Imaging Infection

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KEYWORDS

• Thoracic imaging • Infection • Chest radiography • Computed tomography

KEY POINTS

- Among immunocompetent hosts, the combination of clinical and radiographic findings performs better than radiographic findings alone in the detection and follow-up of pneumonia.
- Computed tomography (CT) findings are most useful in evaluating pleural disease and pulmonary necrosis. Recognition of CT patterns of micronodules can help differentiate infection from noninfectious acute disease.
- In immunocompromised hosts who do not have AIDS, identification of radiologic patterns of invasive fungal disease are key to its early diagnosis and treatment.
- Despite the declining incidence of *Pneumocystis jiroveci* pneumonia (PJP) among patients with human immunodeficiency virus (HIV), recognition of its CT pattern remains important, because PJP may be the presenting illness in patients previously undiagnosed with AIDS. The possibility of immune reconstitution inflammatory syndrome should be considered when new thoracic radiologic findings develop in a patient initiating treatment of HIV.

NORMAL HOSTS

Chest radiography (CR) is sufficiently accurate to diagnose community-acquired pneumonia (CAP) in most immunocompetent patients. Interobserver agreement of 80% to 90% has been reported, but accuracy is diminished in patients with chronic obstructive pulmonary disease (COPD), atelectasis, or congestive heart failure.[1–3] Patients with these confounding conditions who receive a clinical diagnosis of lower respiratory tract infection may have similar rates of septicemia and mortality regardless of whether CR confirms the diagnosis of pneumonia.[2]

In most cases, CR performed at the time of pneumonia diagnosis has clinical utility. For instance, the number of lobes involved and the presence of pleural disease are predictors of disease severity and need for intensive care unit (ICU) admission.[4] The benefit of follow-up CR is less certain. Speed of radiographic improvement is related to patient age as well as initial pneumonia extent and is often outpaced by clinical improvement (Fig. 1). After a week of treatment, more than 50% of patients hospitalized with CAP experience resolution of symptoms, whereas only 25% show radiologic resolution (see Fig. 1).[5] CR performed within 4 weeks of initiating treatment rarely detects progression of infection in patients clinically responding to therapy.[6]

The accuracy of CR for the detection of hospital-acquired pneumonia is less than that for CAP, and lower still for ventilator-acquired pneumonia (VAP) because of confounding opacities caused by atelectasis and pleural effusions. Among patients receiving mechanical ventilation, approximately 60% to 70% of focal parenchymal opacities that contain air bronchograms represent VAP. However, air bronchograms are not helpful in identifying pneumonia in the setting of diffuse

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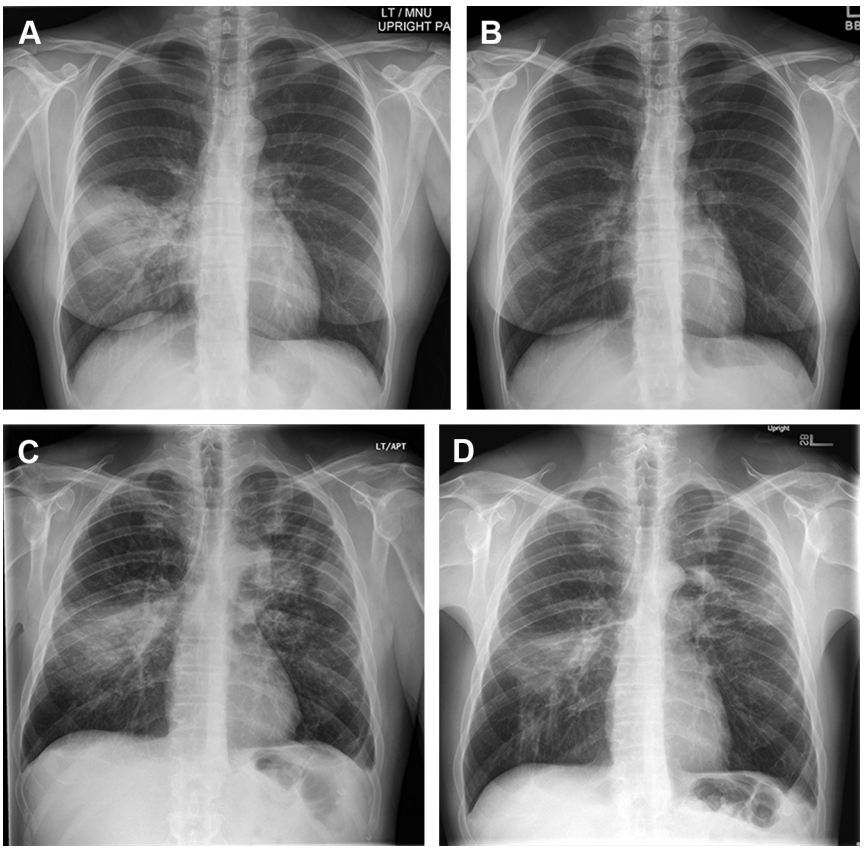

Fig. 1. Resolution of CAP. (*A*, *B*) Two posteroanterior (PA) radiographs 2 weeks apart show nearly complete radiographic resolution of CAP in a 27-year-old woman without comorbidities. (*C*, *D*) Two PA radiographs 2 months apart show minimal improvement in legionella pneumonia. Legionella characteristically shows slow radiographic resolution, in part because of its predilection for hosts with comorbidities.

parenchymal opacities seen with acute respiratory distress syndrome.[7,8] Given these limitations, CR was not chosen as a component of newly proposed criteria for the diagnosis of VAP.[9]

Computed tomography (CT) also has its limitations in the ICU because it cannot reliably differentiate diffuse alveolar damage caused by systemic disease from that caused by diffuse pneumonia.[10] Given its ability to resolve overlying structures and its superior contrast resolution compared with radiography, it can be helpful in differentiating atelectasis or cardiogenic edema from pneumonia and identifying radiographically occult infectious bronchiolitis (discussed later).

Complications of Pneumonia

After pneumonia is diagnosed, additional imaging is often performed if there are clinical or radiographic findings that suggest the presence of pleural disease, lung necrosis, or lymphadenopathy. Presence of parapneumonic effusion is clinically relevant and is the sole imaging finding included in the Pneumonia Severity Index.[11] In most cases, cross-sectional imaging is not necessary if CR shows only very small effusions. An occasional patient can present with a small effusion that rapidly expands over days despite minimal apparent parenchymal infection. This scenario has been termed explosive pleuritis, and is associated with *Streptococcus pyogenes* infections (**Fig. 2**).[12]

Ultrasonography is widely used to assess effusions for pleural drainage, often at the bedside, and may show septations within pleural fluid collections that are not visible on contrast-enhanced CT scanning.[13] These septations are often fibrinous strands rather than dense adhesions between visceral and parietal pleura and are not reliable in predicting efficacy of catheter drainage.[14]

CT scanning is superior to ultrasonography in providing a global assessment of multiloculated pleural fluid, including paramediastinal collections