IMAGING STUDIES

Recommendations

1. Class I: Pleural ultrasound (US) should be performed routinely in addition to conventional chest x-ray (CXR) in the evaluation of pleural space infection, both for diagnostic purposes and image-guidance for pleural interventions (LOE B).
2. Class IIa: Computed tomography (CT) of the chest should be obtained when pleural space infection is suspected (LOE B).

Reasoning.

Chest x-ray. Conventional CXR is often the most available imaging modality leading to the identification of a pleural space infection. A minimum of 175 mL of pleural fluid is necessary to result in blunting of the costophrenic angle on a posteroanterior film, although smaller effusions may be identified on a lateral view.[13] Smaller, loculated effusions may result in lenticular-shaped, pleural-based opacities visible on posteroanterior views but may be difficult to distinguish from underlying parenchymal consolidation. Traditional teaching suggests that lateral decubitus films should be obtained and pleural effusions >1 cm thick measured from the lateral chest wall should be sampled. However radiologically complex parapneumonic effusions, however, often are loculated and unlikely to layer dependently and may therefore be missed by conventional CXRs. In a recent study including 61 patients with CT-proven parapneumonic effusions, anteroposterior, posteroanterior, and lateral CXRs all missed approximately 10% of pleural effusions, in most cases due to the coexistence of lower lobe consolidation.[14] Although useful as a first step in the investigation of a pleural space infection, CXRs should therefore be combined with additional imaging.

Pleural US. Pleural US has in the past decade become the cornerstone of imaging studies for the evaluation of pleural effusions. It is at least as effective as lateral decubitus CXRs to identify small pleural effusions and better than CXRs at estimating the volume of the effusion, while not being hindered by adjacent consolidations or intrathoracic structures.[15] The bedside availability of US, which can be performed competently by nonradiologists, makes it an ideal tool to guide safe and effective diagnostic thoracentesis.[16-18] Pleural US can in addition be performed at the bedside, allowing rapid evaluation in the emergency department or the intensive care unit.[19-21] Several ultrasonographic patterns have been described in a study including 320 patients, which correlate with pleural fluid characteristics. Complex septated, complex nonseptated, and echogenic pleural effusions typically are exudative, and homogeneously echogenic effusions correspond to hemorrhage or empyema. Transudative effusions are anechoic, but anechoic effusions may be exudative in 27% of the cases. Pleural thickening also is indicative of exudative pleural effusion.[21] Two studies suggest that increased septations as assessed by thoracic US may be predictive of clinical outcomes.[22,23]

Computed tomography. Contrast-enhanced CT with tissue phase is a valuable imaging tool in the assessment of pleural-space infections. In addition, it allows a detailed examination of parenchymal abnormalities and may reveal a cause for the pleural space infection, such as bronchogenic carcinoma, endobronchial foreign body, or esophageal rupture. Loculated empyemas, typically lenticular in shape and associated with compression of the adjacent lung parenchyma, generally can be distinguished from pleural based lung abscesses.[24,25] Empyemas are associated with parietal pleural thickening in 86% and pleural enhancement in 96% of patients.[26] Concurrent thickening and enhancement of both the visceral and parietal pleural can lead to the ''split pleura sign,'' seen in 68% of empyemas.[26] High attenuation of the extrapleural adipose tissue in the chest wall suggests empyema and virtually excludes a transudative effusion.[26-29] The presence of air bubbles within the pleural effusion in the absence of preceding pleural intervention is specific for a pleural space infection and may suggest resistance to chest tube drainage alone.[30] A pleural fluid thickness cutoff of 2 to 2.5 cm has been suggested to guide thoracentesis, because smaller effusions on CT are likely to resolve with antibiotics alone.[31,32]

Positron emission tomography and magnetic resonance imaging (MRI). Positron emission tomography does not appear useful in the diagnosis of pleural-space infections, because it does not accurately distinguish inflammatory from malignant pleural effusions.[33-35] MRI eventually may become an attractive alternative to CT. MRI is useful in distinguishing transudates from exudates and allows assessment of extension into soft tissues, such as in chest wall or spinal involvement.[36]

LABORATORY AND PLEURAL FLUID ANALYSIS

Recommendations

1. Class I: The presence of pus, positive Gram's stain, or culture in the pleural fluid establishes the diagnosis of empyema, which should be treated with tube thoracostomy followed by surgical intervention when appropriate (LOE B).
2. Class I: A pleural pH <7.2 in a patient with suspected pleural space infection predicts a complicated clinical course, and tube thoracostomy should be performed followed by surgical intervention when appropriate (LOE B).
3. Class IIa: A pleural fluid LDH >1000 IU/L, glucose <40 mg/dL, or a loculated pleural effusion suggests that the pleural effusion is unlikely to resolve with