Advances in Point-of-Care Thoracic Ultrasound

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KEYWORDS

• Pulmonary ultrasound • Pneumothorax • Pulmonary edema • Pleural effusion • Hemothorax • Pneumonia

KEY POINTS

- Pulmonary ultrasound allows for rapid diagnosis of pneumothorax, pulmonary edema, pneumonia, and intrathoracic free fluid.
- Pulmonary ultrasound is more sensitive and specific than chest radiograph for many pulmonary conditions.
- Pulmonary ultrasound is the most rapidly advancing form of pulmonary imaging.

Videos of various normal and abnormal lung ultrasound findings accompany this article at http://www.emed.theclinics.com/

Although technological advances continue to improve the imaging quality and diagnostic capabilities of computed tomography (CT) scanning, chest radiography remains the mainstay of pulmonary diagnostic imaging in emergent settings because of its relative portability and ease of acquisition and image interpretation. However, compared with pulmonary ultrasound, which has seen rapid growth in the past decade, radiography has inherent limitations.

First, although chest x-ray is portable, it requires a technologist, a machine that is typically not located in patients' rooms, and often requires development in an area remote from patients. The machine itself is large, and the process of obtaining the image requires moving patients to some degree regardless of the type of study. These factors are insignificant at times; but in the setting of a critically ill patient when real estate in the resuscitation bay is limited and time-sensitive interventions are necessary, radiography can be disruptive to patient care. Additionally, although minimal, the ionizing radiation associated with radiography is not insignificant,

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especially as radiographs are repeated to monitor patients' condition and response to treatment.

Perhaps more importantly is the fact that chest radiography is relatively insensitive for findings such as pleural fluid and pneumothorax, especially in supine patients.[1–3] These limitations, in conjunction with advances in ultrasound technology and more widespread training have led to increased use of this technology for the evaluation of pathologic conditions in emergent settings.

Ultrasound machines have become more portable, with decreased boot-up time, while simultaneously providing improved image quality and ease of image acquisition. These factors make thoracic ultrasound ideal for emergency departments, operating rooms, intensive care units, and the prehospital setting. Bedside ultrasound has been a core competency of American Board of Emergency Medicine–accredited emergency medicine training programs since 2008, and most medical schools now have extensive ultrasound education integrated into their curriculum.

Although user dependent, in the right hands, ultrasound is more sensitive than chest radiographs for many types of pulmonary pathology[1–3] and approaches sensitivities and specificities of CT for pneumonia.[4–6] Additionally, it is easily done at the bedside without patient care interruption and can be used in real time to guide procedures (eg, reduction of pneumothorax). Serial ultrasounds are ideal for monitoring changes in patients' condition and response to treatment, as there is minimal lag between physiologic changes and imaging findings. For these reasons, pulmonary ultrasound has high-yield applications in critically ill and injured patients.

Among imaging modalities for respiratory emergencies, pulmonary ultrasound has seen the greatest recent advancement. This article reviews the advantages of pulmonary ultrasound and demonstrates imaging technique as well as ultrasound findings of normal lung and common pathologic states.

BASIC THORACIC EXAMINATION

The initial goal of thoracic ultrasound in dyspneic patients should focus on detecting changes at the lung periphery. Evaluation for the presence or absence of movement between the visceral and parietal pleura (lung sliding; Videos 1 and 2) will assess for pneumothorax. Imaging of the costophrenic angles should be performed to detect pleural fluid, as in the setting of an effusion or hemothorax (Video 3). Parenchymal processes, such as pneumonia and pulmonary edema or contusion, are readily identified by bedside ultrasound via utilization of greater depth of field.

Pneumothorax

The initial diagnosis of pneumothorax has classically been via chest radiograph, but this modality is insensitive for small pneumothoraces (especially in supine patients). The sensitivity of bedside ultrasound for the detection of pneumothorax exceeds that of standard chest radiographs, with sensitivity approaching that of CT.[1,2,4] Radiographic imaging remains the easiest means for rapidly estimating pneumothorax size, but ultrasound can also be used to determine the extent of pneumothorax by mapping out areas where there is an absence of lung sliding.

Technique

During a focused examination for pneumothorax, a linear transducer is optimal because of its ability to provide high-resolution images at shallow depths. However, lower-frequency microconvex, phased array, or curved transducers can also be used. Lower frequency probes offer the advantage of deeper penetration into the lung parenchyma, which may reveal additional pathology.