Thoracic Ultrasound
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CEM Competencies

• The Pleural line
• Lung Sliding
• A-Lines (horizontal artefact)
• B-lines (comet-tail artefact)
• M-mode appearance of normal and abnormal thorax
• Pleural effusions including haemothorax
• The Lung Point
• E and Z lines
• The Diaphragm
Thoracic Ultrasound

- Alveolar-Interstitial Syndrome (Pulm. Oedema)
- Alveolar Consolidation
- Pleural Effusion
- Ultrasound Guided Thoracocentesis
- Thoracic Trauma
- Haemothorax
- Pneumothorax
Thoracic Ultrasound Examination

Equipment suitable for chest US imaging

- 3.5 - 5 MHz convex/phased array transducer
  - suitable for general scanning and for visualization of deeper structures

- 7.5 -10 MHz (higher frequency) linear transducers
  - provides better resolutions of near structures, such as the chest wall and pleura
Thoracic windows

- anterior rib
- bronchial bifurcation
- vascular hilum
- posterior rib
- right atrium
- diaphragm
- liver
- spinal process
- clavicle
- scapula
- aortic knob
- left bronchus
- hilum
- descending aorta
- breast soft tissue
- gastric air bubble
Techniques for Chest Ultrasound Examination

- The chest wall can be divided into six lung regions
- upper and lower
- anterior, lateral and posterior chest wall
  - anterior and posterior-axillary lines
- intercostal spaces offer acoustic windows
- Only the upper posterior lung segments behind the scapula cannot be explored by lung ultrasound
Ultrasound Appearances

- Normally, ultrasound is not transmitted through structures filled with gas.
- Lung parenchyma is not visible beyond the pleura.
Normal

- A normal ultrasound pattern is defined by
  - ‘lung sliding’ with
  - Artifactual horizontal A-lines (reverb - multiples)

- In one third of patients with normal lungs isolated vertical B-lines (comet tails) can be detected in dependant lung regions (3-4 lines)

- B-lines move with the pleural line
Alveolar-Interstitial Syndrome (Pulmonary Oedema)

- ‘B-lines’ or ‘comet tails’ appear as shining vertical lines arising from the pleural line and reach the edge of the screen.
- The number of these vertical B-lines depends on the degree of lung aeration loss.
- More than 4 lines, 7mm apart
Alveolar Consolidation

- Loss of lung aeration enables ultrasound to be transmitted.
- Lung consolidation appears as a hypoechoic tissue structure that is poorly defined and wedge-shaped.
  - Massive lung oedema
  - Lobar bronchopneumonia
  - Pulmonary contusion
  - Lobar atelectasis
Abscess

- Peripheral lung abscesses with pleural contact or included inside a lung consolidation are also detectable by ultrasound
- Rounded hypoechoic lesions with outer margins
Pleural Effusion

- Transudates are always anechoic

- Anechoic effusions can be either a transudate or an exudate.

- Pleural effusions with complex nonseptated, complex septated, and homogenously echogenic patterns are always exudates.

Transudates
LVF
Cirrhosis
Nephrotic Syndrome

Exudates
Infection
Cancer
P.E
Haemothorax
Pleural Effusion

- Anechoic
Pleural Effusion

- Complex Non-Septate
Pleural Effusion

- Complex Septate
Pleural Effusion

- Paraneoplastic
Pleural Effusion - Pitfalls

- Peritoneal fluid
Pleural Effusion - Pitfalls

- Pleural fluid
Pleural Effusion - Pitfalls

- Pericardial fluid
Ultrasound Guided Thoracocentesis
Thoracic Trauma Ultrasound

- Acute diagnosis of haemothorax
- US vs CXR\(^1\)
  - Faster
  - Equivalent accuracy
  - Sensitivity (97.4%, specificity 99.7%)
- Cardiac tamponade
  - Accuracy 97.3% \(^2\)
- Pericardial effusion
- Pneumothorax

1. Sisley J Trauma 1998
2. Rozycki J Trauma 1999
Adaptation of FAST

- Increased sensitivity with increased number of views
- Will identify pleural effusions
- Reliably detects as little as 50-100ml in the thorax
- Sensitivity >96%, specificity 99-100%
Adapted RUQ window

- Move probe
  - cephalad
  - longitudinal

- Image

Liver

Diaphragm

Pleural space
Pneumothorax

- Pneumothorax is defined by the interposition of gas between visceral and parietal pleural layers.
- As a consequence, lung sliding is abolished, ultrasound cannot be transmitted through the lung parenchyma and comet tails (vertical B-lines) are no longer visible.
- Only longitudinal reverberations of motionless pleural line (horizontal A-lines) can be seen.
Pneumothorax

- Erect CXR - Sensitivity 59-81%
- CT detected occult pneumothorax in 52% patients with serious head trauma.

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<th>Population Description</th>
<th>Study Type</th>
<th>Comparison</th>
<th>Results</th>
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<tr>
<td>Dulchavsky SA et al, 2001, USA</td>
<td>382 stable surgical patients (95% post-traumatic)</td>
<td>Prospective diagnostic study</td>
<td>USS v CXR diagnosis</td>
<td>Sensitivity 95% (89-95) Specificity 100% (99-100)</td>
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<td>Rowan et al, 2002, Canada</td>
<td>27 patients sustaining blunt chest trauma who had CT scans</td>
<td>Prospective blinded diagnostic study</td>
<td>USS v CT diagnosis</td>
<td>Sensitivity 100% (82.6-100) Specificity 94% (82-94)</td>
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<tr>
<td>Knudtson et al, 2004, USA</td>
<td>328 consecutive trauma patients</td>
<td>Prospective diagnostic study</td>
<td>USS v CXR diagnosis</td>
<td>Sensitivity 92.3% (74.4-97.9) Specificity 99.7% (98.9-99.9)</td>
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<tr>
<td>Kirkpatrick et al, 2004, Canada</td>
<td>225 trauma patients</td>
<td>Prospective diagnostic study</td>
<td>USS v CT diagnosis or escape of air on thoracostomy</td>
<td>Sensitivity 58.9% (45.0-71.9) Specificity 99.1% (97.5-99.8)</td>
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Pneumothorax

- Normal side of the chest; US shows
  - Gliding of the visceral and parietal pleura - Sliding Sign
  - Comet tail sign
  - Seashore sign – M mode

- with pneumothorax, these signs are **absent** in real-time US

- Normal Sliding Sign excludes pneumothorax
Sliding Sign
Pneumothorax
Normal US Pattern: Dynamic signs

- The seashore sign

  M-mode sign
US Diagnosis of Pneumothorax

- No seashore sign
US Diagnosis of Pneumothorax

- The lung point – specific sign

www.emergencyultrasound.org.uk
Questions