

Pulmonary Embolus: Review Questions

Nuala J. Meyer, MD

QUESTIONS

Choose the single best answer for each question.

1. A 64-year-old man presents to the emergency department complaining of shortness of breath. He has a history of pancreatic cancer. The patient reports a 1-week history of mild pleuritic chest pain and a tender swelling on the medial aspect of his left thigh. On examination, the patient's heart rate is 112 bpm, blood pressure is 134/72 mm Hg, respiratory rate is 22 breaths/min, and SaO_2 is 95% on room air. Cardiovascular examination reveals tachycardia with normal rhythm. Lung examination shows dullness to percussion at the right base with decreased breath sounds. A chest radiograph demonstrates a moderate right-sided pleural effusion, and duplex ultrasonography of the left lower extremity reveals an acute thrombus in the left superficial femoral vein. Thoracentesis is performed and fluid analysis reveals: serous fluid; pH, 7.43; white blood cell count, 566 cells/ μL (2% neutrophils, 83% lymphocytes, 7% macrophages, 9% mesothelial cells); red blood cell count, 2040 cells/ μL ; protein, 1.4 g/dL (serum protein, 5.9 g/dL); L-lactate dehydrogenase (LDH), 58 IU/L (serum LDH, 216 IU/L). No malignant cells are seen on cytopathologic review. What is the likely etiology of this patient's pleural effusion?
- (A) Congestive heart failure
 - (B) Hepatic insufficiency due to pancreatic cancer
 - (C) Metastatic pancreatic cancer
 - (D) Pneumonia
 - (E) Pulmonary embolism (PE)

Questions 2 and 3 refer to the following case.

A 31-year-old pregnant woman at 29 weeks' gestation presents to her obstetrician due to dull left-sided chest pain and acute-onset shortness of breath. She denies calf or thigh tenderness. Physical examination is unremarkable except for sinus tachycardia; arterial

pulse oximetry is normal (96% on room air). Chest radiograph is also normal.

2. What is the best diagnostic study to evaluate this patient for PE?
- (A) Computed tomography pulmonary angiography (CTPA)
 - (B) Duplex ultrasonography
 - (C) Invasive pulmonary angiography
 - (D) Perfusion lung scintigraphy
 - (E) Transthoracic echocardiography
3. PE is determined to be present in this patient. What is the optimal initial and long-term regimen for this patient's thromboembolic disease?
- (A) Intravenous (IV) unfractionated heparin to an activated partial thromboplastin time (aPTT) 1.5 to 2 times baseline, followed by warfarin to an international normalized ratio (INR) between 2 and 3 for several months postpartum
 - (B) IV unfractionated heparin to an aPTT 1.5 to 2 times baseline, followed by warfarin to an INR between 1.5 and 2.5 for several months postpartum
 - (C) IV unfractionated heparin to an aPTT 1.5 to 2 times baseline, followed by twice daily subcutaneous unfractionated heparin for several months postpartum
 - (D) Low-molecular-weight heparin (LMWH) subcutaneously throughout pregnancy and for several months postpartum

Questions 4 and 5 refer to the following case.

A 47-year-old man with a history of chronic obstructive pulmonary disease (COPD), diabetes, and hypertension presents to the emergency department complaining of dizziness, weakness, and dyspnea on exertion. He denies chest pain or calf tenderness. Physical examination reveals mild tachycardia (heart rate, 105 bpm), normal blood pressure (132/76 mm Hg), normal respiratory rate, and mild hypoxemia (88% on room air). D-dimer test

Dr. Meyer is a pulmonary and critical care fellow, University of Chicago, Chicago, IL.



Figure 1. Computed tomography pulmonary angiogram from the case patient in question 5 demonstrating a saddle embolus in the main pulmonary arterial trunk.



Figure 2. Computed tomography pulmonary angiogram from the same patient 1 day later, after he received the medication in question 5.

is positive, and CTPA demonstrates a saddle PE in the main pulmonary arterial trunk (**Figure 1** and **Figure 2**). Transthoracic echocardiography reveals evidence of acute right heart strain, with a poorly contracting right ventricle, tricuspid regurgitation with pulmonary hypertension, and bowing of the interventricular septum towards the left ventricle. Computed tomography of the head is normal and reveals no cause for dizziness. He has no known contraindications to anticoagulation.

4. How should the echocardiographic findings of right ventricular strain alter management of this patient?

- (A) The patient is at increased risk for shock or death from PE and should receive more intensive monitoring
- (B) The patient is at increased risk for shock or death from PE and should receive thrombolytic therapy
- (C) The patient is at increased risk for recurrent PE and should receive LMWH rather than warfarin
- (D) The patient is at increased risk for ongoing embolization and should receive a vena caval interruption device

5. The patient is admitted to the intensive care unit and is anticoagulated with heparin. Over the next 24 hours, he develops hypotension and mental status changes. Dobutamine is initiated to support the right ventricle along with norepinephrine to augment mean arterial pressure. Which therapy would be most appropriate at this time?

- (A) IV alteplase 100 mg over 2 hours
- (B) IV argatroban 2 µg/kg/min

- (C) IV dopamine 2.5 µg/kg/min
- (D) IV tirofiban 0.4 µg/kg/min for 30 min, then 0.1 µg/kg/min
- (E) Warfarin 7.5 mg by mouth at bedtime

ANSWERS AND EXPLANATIONS

1. **(E) PE.** The patient's clinical history strongly suggests PE with an associated left leg deep venous thrombosis (DVT). This patient also has a transudative pleural effusion (fluid protein:serum protein, 0.24; fluid LDH:serum LDH, 0.27). PE may present with pleural effusions in one third to one half of patients, depending on whether chest radiography or computed tomography is performed.¹ Although PE-associated pleural effusions are typically small and exudative, many may be transudative and approximately 10% may be large or massive.² PE should be investigated when evaluating patients with pleural effusions of unknown etiology, whether exudative or transudative. Although congestive heart failure and hepatic insufficiency are causes of transudative pleural effusion, these conditions are not supported by the patient's clinical history. Malignant pleural effusion and pneumonia would result in exudative effusions.
2. **(D) Perfusion lung scintigraphy.** Because this pregnant patient with suspected PE has no known underlying lung disease and a normal chest radiograph, perfusion lung scintigraphy (performed without a ventilation study and often at half-dose of technetium 99m) is an appropriate initial test that has a low percentage of nondiagnostic scans.³ Although the fetus is exposed to slightly higher levels of radiation

with pulmonary scintigraphy as compared with CTPA (0.11 mGy versus 0.01 mGy), this dose remains well below the established threshold of 50 mGy to avoid known fetal malformations, and this dose may be cut in half by requesting a half-dose of perfusion agent. Duplex ultrasonography is effective and safe in diagnosing DVT. It is most sensitive if leg symptoms are present, and it is less sensitive in pregnant patients, who often develop DVT in pelvic veins, which cannot be imaged by ultrasonography. Echocardiography is an effective tool to assess risk for shock or death in patients with PE, but it is insensitive as a diagnostic tool (sensitivity, 52%).⁴ CTPA is an acceptable test in pregnancy, but this modality exposes the mother to higher levels of radiation and may pose an unacceptably high risk of malignancy to proliferating maternal breast tissue. Because of this, CTPA is recommended only in cases when the mother has an underlying lung disease (eg, asthma, COPD) or when frontal chest radiography is abnormal. Invasive pulmonary angiography is not recommended as an initial diagnostic test because it has the highest risk of complications; however, it may be useful when less invasive tests are nondiagnostic and clinical suspicion for PE remains high.

- 3. (D) LMWH subcutaneously throughout pregnancy and for several months postpartum.** Both unfractionated heparin and LMWH are safe and effective in treating thromboembolic disease in pregnancy. Neither crosses the placenta, and their efficacies in treating DVT and PE are essentially equivalent. However, LMWH has a lower incidence of bleeding complications, heparin-induced thrombocytopenia, and osteoporosis as compared with heparin.⁵ Osteoporosis is a serious complication of full-dose heparin during pregnancy, with fractures occurring in 2% of treated women.⁵ LMWH does not appear to accelerate bone density loss. Warfarin is teratogenic and should not be administered during pregnancy.
- 4. (A) The patient is at increased risk for shock or death from PE and should receive more intensive monitoring.** Most patients with PE will have a normal echocardiogram. When evidence of right ventricular strain is present, echocardiography reliably predicts an increased risk of death from PE. Even if patients are hemodynamically stable when the echocardiogram reveals right ventricular compromise, 10% of such patients will develop shock and 5% will die in the hospital.⁶ As such, patients with right ventricular

strain should be initially monitored in the intensive care unit, even when hemodynamically stable. Although some physicians advocate more aggressive treatment for such patients (eg, thrombolytic therapy, vena caval interruption, higher target INR), none of these strategies has adequate data to support their use. Right ventricular strain was also recently shown to predict recurrent embolization;⁷ however, the use of different anticoagulation strategies based on this information has not been evaluated.

- 5. (A) IV alteplase 100 mg over 2 hours.** This patient has developed shock related to PE, and thrombolytic therapy, such as alteplase, is often recommended in the absence of known contraindications. There is insufficient evidence to recommend any specific thrombolytic therapy over another. Dopamine is a vasoconstricting agent that may help to augment mean arterial blood pressure, but it does not offer an advantage over norepinephrine, which this patient is already receiving. Tirofiban is an antiplatelet glycoprotein IIb/IIIa inhibitor indicated in the treatment of acute coronary syndrome; it has no role in treating venous thromboembolic disease. Warfarin and argatroban are acceptable alternatives to heparin for treating thromboembolic disease but are no more effective than heparin and are not indicated for massive PE.

REFERENCES

1. Porcel JM, Madronero AB, Pardina M, et al. Analysis of pleural effusions in acute pulmonary embolism: radiological and pleural fluid data from 230 patients. *Respirology* 2007;12:234–9.
2. Light RW. Clinical practice. Pleural effusion. *N Engl J Med* 2002;346:1971–7.
3. Scarsbrook AF, Bradley KM, Gleeson FV. Perfusion scintigraphy: diagnostic utility in pregnant women with suspected pulmonary embolic disease. *Eur Radiol* 2007 Mar 7; [Epub ahead of print].
4. Bova C, Greco F, Misuraca G, et al. Diagnostic utility of echocardiography in patients with suspected pulmonary embolism. *Am J Emerg Med* 2003;21:180–3.
5. Ginsberg JS, Bates SM. Management of venous thromboembolism during pregnancy. *J Thromb Haemost* 2003;1:1435–42.
6. Grifoni S, Olivetto I, Cecchini P, et al. Short-term clinical outcome of patients with acute pulmonary embolism, normal blood pressure, and echocardiographic right ventricular dysfunction. *Circulation* 2000;101:2817–22.
7. Grifoni S, Vanni S, Magazzini S, et al. Association of persistent right ventricular dysfunction at hospital discharge after acute pulmonary embolism with recurrent thromboembolic events. *Arch Intern Med* 2006;166:2151–6.