

## B. ULTRASOUND FOR EVALUATION OF LUNG PARENCHYMA DISEASE

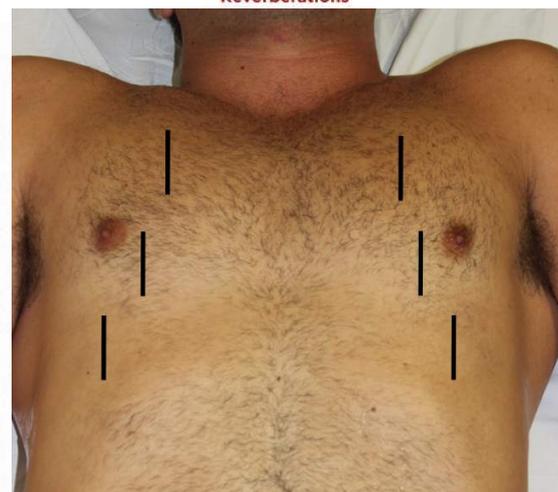
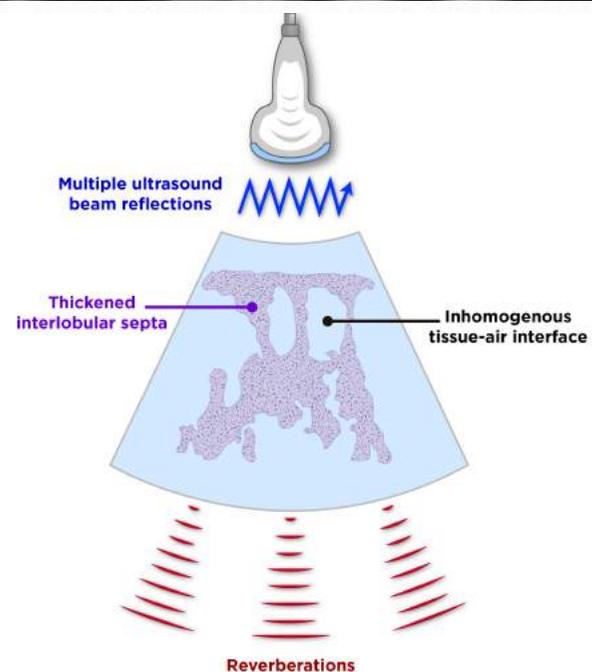
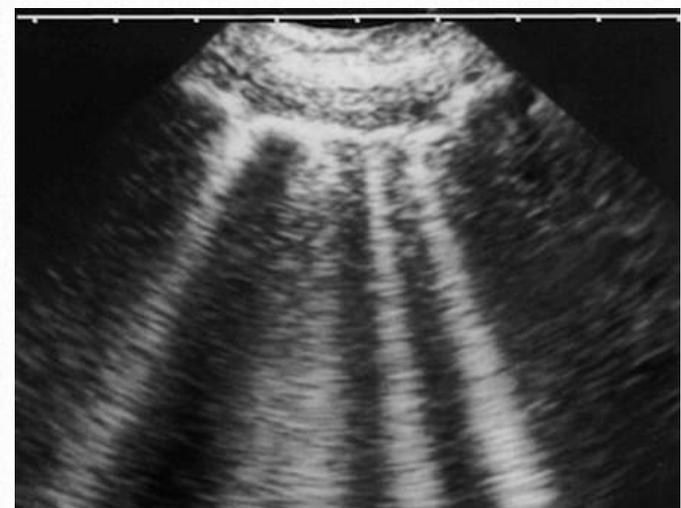
Until recently, it was thought that ultrasound of the lung tissue would be ineffective because the air in the lung parenchyma would cause too much acoustic impedance difference, resulting in essentially a black ultrasound image. However, this has been shown to not be the case; lung tissue has shown to produce distinct ultrasound image signatures for normal and abnormal aeration. Specifically, when the air content decreases (as in pulmonary edema or any interstitial lung disease) an acoustic mismatch needed to reflect the ultrasound beam is created, and a signature ultrasound finding appears (B lines). This reflection of the beam creates some comet-tail reverberation artifacts, called B-lines or ultrasound lung comets. A B-line is a discrete, laser-like, vertical, hyperechoic image that arises from the pleural line, extending to the bottom of the screen without fading, and moves synchronously with respiration. Multiple B-lines (>2) are the sonographic sign of lung interstitial mid-clavicular, and their number increases along with decreasing air content. When the air content is further decreased, such as in lung consolidations, the acoustic window on the lung becomes completely open and the lung may be directly visualized as a solid parenchyma, as the liver or the spleen.

It has been reported that one can assess the space between B lines to help determine further detail about the pathology of the airspace disease. Specifically, multiple B-lines that are 7 mm apart are likely to represent interstitial edema versus B-lines 3 mm or less apart are caused by ground glass areas characterizing alveolar edema. In either case, the number and intensity of B-lines increases with the degree of loss of aeration.

It is important to realize that absence of normal artifacts may also provide useful information. One such artifact is what are termed A-lines, which represent the reverberation artifact of lung pleura. This artifact is a hyperechoic horizontal line that is parallel to the pleural line. The distance from A-line to pleural line is equal to the distance between skin and pleural line, and this may repeat further down the ultrasound image.

The presence of A lines is a sign of normal aeration but may also occur in the setting of pneumothorax. One must always assess for pleural sliding when A lines are visualized. Also, since the presence of A lines is a sign of normal aeration (assuming normal pleural sliding) one should not often see A lines and B lines in the same image.

It is important to realize that sometimes pleural sliding can cause small vertical called Z lines. These only extend 2 to 3 cm and do not represent airspace disease. One can differentiate them from B lines because they are much shorter and can also have A lines in the same image.

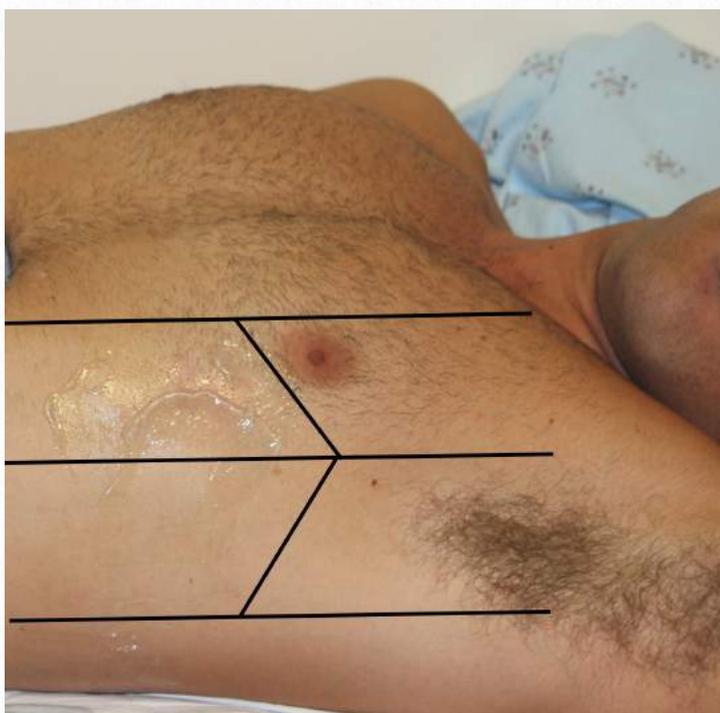


## Basic Lung Exam

**Patient Position:** The supine position usually allows for the majority of lung tissue examination. The full lung parenchyma exam can be very involved (see table and picture below), but a basic six point exam that is used to assess the lung pleura for PTX can provide the majority of information (also shown below).

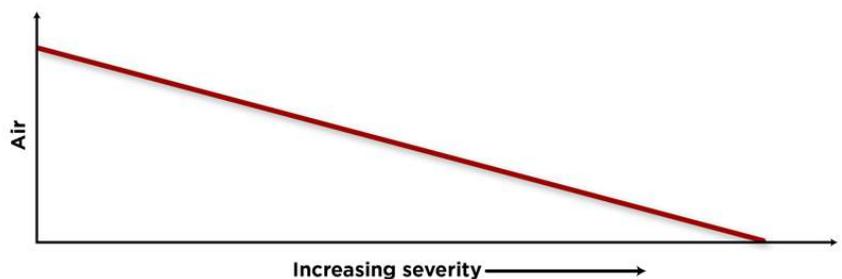
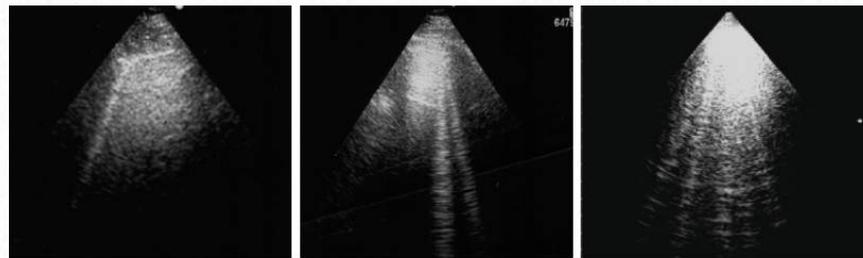
**Probe Position:** Either the curved linear or phased array probe can be used. The curved linear, being a higher frequency, will provide an improved image quality (higher frequency) while still providing enough depth of penetration, however the phased array probe can also be used. The indicator should be at the 12 o'clock position, perpendicular to the ribs (similar to the lung pleura exam). The transducer is oriented to scan between the ribs, as ribs block the transmission of ultrasound. Ideally, two ribs should be in view, one on each of the lateral sides of the ultrasound image. Please see the pictures below for further information on the lung parenchyma exam.

### Probes to Use:



Right	Mid-Axillary	Anterior Axillary	Mid-Clavicular	Para-sternal	Intercostal Space	Left	Mid-Axillary	Anterior Axillary	Mid-Clavicular	Para-sternal
					II					
					III					
					IV					
					V					

## Extensive Lung Parenchyma Exam



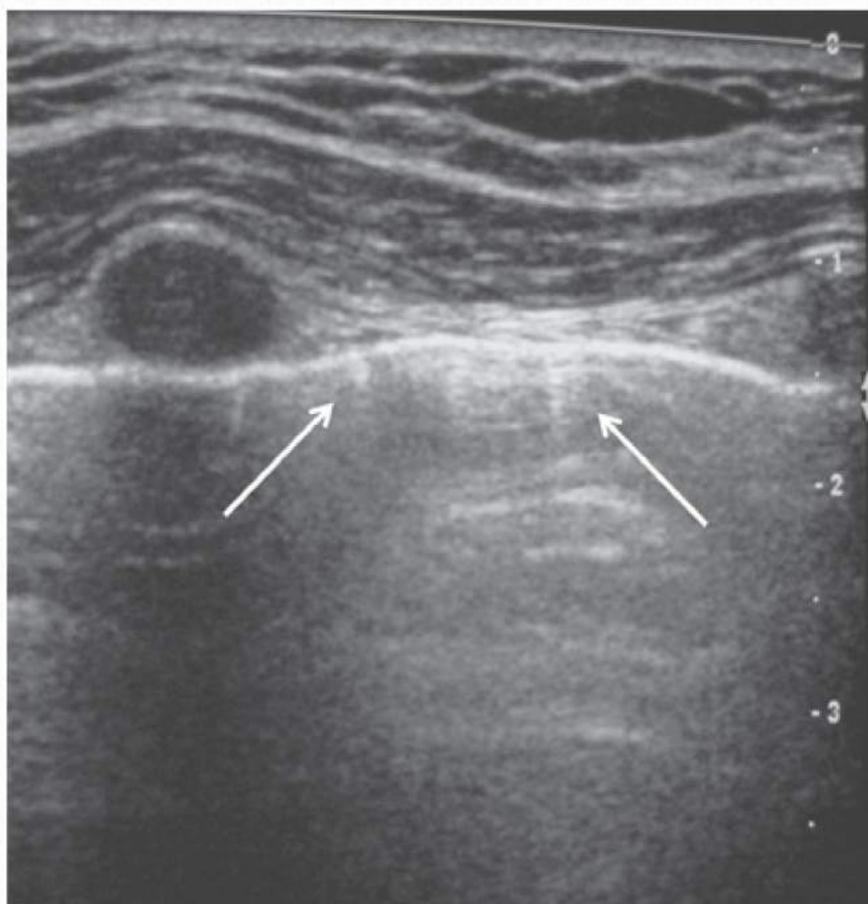
## Lung Ultrasound Artifacts

**A lines** - Defined as horizontal, regularly spaced hyperechoic lines representing reverberations of the pleural line.



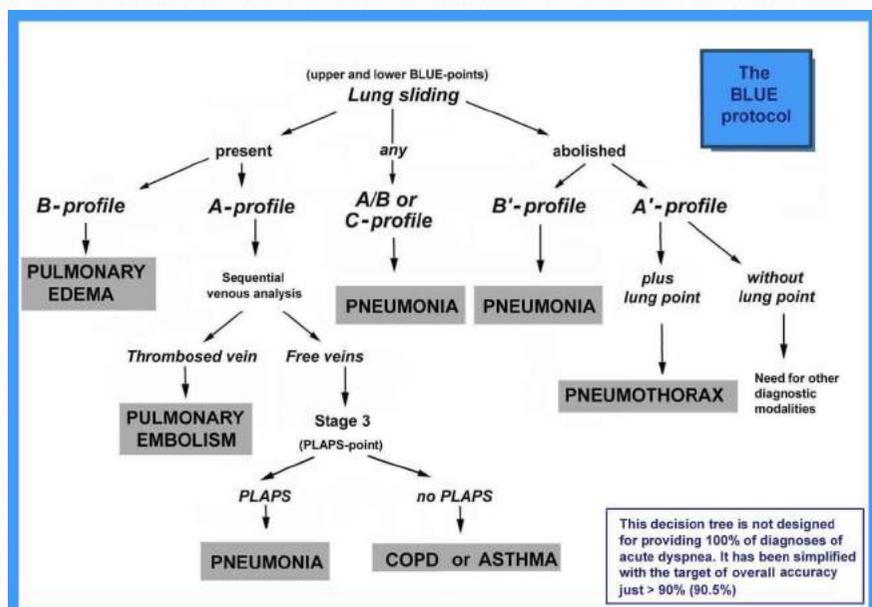
*A lines*

**Z lines** – Short, vertical comet tail artifacts arising from the pleural line but not reaching (usually only extends 2 to 3 cm) the distal edge of the screen (these are not B lines).



Z lines

**Lung Exam Protocol: search BLUE pulmonary ultrasound protocol**



**REFERENCE:** Lichtenstein, D. "Lung ultrasound in acute respiratory failure an introduction to the BLUE-protocol." *Minerva anesthesiologica* 75.5 (2009): 313.