Thoracic Ultrasound

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KEYWORDS

• Ultrasound • Thoracic • Pneumothorax • Pleural effusion
• Pneumonia • Blue • B-lines • Pleural line

Patients with thoracic emergencies can present a diagnostic dilemma to the emergency physician. Furthermore, there are often situations of severe respiratory distress in which an urgent diagnosis is required within minutes to direct potentially life-saving therapy. Traditionally, the emergency physician has relied on historical and physical examination findings to help in the initial differential diagnosis of dyspnea. These have often been found to be unreliable.[1–3] A bedside chest radiograph (CXR) can provide useful information but it has been shown to be inaccurate in many situations. Circumstances often arise in which one experienced physician evaluates the same patient as another physician and comes to diametrically different diagnoses; wet versus dry, pneumonia versus heart failure, pleural effusion versus pneumonia versus chronic obstructive pulmonary disease (COPD), and so forth. CT scan could resolve many of these issues but involves transporting potentially unstable patients out of the department, larger radiation doses (typically 200 times that of a CXR), the use of contrast, and cannot routinely be used in pregnancy. Clearly, there is a need for more exact tools.

Lung ultrasound is a new method of emergency patient assessment. So new in fact, that the latest editions of some North American emergency ultrasound textbooks do not even mention the lung as an organ that can be evaluated using ultrasound, except for passing discussions concerning the detection of traumatic pneumothorax.[4,5] The 2008 edition of *Harrison's Principles of Internal Medicine*[6] continues to state that ultrasound imaging is not useful for pulmonary parenchyma imaging. However, thanks to pioneering work of French intensivist Daniel Lichtenstein, and others, we now can confidently use ultrasound to evaluate patients with respiratory complaints.

Disclosure: Dr Turner is coauthor and presenter of the EDE-2 Course©.

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Emerg Med Clin N Am 30 (2012) 451–473
doi:10.1016/j.emc.2011.12.003 **emed.theclinics.com**
0733-8627/12/$ – see front matter © 2012 Elsevier Inc. All rights reserved.

This article reviews the basic technical and anatomic principles of thoracic ultrasound, describes the important evidenced-based sonographic features found in a variety of pathologic conditions, and provides a framework of how to use thoracic ultrasound to aid in assessing a patient with severe dyspnea.

PRINCIPLES OF THORACIC ULTRASOUND

The basis and utility of thoracic ultrasound is attributed to several important principles first proposed by Lichtenstein[7]:

1. The intimate relationship between air and water in the lung causes a variety of artifacts seen by ultrasound. Because air (and, by extension, the lung) cannot be visualized by sonography, thoracic ultrasound is based primarily on the analysis of these artifacts.
2. Air and water have opposing gravitational dynamics. Consequently, a variety of pathologic conditions (pleural effusions, consolidations) is predominantly "water-rich" and, thus, considered "dependent disorders." These pathologies are generally found in the posterior aspects of a supine patient. On the other hand, there are several "air-rich" conditions (pneumothorax) that are considered "nondependent" disorders and, as a result, are predominantly found in the anterior aspects of a supine patient (**Fig. 1**).
3. All sonographic lung patterns arise from the "pleural line." The pleural line is a bright echogenic line approximately 0.5 to 1.0 cm below the ribs, corresponding to the apposition of the parietal and visceral pleura. Most acute lung disorders abut the lung surface, which explains the wide-ranging utility of thoracic ultrasound. The pathologic condition not attached to the pleural line is necessarily visualized by lung ultrasound (eg, tumor, other hilar processes).

PROBE SELECTION

There are several probe options when performing thoracic ultrasound, each with its inherent advantages and disadvantages. The curved array probe has the advantage of allowing rapid assessment of the lateral thoracic cavity for signs of pleural fluid in

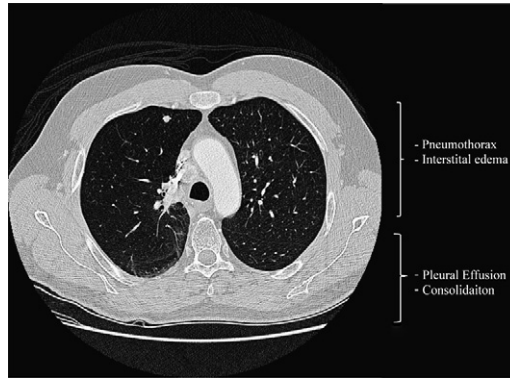

Fig. 1. Water-rich pathology such as pleural effusion and consolidation will tend to occur in the dependent (ie, posterior) regions of the supine patient. Pneumothorax and severe interstitial edema tend to occur in the anterior portions of the lung.

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