional audible stridor, and significant wheezing in all lung fields. His vital signs are BP 102/54, P 108, R 28, and T 37.1°C (98.8°F); SpO₂ is 90% on room air. What is the best next step in management?

- A. Initiate BiPAP
- B. Perform immediate RSI
- C. Administer albuterol 5 mg by nebulizer
- D. Administer decadron 10 mg IV

Correct: Perform immediate RSI

This patient has been exposed to a pulmonary irritant that is causing bronchospasm and stridor from laryngeal edema. Regardless of what the underlying irritating agent is, he requires immediate rapid sequence induction (RSI) and intubation because of his increasing laryngeal edema and the risk of developing ARDS. In particular, water-soluble irritants can irritate both the upper and lower airways, and if edema is present, early airway control is indicated. Symptoms of ARDS may not develop for 24 to 36 hours from these pulmonary irritants, but because of the stridor, direct visualization and control of the airway are warranted. Initiate BiPAP The contraindications for BiPAP include upper airway obstruction that can be bypassed by endotracheal intubation (as in this case), facial deformity from trauma or other causes that do not allow seal of the mask, decreased respiratory effort from an altered level of consciousness, and vomiting or increased secretions. There is no role for BiPAP in this patient with upper airway stridor. Administer albuterol 5 mg by nebulizer Inhalation injury is the leading cause of death from burns, given the significant improvement in fluid management. Bronchospasm is a prominent symptom due to the particles in smoke and the edema from the inflammatory process. Albuterol is indicated as a potential stabilizing measure, but delaying definitive airway management to provide an albuterol treatment is not the right next step for this patient with stridor and impending airway closure. Administer decadron 10 mg IV Corticosteroids have not been shown to be effective at mitigating the symptoms this patient has, and even if they did have an effect, it would take hours.

80. A 29-year-old woman presents with a 6-day history of a persistent and occasionally productive cough that is worse at night. She has no fever or wheezing. On examination, her vital signs are normal, and lung sounds are clear. What is the most appropriate treatment to decrease the severity of her symptoms?

- A. Oral antitussive
- B. Oral steroids
- C. Oseltamivir
- D. Azithromycin

Correct: Oral antitussive

Oral steroids are useful for patients who have asthma and experience a flare secondary to an upper respiratory tract infection. They are not routinely indicated, however, and would not be helpful in this case. Oral antitussive This patient has an upper respiratory tract infection without evidence of bronchoconstriction or pneumonia. Patients with acute bronchitis of a viral etiology or an upper respiratory tract infection can get brief symptom relief with antitussive medications and expectorants. Patients who are wheezing may benefit from using beta-agonists, but there is no role for antibiotics, antiviral agents, or steroids in the treatment of these patients. Oseltamivir Oseltamivir is

indicated only for patients with the influenza virus who present with an acute infection within the first 48 hours after symptom onset. This patient has had symptoms for 6 days and does not have a fever, which is typical with influenza illness. Azithromycin Neither azithromycin nor any other antibiotic is indicated for upper respiratory tract infections in patients without COPD because the underlying infection is most commonly viral.

81. Which statement regarding the management of acute severe asthma is correct?

- A. Use of noninvasive positive pressure ventilation is based on strong evidence
- B. Intravenous beta-agonists are more effective than nebulized beta-agonists
- C. Early use of glucocorticoid therapy decreases admission rates
- D. Heliox is most beneficial when used in profoundly hypoxic patients

Correct: Early use of glucocorticoid therapy decreases admission rates

No compelling evidence has shown intravenous beta-agonists to have superior efficacy over nebulized beta-agonists in the management of asthma. Some studies have even shown that intravenous beta-agonists might produce worse outcomes. Continuous nebulization seems to be more effective than intermittent delivery for severe asthma exacerbations, but there seems to be no difference for mild to moderate attacks. Use of noninvasive positive pressure ventilation is based on strong evidence The best evidence for the use of noninvasive positive pressure ventilation (NIPPV) is for COPD exacerbations and cardiogenic pulmonary edema, in which NIPPV results in decreased rates of intubation and shorter ICU stays, as well as reduced mortality rates. Although NIPPV is used for severe asthma prior to mechanical ventilation, there is minimal evidence to suggest that any patient-centered outcomes are changed by its use with severe asthma exacerbations. Early use of glucocorticoid therapy decreases admission rates Standard management for a severe asthma exacerbation includes correction of hypoxemia; administration of nebulized beta-agonists, anticholinergic agents, systemic glucocorticoids, or magnesium; and occasionally, positive pressure ventilation. Glucocorticoids should be used early to treat a severe acute asthma attack and should not be withheld while waiting for other therapeutic regimens such as beta-agonist therapy to be completed. Studies involving patients with severe asthma have shown that the early use of corticosteroids significantly reduces admission rates and decreases the duration of asthma exacerbation. The optimal dose of glucocorticoids is unknown for severe asthma exacerbations, and high doses of glucocorticoids have no proven additional benefit over standard dosing. Both intravenous and oral administration are effective options; however, the intravenous route is ideal for patients who cannot tolerate oral intake due to the severity of the presentation. Heliox is most beneficial when used in profoundly hypoxic patients Heliox is a mixture of helium and oxygen; typical ratios are 80:20 and 70:30 helium to oxygen. These ratios are specifically designed to decrease the density of gas by replacing nitrogen with helium. The result is less turbulence and more laminar flow in large airways, which decreases airway resistance, reduces work of breathing, and improves ventilation. However, due to the high percentage of helium in the mixture, heliox is inappropriate for profoundly hypoxic patients. To date, there is a lack of evidence to suggest that heliox improves outcomes in patients with severe asthma exacerbations.
