Primary EMBU applications

1. Cardiac / IVC / shock
2. FAST and pneumothorax
3. Aorta
4. Gallbladder and biliary
5. First trimester pregnancy and female pelvis
6. Evaluation for ureterolithiasis and acute renal failure
7. Procedural guidance
8. Evaluation for DVT

Summary: Clinician-performed ultrasonography

<table>
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<th>Specialty</th>
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<td>Natarajan, 2010</td>
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FAST: Rationale

• Sensitivity / specificity for the detection of hemorrhage 80-90% / 90-95%

Compared to CT
- No radiation
- No contrast
- Rapid
- Repeatable
- In resuscitation area
- Low cost
- No organ specific information
- Misses retroperitoneal injury

Compared to DPL
- Non-invasive
- Rapid
- Repeatable
- Low cost
- Information about pleural and pericardial spaces
- Misses hollow viscus injury

Young/new bedside sonologist

[Image of young/new bedside sonologist]
**FAST: a limited...**

...focused... exam

- FAST should put the patient in one of 3 diagnostic categories:
  - "Yes"... Positive for free fluid
  - "No"... Negative for free fluid
  - "I don't know"... Indeterminate for FF

...This + clinical condition determines the next step:

Either O.R. stat
... or CT/DPL
... or neither (clinical management)

**Dependent areas of the Abdominal Cavity**

4 regions... TEN potential spaces

- **Region 1: RUQ**... 4 Spaces
  1. Pleural
  2. Subphrenic
  3. Hepatorenal (Morison's)
  4. Infrarenal

- **Region 2: Subxiphoid**... 1 Space

- **Region 3: LUQ**... 4 Spaces
  1. Pleural
  2. Subphrenic
  3. Splenorenal
  4. Infrarenal

- **Region 4: Suprapubic**... 1 Space

**Subxiphoid: 1 Space pericardial**

**Suprapubic: 1 space: Retrovesicular / P of Douglas**

4 regions... 10 potential spaces

- **RUQ:** 4 Spaces
  1. Pleural
  2. Subphrenic
  3. Hepatorenal
  4. Infrarenal

- **LUQ:** 4 Spaces
  1. Pleural
  2. Subphrenic
  3. Splenorenal
  4. Infrarenal

**Region 1: RUQ The 4 spaces**

- Check the 4 potential spaces
  - Rarely all seen on a single view

  1. Pleural
  2. Subphrenic
  3. Hepatorenal (Morison’s)
  4. Infrarenal
1. Pleural space
   - The presence of air in the normal lung gives the appearance of "liver above the diaphragm"

Hemothorax causes LOSS of mirror artifact

Region 1: RUQ

3. Morisons (Hepatorenal)

4. Inferior pole of kidney

Region 1: RUQ

RUQ: 25 min s/p MVC

RUQ: Fall from height
Region 1: RUQ

Region 2: The pericardial space

- Transverse plane shows all 4 chambers (Pointer to "9 o'clock")

Region 2: the Subxiphoid 4-chamber view

High speed MVC, unrestrained driver

- 17 year old pedestrian male struck by car immediately outside hospital. transported into E.D. with loss of vital signs.
Region 3: LUQ
Check 4 potential spaces
1. Pleural
2. Subphrenic
3. Splenorenal
4. Inferior pole

Region 3: LUQ
Splenorenal space
Hemothorax

LUQ exam
Parenchymal injury is NOT the primary focus of FAST
21 year-old female kicked during domestic assault: LUQ

Region 4: Suprapubic
Rectovesical space (m)
Rectouterine space = Pouch of Douglas (f)

- Probe immediately cephalad to pubic symphysis
  - (Maximize bladder window)
- Angle probe caudad
  - Superior to seminal vesicles (male)
  - Level of cervix (female)
  - Inferior to peritoneal reflection
- Scan before Foley

Normal suprapubic view

21 year-old female kicked during domestic assault: Suprapubic sagittal
Case: massive lateral impact to pelvis

Pelvis

Longitudinal and transverse suprapubic view

Pleural evaluation: Pneumothorax

Bedside sono and PTX: Science

- 2005 prospective study of clinician-performed ultrasound, compared to CXR
  - Chest CT / chest tube gold standard
  - N = 176
  - Only those getting CT studied
  - Sono estimate of PTX size by axillary scans
- Sens / Spec of EUS: 98% / 99%
- Sens / Spec CXR: 75% / 100%
- Accurate estimation of "small" (<10%) and "large" (>40%) PTX


E-FAST Kirkpatrick. J. Trauma, 2004
- Comparison of CXR and ultrasound in trauma patients
- 268 pts, 65 PTX identified in 52 patients
- Sensitivity of E-FAST 39%
- Sensitivity of supine CXR 21%
- Specificity for both High (>98%)
- By sonography, 12 of 13 patients with biboth PTX had one or both PTX missed (both PTX > 40%)
- 96% of false negative exams for FAST (19/26 hemithoraces)
- 80% of false negative exams for FAST
- Higher ISS increased missed PTX rate
- Patients with ISS > 16 had 8-fold increase in occult PTX compared to those with ISS < 16
Bedside sono and PTX: Science

2006: prospective study of clinician-performed ultrasound, compared to supine CXR
- Chest CT / chest tube gold standard
  - N = 607
- Sens / Spec of EUS: 57% / 100%
  - 21 of 49 (43%) PTX missed by EUS
- Sens / Spec CXR: 31% / 100%
  - 34 of 49 (69%) PTX missed by CXR
- No false negative EUS identified by CXR
  - Dean et al, Acad EM, 2006

Technique:
1. Probe placement
- Probe in midclavicular line
- Longitudinal axis
- Adjust depth, focus, frequency (pleura is < 5 cm below skin)

Technique:
2. Identify (in order):
1. Shadow
2. Rib
3. Rib space
4. Pleural line

Technique:
3. Make the diagnosis!
- NORMAL
  1. Pleural sliding
  2. Pleural based comet tail artifact
- PNEUMOTHORAX
  1. ABSENCE of pleural sliding
  2. Leading edge sign

Normal (expanded) lung: Lung Sliding
Pneumothorax: **ABSENCE** of lung sliding

“**Leading edge**” = “**Lung Point**” sign

**Leading Edge** = **Lung Point**

**Pearls and Pitfalls**

**How much of chest do I scan?**

- Mid-clavicular line each side
- Clavicle to diaphragm
- Examine each rib space
- **Systematic scanning in real-time**

- If heart encountered: scan rib-spaces in left anterior axillary line
- Other areas per clinical judgment
- **Systematic scanning in real-time**
Pearls and Pitfalls: Probe selection

- Convex, microconvex: Most widely described
  - Easy transition from FAST
  - "Pie-slice" exaggerates pleural sliding
  - Good for intercostal windows
  - Ribs and shadows clear

Caveats and pitfalls

- Problem: Hand motion appears like lung sliding
- Solution: Anchor probe to the chest wall with fingertips

Cardiac motion and diaphragms pitfalls

- May be confused with pleural sliding
  - False negative
- May be confused with leading edge
  - False positive

Cardiac / diaphragm pitfalls

- Solution:
  - Identify cardiac motion
  - Scan left anterior axillary line at level of heart
  - Anticipate location of diaphragms

Sono in PTX: Causes of false negatives

- Small / localized PTX
- Solution: Systematic, methodical scanning on mid-clavicular line ... wider area if pleural scarring suspected

- Bilateral PTX
- Clinician reassured by "symmetric" absence of pleural sliding
  - In 12/13 bilateral PTX's, 1 or both sides were missed
  - Solution: Consider bilateral PTX

Sono in PTX: False positives

- Pleural scarring / adhesion, COPD/blebs, pulmonary contusion
  - Solution: Consider patient's clinical appearance, age, medical hx

- Poor respiratory effort
  - Solution: Urge pt to "take deep breaths in and out"
    - If pt intubated, give 1-2 "sigh breaths"
Bedside sono and PTX: Science

• 2001: prospective study of clinician-performed ultrasound in stable trauma patients
  – Plain films gold standard
  – N = 382
• Sensitivity 95%, specificity 100%
  – Only 2 false negatives: pts w/ subQ emphysema

Dulchavsky SA et al. J. Trauma 50: 201-5. 2001

Questions?