

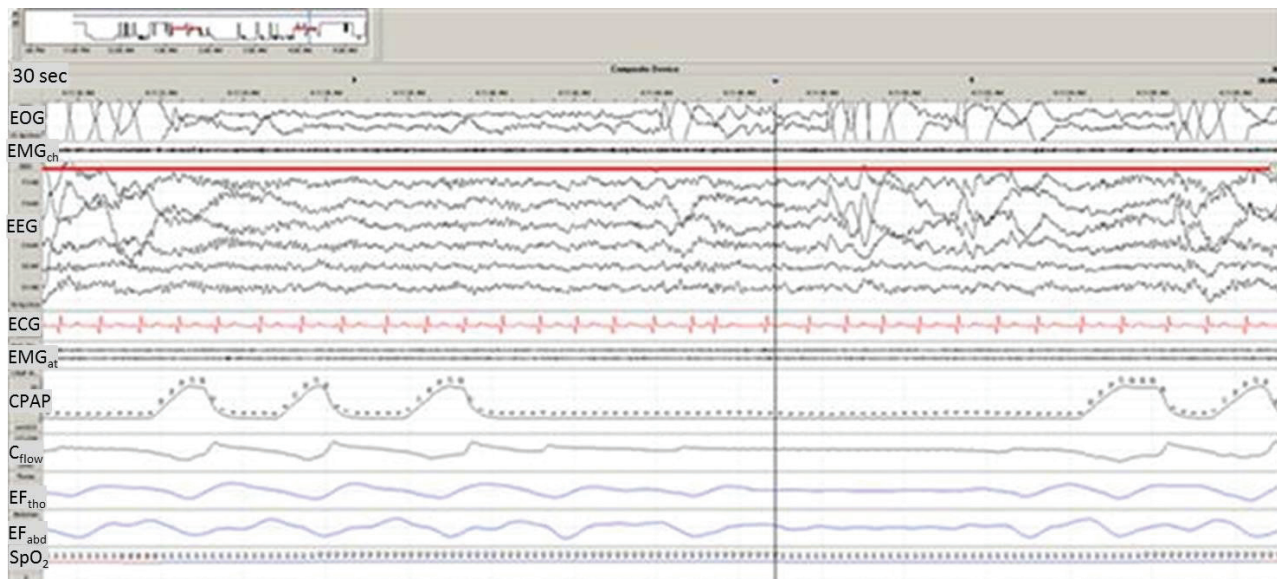
**3.** A 40-year-old previously healthy man is admitted to the ICU secondary to progressive acute respiratory failure from pneumonia. He requires mechanical ventilation and initiation of neuromuscular blockade. He has been receiving volume-control ventilation with tidal volume of 6 ml/kg predicted body weight,  $\text{FiO}_2$  of 1.0, and PEEP of 16 cm  $\text{H}_2\text{O}$  for the past 18 hours to maintain an oxygen saturation of 90%. He is hemodynamically stable with a peak pressure of 37 cm  $\text{H}_2\text{O}$  and a plateau pressure of 29 cm  $\text{H}_2\text{O}$ . Which of the following treatments should be initiated?

- A. Inhaled nitric oxide
- B. High-frequency oscillatory ventilation
- C. Prone positioning
- D. Airway pressure-release ventilation

**4.** A 38-year-old man is admitted to the ICU for hypercapnic respiratory failure. He weighs 502 lb (226 kg). He is intubated, and over the next 24 h his  $\text{PCO}_2$  falls from 71 to 51 mm Hg. He is extubated and transferred out of the ICU the next day. He snores loudly at night, and nurses observe frequent apnea, so he is started on bilevel PAP at 10/5 cm  $\text{H}_2\text{O}$  during sleep. He is discharged 2 days later and is scheduled for another polysomnography. The study is performed as a split night, and he has severe OSA during the baseline (apnea-hypopnea index = 56/h) and CPAP, after which bilevel PAP is initiated. He is on a bilevel pressure of 20/6 cm  $\text{H}_2\text{O}$ , and a number of epochs like this are noted in the REM period; no leak is noted (Figure 4-A). In non-REM, events like this are not seen, the overall apnea-hypopnea index is <5/h, and oxygen saturation stays at >90%.

What would be the most appropriate way to manage this patient's PAP to improve his REM-related problem?

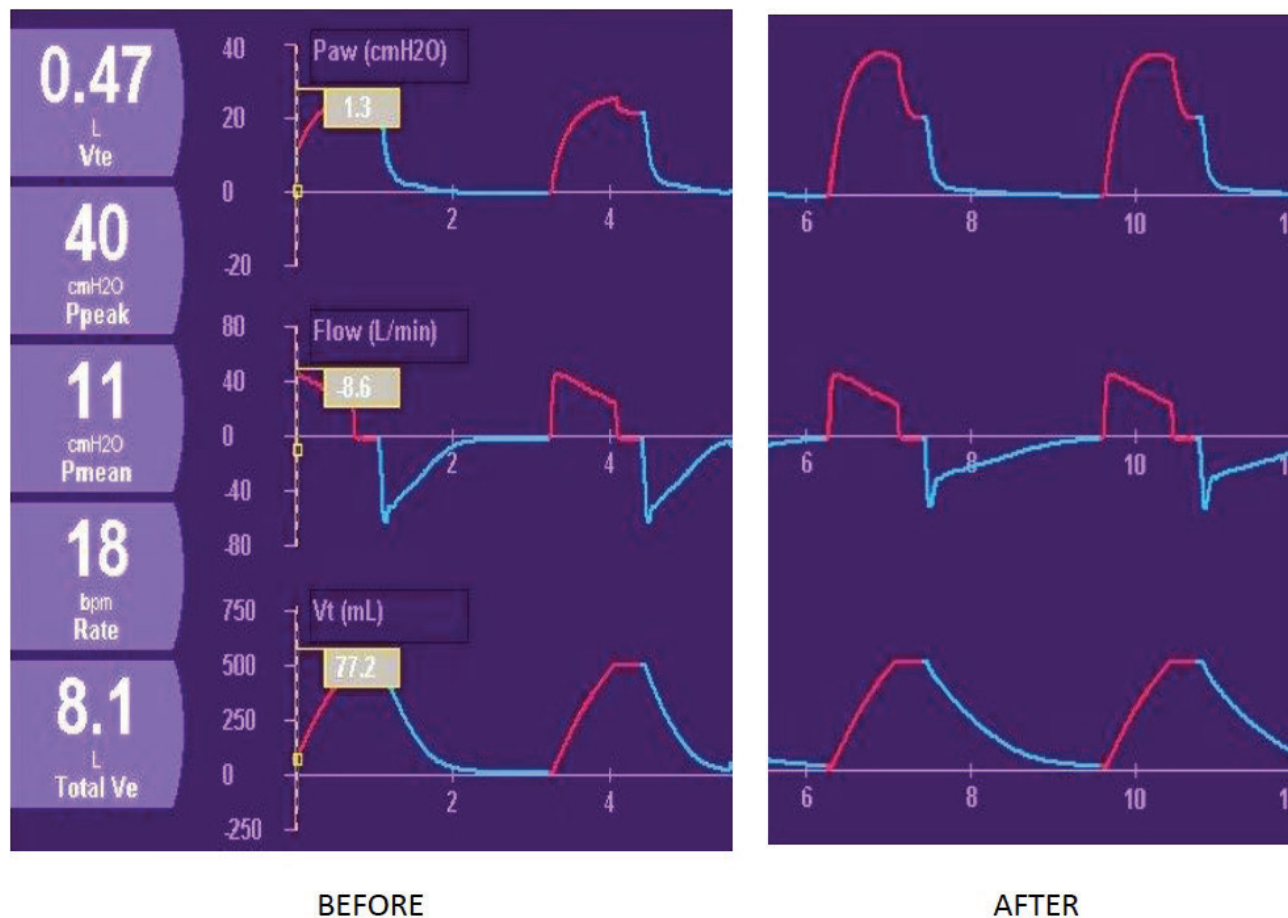
- A. Increase inspiratory PAP (IPAP) to 24 cm  $\text{H}_2\text{O}$ .
- B. Decrease IPAP to 16 cm  $\text{H}_2\text{O}$ .
- C. Increase expiratory PAP (EPAP) to 10 cm  $\text{H}_2\text{O}$ .
- D. Initiate a backup rate at 16 bpm.



**Figure 4-A** Polysomnogram, 30-s epoch.  $C_{\text{flow}}$  = airflow from CPAP; ECG = lead 2 of electrocardiography; EEG = six leads of electroencephalography (two frontal, two central, two occipital);  $\text{EF}_{\text{abd}}$  = abdominal effort;  $\text{EF}_{\text{tho}}$  = thoracic effort;  $\text{EMG}_{\text{at}}$  = electromyography of anterior tibialis muscle;  $\text{EMG}_{\text{ch}}$  = electromyography of chin muscle; EOG = electrooculography.

**5.** A patient receiving mechanical ventilation has suddenly had ventilator alarms activated. A recording of the ventilator graphics immediately before and after alarm activation is shown Figure 5-A. What is the appropriate next step?

- A. Emergency tube thoracostomy
- B. IV diuretics
- C. Endotracheal tube suctioning
- D. Laryngoscopic evaluation of tube placement



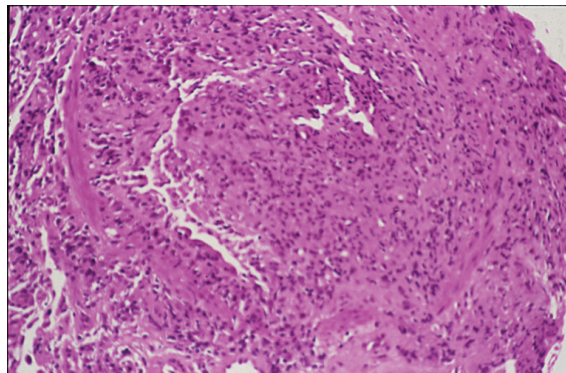
**Figure 5-A**

**6.** A 60-year-old woman with a history of COPD status post bilateral lung transplantation (LT) 9 months ago is seen for her routine follow-up visit. Her post-transplant course is notable for an episode of acute cellular rejection at 6 weeks following LT. She was cytomegalovirus (CMV) and Epstein-Barr virus (EBV) negative prior to transplantation and received lungs from a CMV-positive and EBV-positive donor. The patient reports recent symptoms of cough, sputum production, and mild dyspnea on exertion. She denies fever, chills, or sweats. She remains on her medication regimen of tacrolimus, mycophenolate mofetil, prednisone, trimethoprim-sulfamethoxazole, and valganciclovir. Her lung examination is clear. Pulmonary function tests (PFTs) show an FEV<sub>1</sub> of 1.4 L and an FVC of 2 L (baseline FEV<sub>1</sub>, 1.7 L and FVC, 2.2 L). Her chest CT scan is shown in Figure 6-A. Labs are unremarkable, and tacrolimus level is therapeutic. She undergoes bronchoscopy with transbronchial biopsy with the histology shown (Figure 6-B). Cultures are negative to date. CMV polymerase chain reaction is pending. The most likely diagnosis in this case is:

- A. Acute cellular rejection
- B. Chronic rejection
- C. Posttransplant lymphoproliferative disorder
- D. CMV infection



**Figure 6-A**



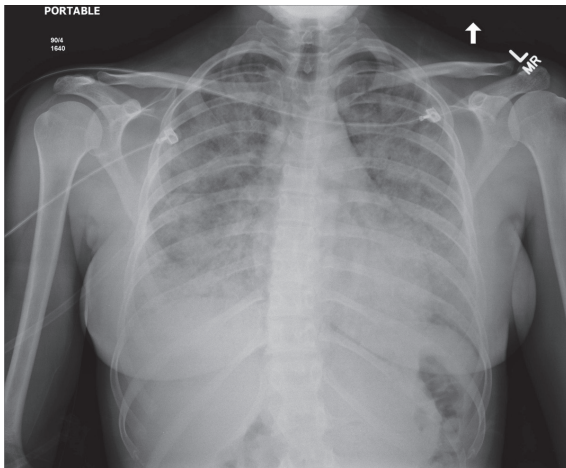
**Figure 6-B** Hematoxylin-eosin stain (magnification  $\times 10$ ).

**7.** A 32-year-old woman is referred for evaluation for progressive dyspnea and an abnormal chest radiograph (Figure 7-A). She appears otherwise healthy without infectious symptoms. She requires 6 L/min supplemental oxygen at rest and 10 L/min with exertion to maintain normoxia. Although therapeutically anticoagulated for a history of Protein S deficiency without prior thromboembolic events, a CT angiogram of the chest was obtained (Figure 7-B), which did not reveal any thromboembolic disease. A diagnostic bronchoscopy was attempted, but due to refractory hypoxia, she was intubated and referred for a surgical lung biopsy. Bronchoscopy was not reattempted due to severe, refractory hypoxia, and a minithoracotomy was performed (Figure 7-C). Postoperatively, the patient was profoundly hypoxic despite maximal ventilatory support.

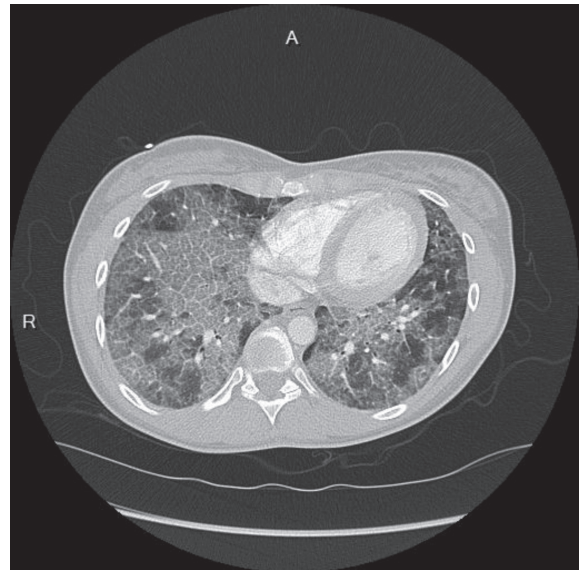
The best therapeutic intervention to treat her underlying disease process would be:

- A. Plasmapheresis
- B. IV administration of corticosteroids
- C. Whole-lung lavage
- D. IV administration of cyclophosphamide

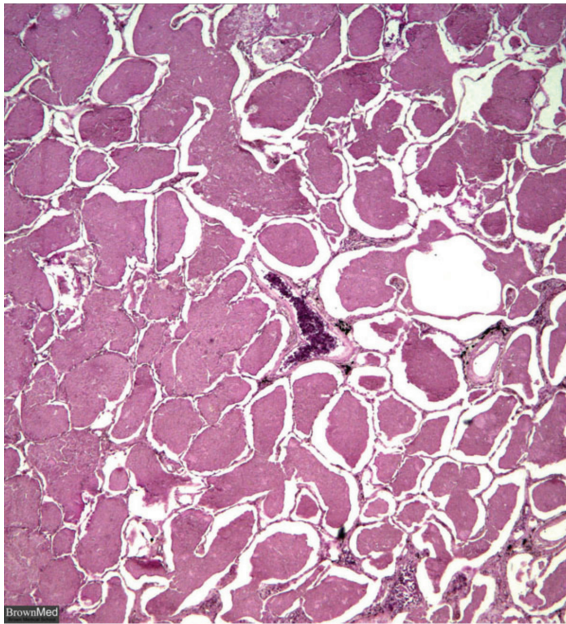




**Figure 7-A** Posteroanterior chest radiograph.



**Figure 7-B** CT image of the patient's chest.



**Figure 7-C** Stained section of surgical lung biopsy specimen (hematoxylin and eosin stain,  $\times 10$  magnification).

**8.** A 52-year-old man comes to your outpatient clinic for optimization of COPD recently diagnosed by his family physician. He slows his walking speed because of shortness of breath, but is not limited in how far he can walk. He was prescribed albuterol (salbutamol) 1 year ago, which he uses twice daily, but he feels it provides minimal relief. He has suffered from frequent colds that go to his chest, and has required antibiotics for these "chest colds" on two occasions in the past 2 years. He has a 30 pack-year smoking history, but has not smoked for 7 years. His only medication is albuterol, and he has no other significant medical history.

Pulse oximetry reveals an oxygen saturation 96% on room air, and his other vital signs are normal. Chest examination confirms decreased breath sounds, but no crackles or wheezes, and there are no focal signs of consolidation. The remainder of the examination findings are normal. His chest radiograph reveals hyperinflation, but there are no masses or effusions and the cardiac silhouette is not enlarged.

Postbronchodilator spirometry reveals the results shown in Table 8-A.

Which therapeutic intervention would be most appropriate for this patient with COPD?

- A. The current therapy is appropriate. No change is indicated.
- B. Increase the short-acting  $\beta_2$ -agonist (albuterol) dosing frequency to qid.
- C. Start maintenance inhaled corticosteroid/long-acting  $\beta_2$ -agonist (ICS/LABA).
- D. Start maintenance inhaled long-acting muscarinic antagonist (LAMA).

**Table 8-A** Postbronchodilator Spirometry

	Predicted	Observed	%Predicted	LLN-ULN
FVC [L]	5.64	4.06	72	4.6 – 6.7
FEV <sub>1</sub> [L]	4.21	2.32	55	3.4 – 5.0
FEV <sub>1</sub> /FVC	0.75	0.57		0.65 – 0.83

[FEV<sub>1</sub> = forced expiratory volume in 1 second; FVC = forced vital capacity; LLN = lower limit of normal; ULN = upper limit of normal]

**9.** A 68-year-old woman is evaluated for hypoxia. She has a history of nonischemic cardiomyopathy with an ejection fraction of 25% status post implantable cardioverter defibrillator placement, severe diastolic dysfunction, atrial fibrillation, hypertension, and hypothyroidism. She has fatigue and back pain and was found to have compression fractures as the likely etiology of her pain; however, she was also noted to be significantly hypoxic, with an SaO<sub>2</sub> of 84% when breathing ambient air. Review of systems is positive for slowly progressive dyspnea on exertion.

Medications include amiodarone, aspirin, carvedilol, digoxin, furosemide, levothyroxine, lisinopril, lovastatin, spironolactone, and warfarin.

Physical examination shows her to be short of breath at rest, with a temperature of 98.7°F (37.1°C), BP 98/51 mm Hg, a heart rate of 70/min, and a respiratory rate of 24/min. Jugular venous pressure is 10 cm above the angle of Louis, and heart rate is irregularly irregular without rubs, murmurs, or gallops. Chest examination is notable for diffuse inspiratory crackles bilaterally. A 1+ bilateral lower-extremity edema is noted.

Her chest radiograph and representative images from her chest CT scan are shown: Figure 9-A, Figure 9-B, Figure 9-C, and Figure 9-D.

Which of the following factors puts the patient at risk of having developed amiodarone pulmonary toxicity?

- A. Age >60 years
- B. Concomitant statin use
- C. Ejection fraction <30%
- D. Female sex

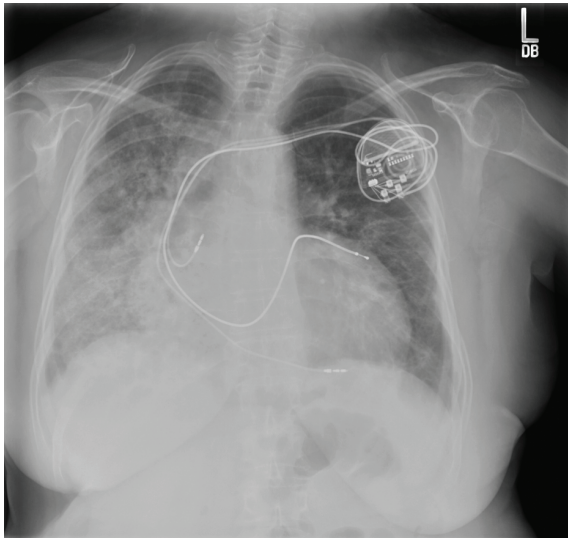


Figure 9-A

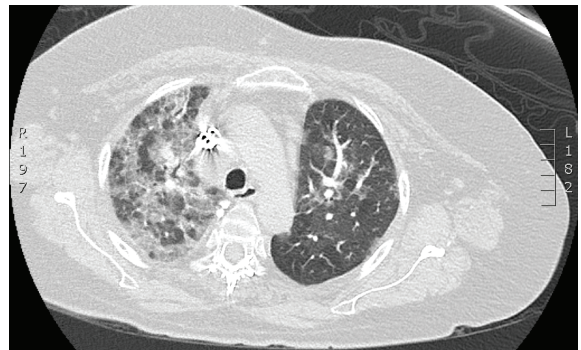


Figure 9-B

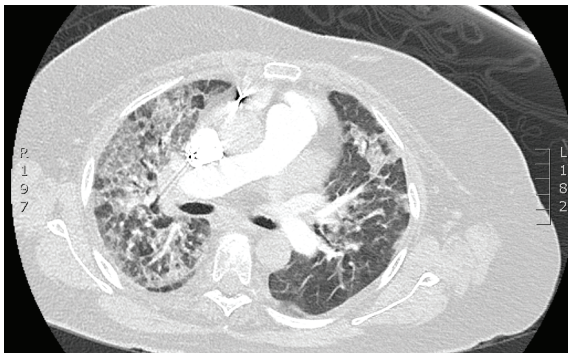


Figure 9-C

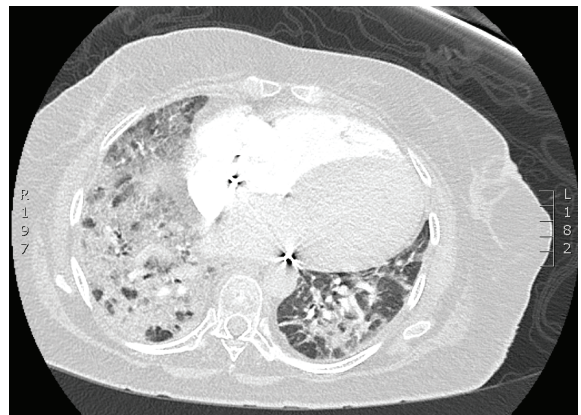


Figure 9-D

**10.** Which of the following factors is associated with a decreased risk of upper-extremity catheter-associated DVT?

- A. Longer duration of central-line use
- B. Antecubital vs internal jugular or subclavian insertion of the central venous catheter
- C. Infection of the central venous catheter
- D. Smaller vs larger diameter of the central venous catheter

**11.** A 27-year-old paramedic is brought to the ED in respiratory distress by her coworkers. She has a long history of asthma that is usually minimally symptomatic but has been punctuated by the sudden development of severe attacks requiring intubation on four prior occasions. There are normally no clear precipitating factors for these attacks, and on each occasion she recovers relatively quickly and has normal pulmonary function tests (PFTs) at her follow-up visits. Today's attack started very suddenly at work.



She routinely takes fluticasone (two puffs bid) and rarely requires a dose of albuterol (salbutamol). She has very good exercise tolerance and plays on a softball team. She has no nocturnal respiratory symptoms. On arrival at the ED, she is in too much distress to provide additional history, but her coworkers state that she complained of throat tightness and marked dyspnea, and they noted some wheezing.

On physical examination, she is tachypneic, breathing at 32/min with use of accessory muscles. Her pulse is regular at 120/min. There is diffuse inspiratory and expiratory wheezing. The remainder of the physical examination is unremarkable. She cannot cooperate with the peak expiratory flow-rate measurements. Her oxygen saturation is normal on a 50% face mask. Her chest radiograph is normal. After six treatments with inhaled albuterol (salbutamol) and ipratropium, she looks as if she is tiring. After induction with ketamine, she is intubated and placed on assist-control ventilation with 500 mL tidal volume and 5 cm H<sub>2</sub>O of PEEP. Her wheezing immediately improves, and her mechanics are normal with peak airway pressures of 18 cm H<sub>2</sub>O and a plateau pressure of 14 cm H<sub>2</sub>O. She is extubated the next morning and discharged home after another day of observation in the hospital. At the time of discharge, her spirometry is normal.

Which of the following is most likely to benefit her in the future?

- A. The addition of a long-acting  $\beta$ -agonist to her fluticasone
- B. Prescription for epinephrine to carry with her to treat her next attack
- C. Referral for consideration of bronchial thermoplasty
- D. Referral to an otolaryngologist and speech pathologist

**12.** A 63-year-old man without significant pulmonary disease is intubated and undergoes a right colectomy for colon cancer. Prior to the procedure, his lungs are clear and gas exchange is normal. According to accumulating evidence, his perioperative ventilator management strategy should consist of:

- A. Tidal volumes of 10 to 12 mL/kg and maintaining end-inspiratory plateau pressures <45 cm of water
- B. Tidal volumes of 10 to 12 mL/kg and maintaining end-inspiratory plateau pressures <30 cm of water
- C. Tidal volumes of 6 to 8 mL/kg and maintain end-inspiratory plateau pressures <30 cm of water
- D. Tidal volumes of 6 to 8 mL/kg and maintaining end-inspiratory plateau pressures <45 cm of water

**13.** A novel antibiotic is undergoing testing in patients with ventilator-associated pneumonia (VAP). In normal, healthy subjects, the volume of distribution of this antibiotic is 13 L with a half-life of 2.9 h, thus requiring a dose of 2 g q8h. Assuming normal renal and hepatic function, which dose adjustment should be performed in patients with VAP who are critically ill in the ICU?

- A. Administer a loading dose (eg, 3 g at first dose).
- B. Decrease the dosing interval (eg, 2 g q12h).
- C. Decrease the dose (eg, 1 g q8h).
- D. No change in dose (ie, 2 g q8h).

**14.** A 34-year-old woman has had subacute onset of dyspnea over a 2-week period associated with a dry cough. She reports abdominal pain and distention with nausea, but without vomiting or diarrhea. She has also noted a weight gain of 6 pounds (3 kg) over the prior week and swelling in her ankles. She denies fevers, chills, or sweats. Her past medical history is unremarkable. She denies tobacco or alcohol use. She is married and has been trying to get pregnant and began treatment for infertility 1 month ago.

On physical examination, she is in mild distress, her respiratory rate is 25/min, pulse is 120/min, BP is 100/58 mm Hg, and she is afebrile. Her oxygen saturation is 90% on 4 L/min of supplemental oxygen. Lung examination reveals decreased breath sounds at both bases, and cardiac examination reveals tachycardia. Abdominal examination is notable for mild distension and a fluid wave. Extremities reveal 2+ edema. Laboratory results are notable for a hemoglobin level of 14 g/dL (140 g/L), a WBC count of  $8.4/\mu\text{L}$  ( $8.4 \times 10^9/\text{L}$ ), and a creatinine level of 1.3 mg/dL ( $114.9 \mu\text{mol/L}$ ). Her chest radiograph reveals moderate-sized bilateral pleural effusions. She is transferred to the ICU for observation. What should be ordered to confirm the likely diagnosis in this case?

- A. Abdominal/pelvic ultrasound
- B. Chest CT scan
- C. Diagnostic thoracentesis
- D. Blood cultures

**15.** A 40-year-old never smoker is seen for evaluation of an anterior mediastinal mass. She describes 3 years of intermittent left shoulder pain, increasing in frequency and intensity over time. This recently led to chest imaging that revealed a large anterior mediastinal mass.

She is able to be active without significant dyspnea. She is not coughing, wheezing, having fevers, or appetite problems. She has noticed intermittent diplopia and drooping of her eyelids. She is a never smoker without prior known chronic lung problems. She is otherwise healthy. There is no family history of malignancy.

A CT scan of the chest shows a large anterior mediastinal mass extending toward the left hilum exerting mild mass effect on the left main pulmonary artery (Figure 15-A). There are two pleural-based nodules, one at the left lung apex and the other in the fissure on the left. The left hemidiaphragm is elevated. The mass and pleural-based nodules are avid on fluorodeoxyglucose PET imaging. Which of the following is the most likely cause of this patient's mediastinal mass?

- A. Lymphoma
- B. Germ cell tumor
- C. Substernal thyroid
- D. Thymoma



**Figure 15-A** CT scan of the chest showing a large anterior mediastinal mass.