***SFGH Scanning Protocols***

(Adapted from the ACEP Ultrasound Imaging Criteria Compendium)

***Lung & Pleura***

**Indications**

1. **Primary** 
   1. Acute pneumothorax
   2. Abnormal collections of pleural fluid
2. **Extended/Advanced**
   1. Interstitial lung fluid caused by CHF and other conditions
   2. Pneumonia

**Contraindications**

1. Known, tension pneumothorax requiring emergent intervention
2. Relative Contraindications
   1. Significant pain in the area to be scanned
   2. Open wounds or dressings in area to be scanned

**Limitations**

1. Morbidly obese patients can present so much adipose tissue that adequate imaging with ultrasound is technically difficult.
2. Bedside thoracic ultrasound is more sensitive than supine chest X-ray in the diagnosis of pneumothorax and pleural effusion. However, the performance of the exam is dependent on the skill level of the sonologist.

**Technique**

* 1. In the absence of pleural adhesions, a pneumothorax typically occurs in the most anterior aspect of the chest in a supine patient. Conversely, pleural effusions or hemothoraces tend to accumulate posteriorly in the costophrenic sulci. When evaluating a patient for pulmonary edema, the patient is often in a semi-recumbent or upright position.
  2. ***Pneumothorax Evaluation***
     1. Anterior chest- In a trauma patient on a backboard, the anterior chest will be the most sensitive area to identify a pneumothorax. In this window, a linear array transducer is ideal, with the focal zone set at the pleural line. However, a curvilinear or phased array transducer may also be used, using their high frequency range, and with adjustment of the focal zone. The transducer is placed in the mid-clavicular line, immediately inferior to the clavicles, and the orientation marker is directed cephalad in a sagittal plane. Two ribs, with distal shadowing should be identified. The pleural line beneath the ribs should be identified. The physician should evaluate for pleural sliding or shimmering as the patient breathes, indicating that the lung is expanded with the visceral and parietal pleura directly apposed. Other findings that exclude pneumothorax under the transducer include “lung pulse” (motion of visceral pleura and lung in time with cardiac motion) and the presence of “comet-tail artifact”also known as “Z-lines” (see below). The absence of any of these findings is highly suggestive of the presence of a pneumothorax. Conversely, the presence of the “leading edge” or “lung point” sign (created by the site of transition between expanded and collapsed lung) is pathognomonic of the *presence* of pneumothorax. Each interspace in the mid-clavicular line should be systematically evaluated to the level of the diaphragm on both sides. At each interspace, the sonologist should anchor the probe to the patient’s chest wall using his/her examining hand, in order to minimize chest wall motion, which can be mistaken for lung sliding. The movement of the pericardium should not be mistaken for either pleural sliding or the lung-point sign in the left chest. In most cases, the probe should be placed more laterally when examining the left chest in the region of the heart.
     2. Lateral chest- The technique for examining the lateral chest is identical to the anterior chest, except the physician will examine each interspace in the mid-axillary line.
     3. Posterior thorax- The technique for examining the posterior thorax is identical to the anterior chest, except the physician will examine each interspace on the patient’s back. The patient is examined sitting up if possible. Ultrasound waves do not penetrate the scapulae, so these should be abducted by asking the patient to grasp the contralateral shoulder with each hand.
     4. Abbreviated exam- In critical situations, an ultrasound exam of the entire chest may not be feasible. In such circumstances, the evaluation may be limited to a single location on each anterior hemothorax. This two-point exam may identify large pnemothoraces, but miss a smaller pneumothorax.
     5. M-Mode evaluation- M-Mode can be used to help identify or to document the presence of a pneumothorax. The M-mode sampling bar is placed in the middle of the intercostal space and the resulting M-Mode tracing is evaluated over time. In the normal patient a linear pattern superficial to the pleural line is in sharp distinction to the granular pattern deep to it (the “seashore sign”). With pneumothorax, there is a horizontal linear pattern above and below the pleural line (“stratosphere sign” or “barcode sign”).

***Pneumothorax Exam***





* 1. ***Pleural Effusion Evaluation***
     1. Evaluation of right lung base in the supine patient. Similar to the evaluation of fluid in Morrison’s Pouch, the physician can rapidly identify fluid above the diaphragm. Typically, a curvilinear or phased array probe is placed in an intercostal space around the nipple line in the coronal plane or parallel with the ribs, with the orientation marker directed cephalad. Following the identification of the kidney, liver, and diaphragm, the examiner angles or rocks the probe to evaluate above the diaphragm, using the liver as the acoustic window. Free fluid in the hemithorax will be identified as an anechoic or black area above the diaphragm. The examiner may also identify consolidated lung sitting in large pleural effusions. The examiner should be aware that B-mode ultrasound is preferred to identify the presence of pleural effusion and hemothorax.
     2. Evaluation of left lung base in the supine patient. Similar to the evaluation of free abdominal fluid in the left flank, the physician can rapidly identify fluid above the left diaphragm. Typically, a curvilinear or phased array probe is placed in an intercostal space around the mid-axillary line in the coronal plane or parallel with the ribs, with the orientation marker directed cephalad. Following the identification of the spleen, liver, and diaphragm, the examiner angles or rocks the probe to evaluate above the diaphragm, using the spleen as the acoustic window. Free fluid in the hemithorax will be identified as an anechoic or black area above the diaphragm. The examiner may also identify consolidated lung sitting in large pleural effusions. This view is often more challenging secondary to the relatively smaller size of the spleen compared to the liver.
     3. Evaluation in the upright patient can be performed by placing the transducer on the midscapular line in a sagittal orientation, and sliding it from the level of the liver (on the right) or the spleen (on the left) in a cephalad direction until the diaphragm and costophrenic sulcus are identified. In the normal patient, this will be recognized by the presence of pleural sliding. Abnormal fluid collections (effusion, hemothorax, empyema, etc.) appear anechoic or hypoechoic.
     4. Large pleural effusions. Occasionally, a large fluid collection may be identified during the evaluation of the pleura on the anterior chest wall.
     5. E-FAST. During trauma scenarios, many clinicians now include evaluation of the pleural spaces for hemothorax during the E-FAST exam. The technique is as described above for “Evaluation of the lung bases in the supine patient”

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* 1. ***Interstitial lung fluid*** 
     1. Undifferentiated dyspnea- There is a substantial body of literature supporting the use of ultrasound for the differentiation of intrinsic lung disease and pulmonary edema states as a cause of acute dyspnea. The ultrasound finding of relevance is the presence of widespread B-lines. These are fine reverberation artifacts that extend from the pleural line to the far field. (Traditionally, depth is set at 15 cm.) These represent accumulation of fluid within the pulmonary interstitium. Many qualitative and quantitative methods have been described to assess B-lines. One of the most widely used divides the anteriolateral thorax into eight zones. In each hemithorax, the four zones are defined approximately by the anterior axillary line (anterior and posterior) and the nipple line (superior and inferior). Scattered B-lines may be normal in the more posterior areas of lung in the supine patient, but are abnormal if found anteriorly. In general, the greater the number of rib spaces with B-lines, and the more anterior in distribution, the more specific the finding for abnormal increased interstitial lung water. If the B-lines are unilateral or more localized, a focal process such as pneumonitis is more likely. Bilateral and extensive B-lines are more likely to be due to a more generalized process such as volume overload, heart failure, or ARDS. In infants and children, the differential diagnosis of B-lines is different from that in adults, and is the subject of ongoing elucidation. In extreme cases, the B-lines can become confluent, giving the appearance of a swinging curtain of artifact. A recent consensus conference has endorsed the use of “B-lines” to apply to the variety of terms used in the early literature on the topic including “lung rockets”. Ideally a small footprint curvilinear transducer is used.

***B Lines***



