JAMA Insights

Point-of-Care Ultrasound for the Diagnosis of Pneumonia

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Community-acquired pneumonia (CAP) accounts for 1.4 million emergency department visits and 740 000 hospitalizations annually in the US.[1] The most common diagnostic imaging modality is chest radiography, which has a median sensitivity of 0.70 (range, 0.16-0.95) and specificity of 0.70 (range, 0-0.94) for diagnosis of CAP compared with computed tomography (CT), the reference standard for pulmonary opacities.[1] Compared with chest radiography, CT has superior diagnostic utility, but is more expensive, causes more radiation exposure, and may be less readily accessible, especially in lower- and middle-income countries.[1,2]

Multimedia

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Diagnosis of Community-Acquired Pneumonia. Point-of-care ultrasound (POCUS) is an imaging modality that the 2025 American Thoracic Society Clinical Practice Guideline on CAP endorses as an acceptable diagnostic alternative to chest radiography for adults with suspected CAP at centers with appropriate clinical expertise.[2]

POCUS. POCUS refers to the use of portable ultrasound to provide real-time diagnostic information,[3] and is typically performed by emergency medicine physicians, hospitalists, and primary care clinicians.[3] Advantages of POCUS over chest radiography and CT include its portability, immediate results, and lack of ionizing radiation.[1,3]

Sonographic Manifestations of Pneumonia With POCUS. POCUS utilizes high- and low-frequency probes to detect acoustic artifacts suggestive of pneumonia. Important sonographic findings include B-lines, consolidation, parapneumonic effusions, and air bronchograms.[4]

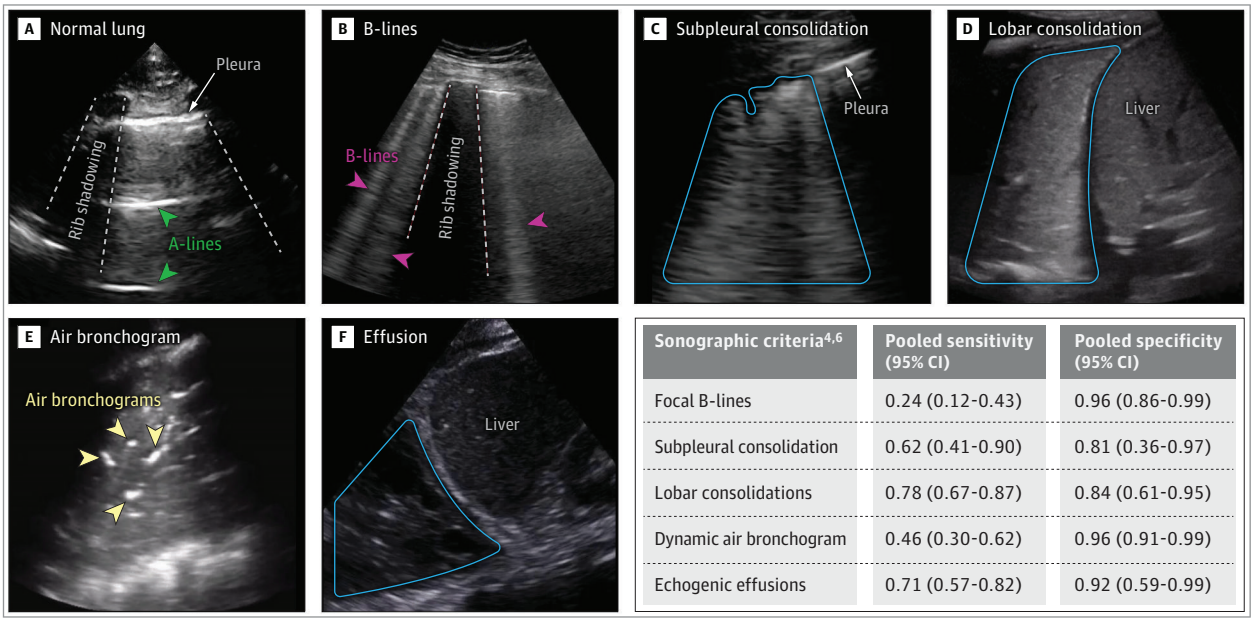
Normal lung (**Figure**, A) appears as anechoic (ie, dark) regions on POCUS due to the diffraction of ultrasound waves against air. Normal lung exhibits A-lines, which are horizontal reverberation artifacts that appear parallel to the pleural line at regular intervals. A-lines accompanied by pleural sliding (visualized movement along the pleural line) indicate well-aerated parenchyma. Ultrasound does not readily penetrate ribs, which cast adjacent shadows.

B-lines (Figure, B) are vertically oriented, hyperechoic (ie, bright) artifacts emanating from the pleura; focal B-lines are confined to a single hemithorax.[5] B-lines distributed in bilateral hemithoraces are nonspecific and can occur with pulmonary edema, interstitial lung disease, or aspiration.[5] B-lines identified on POCUS are distinct from Kerley B-lines, which are linear horizontal opacities on chest radiograph representing edematous, thickened interlobular septa.[5]

On POCUS, consolidation appears as hyperechoic regions of lung parenchyma and may be accompanied by B-lines. Subpleural consolidations are characterized by irregular pleural lines, often arising from distal airway inflammation (Figure, C). Lobar consolidations represent dense lung infiltrates involving an entire lobe or a substantial portion of a lobe of the lung (Figure, D).

Air bronchograms are identified on POCUS as hyperechoic lines or dots and represent air-filled bronchi or bronchioles that are visible due to surrounding consolidation (Figure, E). Static air bronchograms do not move during respiratory cycles and are suggestive of resorptive atelectasis, defined as collapsed lung distal to an obstructed airway. In contrast, dynamic air bronchograms appear

Figure. Ultrasonographic Images of Lung Point-of-Care Ultrasound (POCUS) Findings and Sensitivity and Specificity for Pneumonia Diagnosis



Sonographic criteria[4,6]	Pooled sensitivity (95% CI)	Pooled specificity (95% CI)
Focal B-lines	0.24 (0.12-0.43)	0.96 (0.86-0.99)
Subpleural consolidation	0.62 (0.41-0.90)	0.81 (0.36-0.97)
Lobar consolidations	0.78 (0.67-0.87)	0.84 (0.61-0.95)
Dynamic air bronchogram	0.46 (0.30-0.62)	0.96 (0.91-0.99)
Echogenic effusions	0.71 (0.57-0.82)	0.92 (0.59-0.99)

to slide with respiration and represent real-time movements of air and sections within bronchi visible on POCUS.

Parapneumonic effusions appear anechoic on POCUS (Figure, F). Effusions that are echogenic or have internal septations may represent a complicated parapneumonic effusion or empyema.[6]

Viral pneumonia typically manifests as diffuse B-lines and/or subpleural consolidations, while bacterial pneumonia often presents with focal B-lines and subpleural and/or lobar consolidations.[4] Additional supportive findings of bacterial pneumonia include dynamic air bronchograms and echogenic effusions.[4]

Diagnostic Performance of POCUS for Pneumonia. A 2025 meta-analysis of 8 prospective cohort studies (N = 1011 adults with suspected CAP) reported that lung POCUS exhibiting B-lines, consolidations, or air bronchograms had a pooled sensitivity of 0.90 (95% CI, 0.81-0.96) and specificity of 0.91 (95% CI, 0.80-0.98) for diagnosing CAP compared with the reference standard of chest CT.[7] A 2024 meta-analysis of 30 studies (24 prospective cohort, 6 retrospective cohort) of 4546 children aged 0 to 21 years reported that lung POCUS exhibiting B-lines, consolidations, or air bronchograms had a pooled sensitivity of 0.89 (95% CI, 0.88-0.91) and specificity of 0.91 (95% CI, 0.89-0.92) for diagnosing CAP compared with a reference standard of chest radiograph.[8]

A 2025 meta-analysis that included 26 studies (22 prospective cohort and 4 retrospective cohort) of 3454 adults with community-acquired, hospital-acquired, or ventilator-associated pneumonia examined the individual diagnostic performance of focal B-lines, subpleural consolidation, lobar consolidation, and dynamic air bronchograms compared with reference standards of CT or clinical adjudication.[4] Among sonographic criteria for diagnosing pneumonia, lobar consolidations had the highest sensitivity (0.78 [95% CI, 0.67-0.87]), and dynamic air bronchograms and focal B-lines had the highest specificity (0.96 [95% CI, 0.91-0.99] and 0.96 [95% CI, 0.86-0.99], respectively)[4] (Figure).

A 2021 meta-analysis of 2 randomized clinical trials that included 488 adults presenting to the emergency department with unspecified dyspnea determined that the addition of POCUS to a standard diagnostic pathway (history, physical examination, chest radiograph, and laboratory testing) correctly identified 92% of patients with underlying pneumonia compared with 14% to 83% of patients who underwent standard diagnostic workup without POCUS.[3]

Scanning Approach and Clinical Integration. There are multiple scanning protocols for lung POCUS, although there is no universally accepted protocol, which limits comparison across studies.[4,7,8] The commonly used Bedside Lung Ultrasound in Emergency protocol, originally developed for critically ill patients with acute respiratory failure, provides a standardized approach for POCUS scanning and interpretation that is typically completed in approximately 3 minutes.[9] The Bedside Lung Ultrasound in Emergency protocol demonstrates a sensitivity of 0.88 (95% CI, 0.84-0.92) and specificity of 0.93 (95% CI, 0.83-0.97) for diagnosis of pneumonia compared with a combined reference standard of clinical suspicion, laboratory testing, and imaging (CT or chest radiograph).[4]

Reliability and Training With POCUS. Interobserver agreement for POCUS interpretation for pneumonia is high (κ range, 0.82-0.96).[4] Although the American Medical Association (AMA) recognizes the use of POCUS by appropriately trained physicians,[10] training is not standardized across medical specialties or organizations. Both the AMA and 2025 American Thoracic Society guideline emphasize that appropriate clinical expertise is essential for reliable application of POCUS. Until national standards are established, individual medical centers should determine appropriate POCUS privileging.[2,10]

Practical Applications and Limitations of POCUS. Clinicians should incorporate POCUS findings with a patient's history, physical examination, laboratory findings, and other imaging findings, if available.[3] POCUS has limitations, such as its inability to visualize the entire lung parenchyma, and therefore may not detect centrally located pneumonias. Large body habitus and chest wound dressings may negatively affect POCUS image quality.[1]

Lung POCUS provides immediate results and does not use ionizing radiation, and is endorsed by clinical practice guidelines for diagnosis of pneumonia when performed by trained clinicians.

ARTICLE INFORMATION

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