January 2015 Imaging Case of the Month

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Clinical History: A 68-year-old woman with a history of myelodysplastic syndrome associated with transfusion-dependent anemia and thrombocytopenia presented with recent onset left chest pain and fever. The patient had a remote history of total right knee arthroplasty, hypertension, asthma, and schizoaffective disorder. Several months earlier the patient was hospitalized with methicillin-sensitive Staphylococcus aureus infection involving the right knee arthroplasty, associated with bacteremia and a septic right elbow. This infection was treated with incision and drainage of the elbow, antibiotic bead placement about the right knee arthroplasty with an antibiotic-impregnated spacer, and antibiotics (6 weeks intravenous cefazolin followed by chronic doxycycline suppression therapy, the former later switched to nafcillin and rifampin). The patient had been discharged from the hospital with only compression hose for deep venous thrombosis prophylaxis, owing to her episodes of epistaxis in the setting of transfusion-dependent anemia.

Upon presentation, the patient was hypotensive, tachycardic, and hypotensive. Laboratory data showed a white cell count of 3.9 cells x 10^9 / L, a platelet count of 7000 x 10^9 / L, and a hemoglobin level of 7 g/dL.

Frontal chest radiography (Figure 1A) was performed (a baseline chest radiograph- Figure 1B- is presented for comparison).

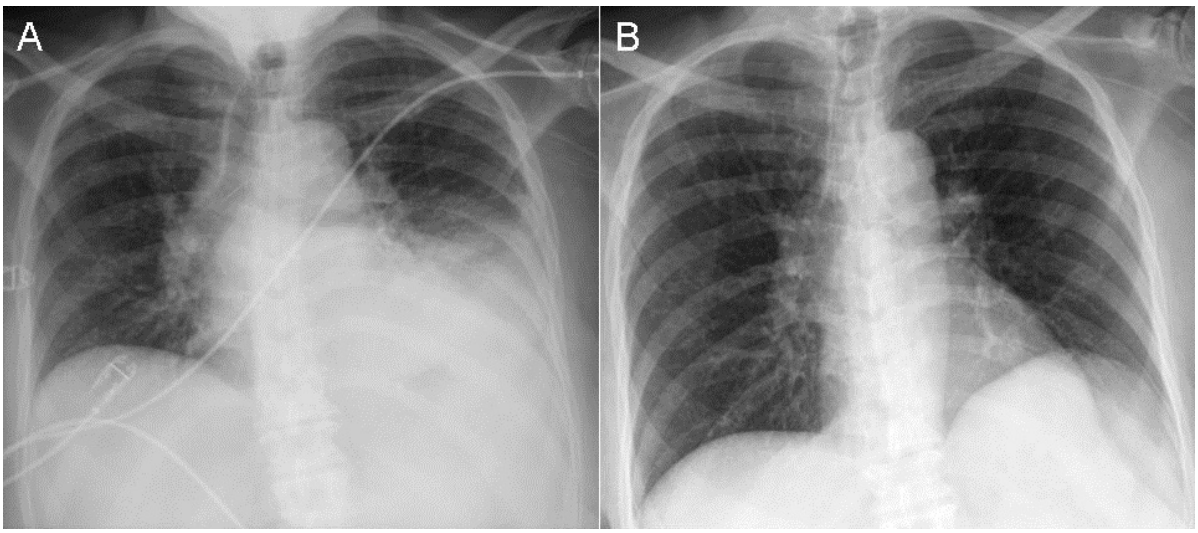

Figure 1. Panel A: Frontal chest radiography Panel B: Frontal chest radiograph obtained 3 months to presentation.

Which of the following statements regarding the chest radiograph is ***most accurate***?

1. The frontal chest radiograph shows bilateral hilar and mediastinal lymph node enlargement
2. The frontal chest radiograph shows enlarged lung volumes with numerous cystic foci
3. The frontal chest radiograph shows linear and reticular abnormalities with architectural distortion associated with fibrotic lung disease
4. The frontal chest radiograph shows lingular and left lower lobe consolidation and left pleural effusion
5. The frontal chest radiograph shows multiple poorly defined bilateral pulmonary nodules

Correct!

4. The frontal chest radiograph shows lingular and left lower lobe consolidation and left pleural effusion

The frontal chest radiograph shows fairly homogeneous opacity obscuring the left heart and left diaphragm borders associated with peripherally located opacity, with a meniscoid shape, suggesting left pleural effusion. The lung volumes are diminished (rather than enlarged, as suggested in choice 2), but features of fibrotic lung disease- linear and reticular opacities with architectural distortion and honeycombing- are lacking. No evidence of pulmonary nodules is seen and the hilar and mediastinal contours do not suggest lymph node enlargement.

Clinical Course: Red blood cell and platelet transfusion was begun, and intravenous antibiotic therapy was started for a presumptive diagnosis of healthcare-acquired pneumonia. Additionally, intravenous corticosteroid therapy was begun given the patient's history of asthma and the detection of wheezing at physical examination. Unenhanced thoracic CT was performed (Figure 2).

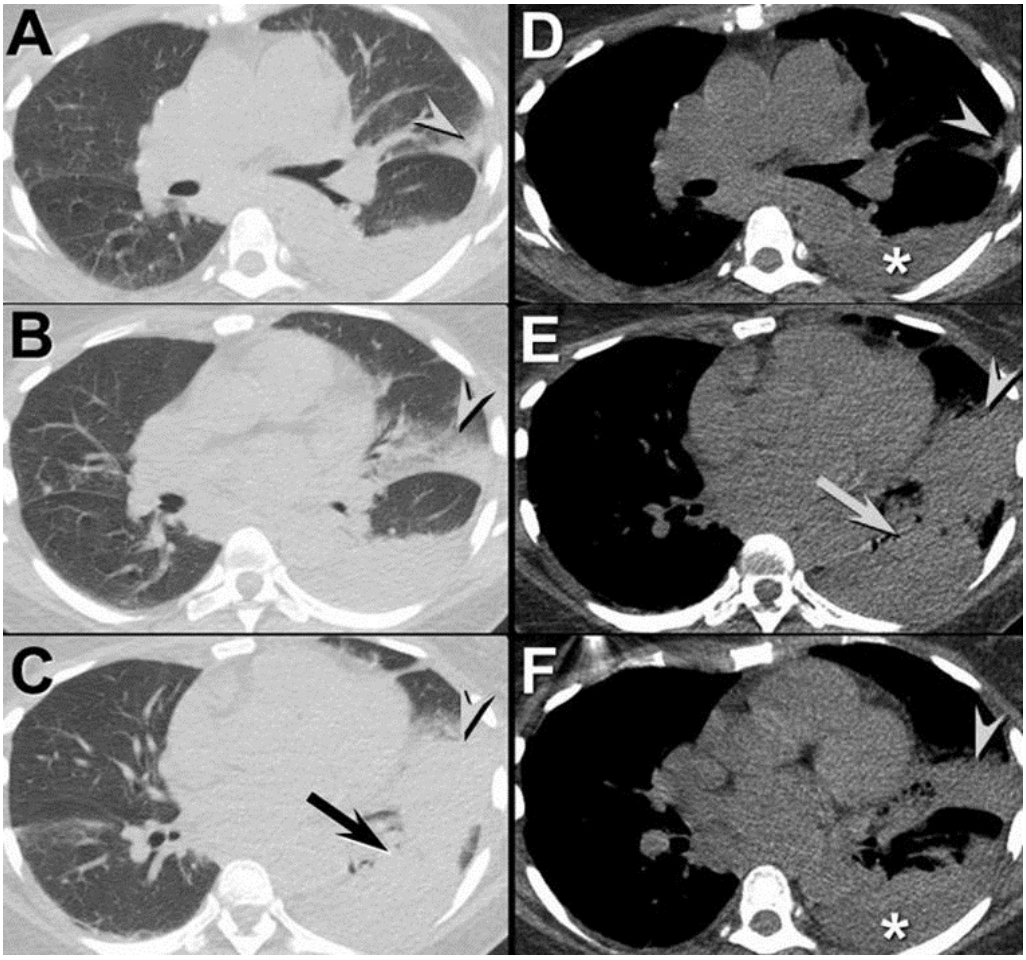

Figure 2. Axial unenhanced thoracic CT.

Which of the following statements regarding the findings at thoracic CT (Figure 2) is ***most accurate***?

1. Unenhanced thoracic CT shows a large pericardial effusion, possibly causing tamponade
2. Unenhanced thoracic CT shows aortic wall hyperattenuation suggesting acute intramural hematoma
3. Unenhanced thoracic CT shows left mainstem bronchial obstruction
4. Unenhanced thoracic CT shows lingular and left lower lobe consolidation associated with a small-to-moderate left pleural effusion
5. Unenhanced thoracic CT shows tension pneumomediastinum

Correct!

4. Unenhanced thoracic CT shows lingular and left lower lobe consolidation associated with a small-to-moderate left pleural effusion

The unenhanced thoracic CT confirms the chest radiographic findings of lingular and left lower lobe consolidation, suggesting pneumonia, associated with a small-to-moderate sized left pleural effusion that may have some loculation inferiorly (Figure 3).

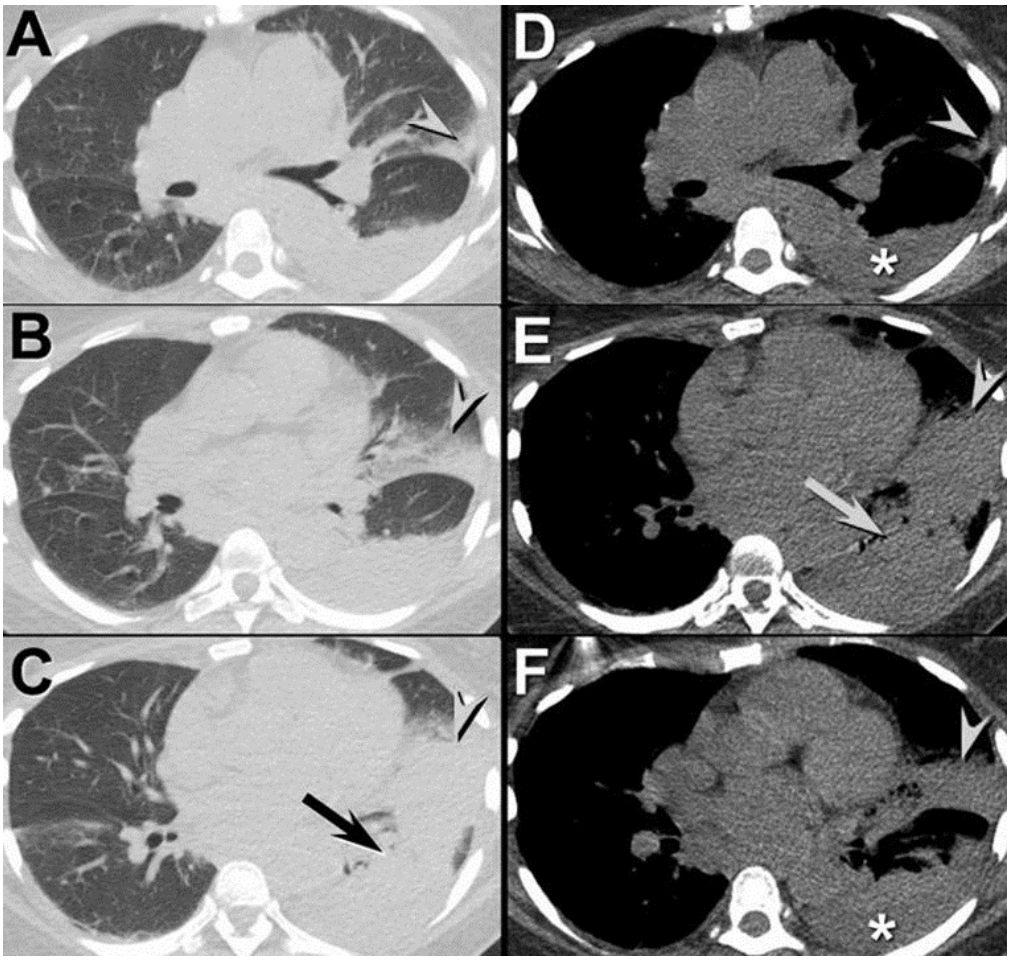

Figure 3. Axial unenhanced thoracic CT shows lingular (arrowheads) and left lower lobe (arrows) consolidation associated with a small left pleural effusion (*), with minimal nodular opacity in the right upper lobe and mild opacities in the right middle and right lower lobes. No evidence of right pleural effusion is seen. The unenhanced thoracic CT findings confirm the chest radiographic findings.

No evidence of pericardial effusion is seen, and the attenuation of the aortic wall is within normal limits. The mild, regular hyperattenuation of both the ascending and descending thoracic aortic wall is the result of anemia, not intramural hematoma- no evidence of acute aortic syndrome is present. The left mainstem bronchus is patent; no evidence of obstructing lesion is seen. Pneumomediastinum is not present.

Clinical course: The patient was noted to have an increasingly altered level of consciousness, manifest as worsening lethargy and confusion, associated with intermittent tachycardia (heart rate ≈ 120's) and fever. Due to the inability to control the airway and worsening repository status manifested as worsening hypoxia and increasingly labored breathing, the patient was intubated. Blood cultures and enhanced brain CT were performed. Lower extremity venous ultrasound showed no evidence of deep venous thrombosis. Brain CT showed a poorly defined right parietal low attenuation focus raising the possibility of an acute infarct or possibility encephalitis. Repeat frontal chest radiography (Figure 4) was performed.

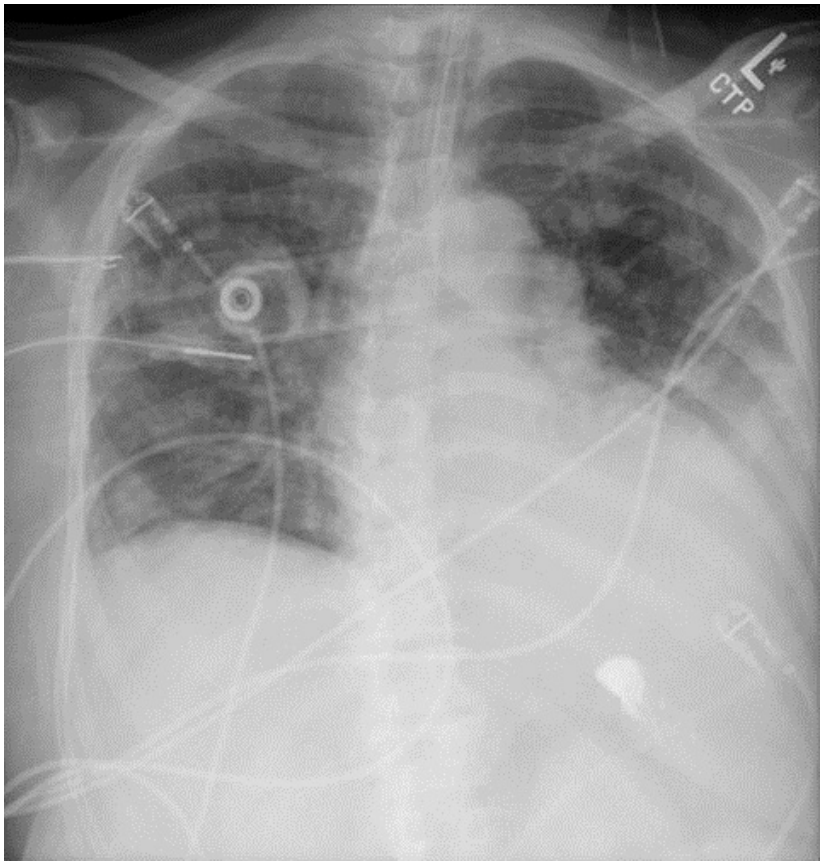

Figure 4. Repeat frontal chest radiography.

Which of the following statements regarding the chest radiograph is ***most accurate***?

1. The frontal chest radiograph shows a large right pneumothorax
2. The frontal chest radiograph shows left lower lobe collapse
3. The frontal chest radiograph shows multiple poorly defined bilateral pulmonary nodules
4. The frontal chest radiograph shows new enlargement of the heart suggesting the possibility of a new pericardial effusion
5. The frontal chest radiograph shows new right lower lobe consolidation and right pleural effusion

Correct!

3. The frontal chest radiograph shows multiple poorly defined bilateral pulmonary nodules

The frontal chest radiograph shows interval development of poorly defined, bilateral nodular opacities superimposed on the previously noted lingular and left lower lobe consolidation and left pleural effusion (Figure 5).

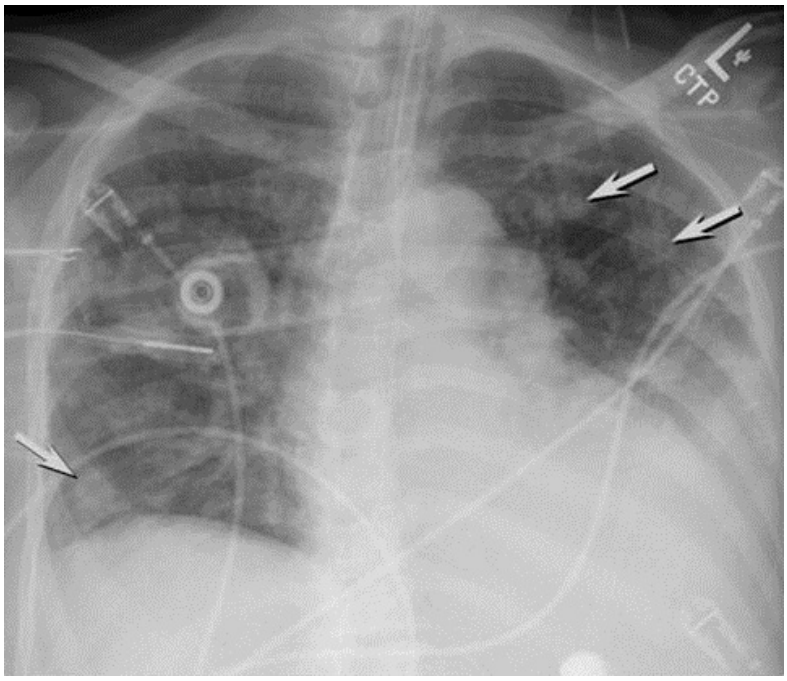

Figure 5. Frontal chest radiography shows continued lingular and left lower lobe consolidation, with left pleural liquid, now with development of multiple, vague, poorly defined nodular opacities (arrows) bilaterally. The patient is now intubated.

While left lung opacity is present, there is no associated volume loss to suggest collapse of the left lower lobe. No pneumothorax is present. Poorly defined, generalized increased right lung opacity is the result of atelectasis due to low lung volumes combined with the new lung nodules, but frank right lung consolidation is not evident. The cardiac silhouette appears stable and no specific features to suggest interval development of pericardial effusion are seen.

Which of the following represents ***the next most appropriate*** step for the evaluation of this patient?

1. ^{68}Ga-citrate scintigraphy
2. ^{99m}Tc-MAA Ventilation-perfusion scintigraphy
3. Contrast-enhanced thoracic CT
4. Left decubitus chest radiography
5. Thoracic ultrasound

Correct!
3. Contrast-enhanced thoracic CT

Contrast-enhanced thoracic CT is the next most appropriate step among the choices listed. Thoracic ultrasound would be useful for evaluating the pleural fluid but this finding has not changed compared to the prior chest radiograph. Similarly, decubitus chest radiography could demonstrate whether or not the left pleural effusion is loculated versus free-flowing, but the lack of change in the size and configuration of the left pleural effusion at chest radiography suggests that this finding need not be the target of active investigation. ^{99m}Tc-Ventilation-perfusion scintigraphy is often useful for the investigation of suspected pulmonary embolism, but is unlikely to provide a diagnostic result (either high or low / very low probability for pulmonary embolism, or normal), in an intubated patient with numerous pulmonary abnormalities. ^{68}Ga-citrate scanning can be useful for the assessment of some diffuse lung disorders but would not be helpful in the setting of new nodular opacities in an acutely ill patient- lack of tracer uptake would not provide and explanation for the new nodular opacities, and active tracer accumulation within these opacities would not provide a specific enough list of differential diagnostic possibilities to allow presumptive therapy or direct intervention.

Repeat thoracic CT using a pulmonary embolism protocol was performed (Figure 5).

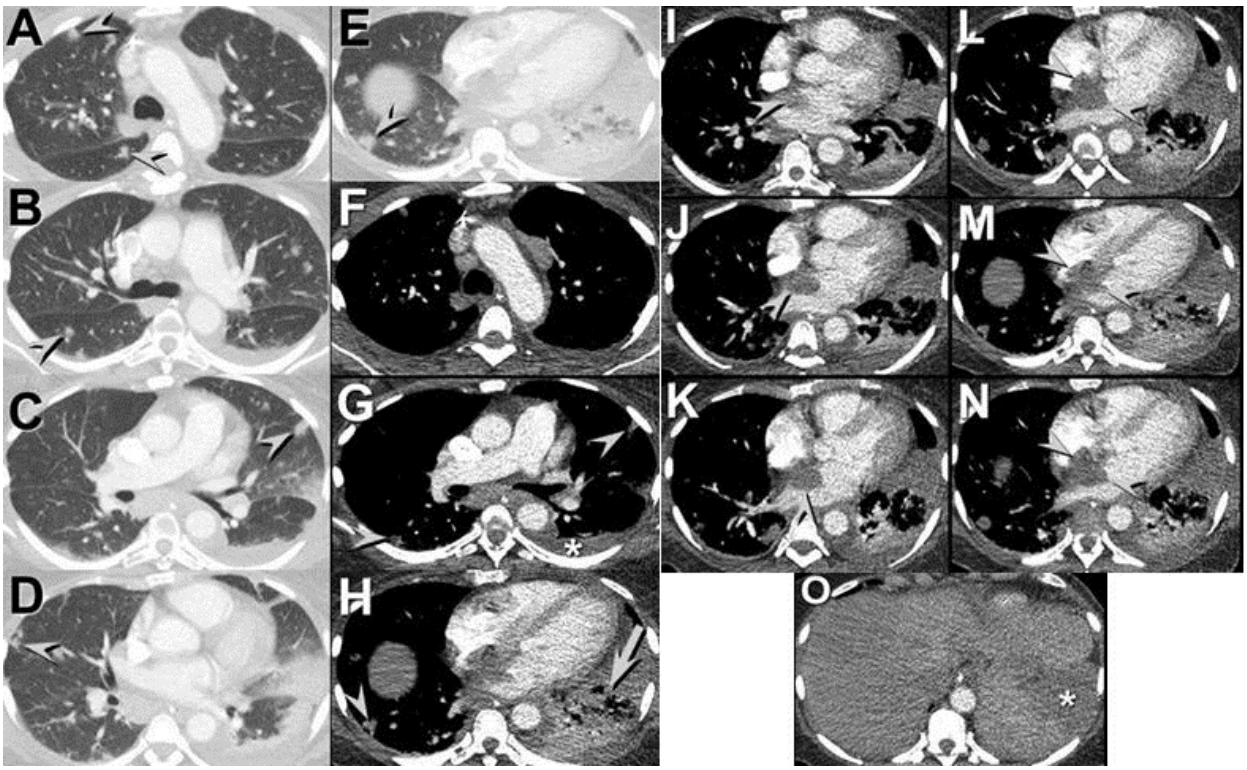

Figure 6. Panels A-H: Axial contrast-enhanced thoracic CT displayed in lung (A-E) and soft tissue (F-H) windows. Panels I-0: Caudally acquired axial contrast-enhanced thoracic CT images.

Which of the following statements regarding the enhanced thoracic CT study is ***most accurate***?

1. Thoracic CT shows a moderate pericardial effusion
2. Thoracic CT shows enlargement of a new multiloculated left pleural effusion suggesting empyema
3. Thoracic CT shows new areas of mucus plugging with endobronchial obstruction
4. Thoracic CT shows new, multiple, poorly defined, randomly distributed bilateral pulmonary nodules
5. Thoracic CT shows pulmonary interstitial emphysema

Correct!

4. Thoracic CT shows new, multiple, poorly defined, randomly distributed bilateral pulmonary nodules

The contrast-enhanced thoracic CT shows interval development of (arrowheads) superimposed on the previously noted lingular and left lower lobe consolidation (arrow) and left pleural effusion (*). While a left pleural effusion is still present, the effusion is not enlarged compared to the prior CT (Figure 3). There is no significant pericardial fluid collection. No evidence of endobronchial obstruction is noted. No foci of gas in the pulmonary interstitium are seen.

Further clinical course: The patient's mental status continued to worsen, and focal left-sided weakness became more apparent, suggesting that the acute head CT findings more likely reflected stroke rather than encephalitis. Repeat head CT confirmed this impression- an area of low attenuation, consistent with cytotoxic edema, conforming to the right middle cerebral artery vascular territory, was recognized. Transthoracic echocardiography was performed which disclosed a finding that was felt to explain the patient's fever, stroke and new pulmonary nodule; this finding is also present on the repeat enhanced thoracic CT (Figure 6: Panels I-O).

What abnormality on the thoracic CT ***provides an explanation*** for the patient's symptom complex?

1. Aortic dissection
2. Bronchopleural fistula
3. Hemopericardium with tamponade
4. Lingular and left lower lobe pneumonia with parapneumonic effusion
5. Paradoxical embolism

Correct!
5. Paradoxical embolism

The contrast-enhanced thoracic CT shows a low attenuation, dumbbell-shaped structure crossing the interatrial septum, representing a paradoxical embolism. The patient never completely cleared the septic knee arthroplasty infection, and this persistent infectious nidus became a source for septic emboli, which explains the new pulmonary nodules detected at chest radiography. The patient's stroke is explained by the fact that one of these pulmonary emboli managed to cross a patent foramen ovale in the interatrial septum to gain access to the systemic circulation, embolizing the right middle cerebral artery, producing stroke, The contrast-enhanced thoracic CT again shows findings consistent with lingular and left lower lobe pneumonia and left pleural effusion, which may be parapneumonic in etiology, but these abnormalities do not explain the septic pulmonary emboli nor the stroke. There is no gas in the left pleural space to suggest bronchopleural fistula, and no evidence of aortic dissection is present. Furthermore, aortic dissection could account for the stroke, but could not provide an adequate explanation for the new septic emboli. No evidence of pericardial effusion is seen.

Diagnosis: Septic pulmonary embolism with paradoxical embolism caught in transit

References

1. Saremi F, Emmanuel N, Wu PF, Ihde L, Shavelle D, Go JL, Sánchez-Quintana D. Paradoxical embolism: role of imaging in diagnosis and treatment planning. Radiographics. 2014;34(6):1571-92. [CrossRef] [PubMed]
2. Podroužková H, Horváth V, Hlinomaz O, Bedan J, Bambuch M, Němec P, Orban M. Embolus en Ann Thorac Surg. 2014 Dec;98(6):e151-2.trapped in patent foramen ovale: impending paradoxical embolism. Ann Thorac Surg. 2014 Dec;98(6):e151-2. [CrossRef] [PubMed]
3. Nii T, Yoshikawa H, Okabe T, Tachibana I. Septic pulmonary and systemic embolism in tricuspid endocarditis. BMJ Case Rep. 2014 Nov 24;2014. [CrossRef] [PubMed]
4. Maldjian PD, Anis A, Saric M. Radiological reasoning: pulmonary embolism--thinking beyond the clots. AJR Am J Roentgenol 2006;186(3Suppl):S219-23. [PubMed]
5. Buchholz S, Shakil A, Figtree GA, Hansen PS, Bhindi R. Diagnosis and management of patent foramen ovale. Postgrad Med J. 2012;88(1038):217-25. [CrossRef] [PubMed]
6. Hwang J, Choe YH. Cardiovascular sources of systemic embolism: detection and characterization using multidetector CT and MR imaging. Int J Cardiovasc Imaging 2011;27(5):727-44. [CrossRef] [PubMed]