Critical Care Ultrasonography

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Objectives

- Determine ultrasound utility in the ICU
- Review questions that can be answered with goal directed echocardiography (GDE)
- Apply these concepts in case studies
Do you have an US in your ICU?

• A. Yes
• B. No
Do you use US for procedural guidance?

• A. Yes
• B. No
Do you use US for evaluation of shock?

• A. Yes
• B. No
Do other providers in your ICU use US?

- A. Yes
- B. No
Clinical Applications

• Versatile modality for diagnosing and guiding treatment of critically ill patients.
• Rapid, noninvasive, provides high-yield assessment and interpretation leads to earlier treatment
• No radiation exposure
• No need to travel off unit. Readily available, easy to reassess
Clinical Applications

- ID life-threatening disease process
- ID etiology of shock state and aid in management
- Monitor progression of disease and response to tx
- ID coexisting diagnosis
What does it require?

• Trained staff
  • Training should include general critical care ultrasound, “basic” critical care echo, and advanced critical care echo

• Ultrasound
  • Cardiac probe (phased array) and vascular probe (linear array)
  • Doppler is not necessary
  • Curvilinear probe not necessary
Lung/Pleural Ultrasound

- Rule out PTX
- Focal/diffuse consolidation
- Interstitial edema
- Pleural effusion
- Procedural guidance
Literature

**CHEST** Recent Advances in Chest Medicine

**Thoracic Ultrasonography for the Pulmonary Specialist**

*Seth J. Koenig, MD; Mangala Narasimhan, DO, FCCP; and Paul H. Mayo, MD, FCCP*

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**CHEST** Original Research

**Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure**

*The BLUE Protocol*

*Daniel A. Lichtenstein, MD, FCCP; and Gilbert A. Mezière, MD*
Background: BLUE

• Observational study that assessed potential of lung ultrasound to diagnose acute respiratory failure

• Compared initial ultrasound findings to final diagnosis

• N=260

• Assessed for lung artifact, lung sliding, alveolar consolidation, pleural effusion

• Combined with venous US to create profiles
## Results

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma/ COPD</td>
<td>89%</td>
<td>97%</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>97%</td>
<td>95%</td>
</tr>
<tr>
<td>PE</td>
<td>81%</td>
<td>99%</td>
</tr>
<tr>
<td>PTX</td>
<td>81%</td>
<td>100%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>89%</td>
<td>94%</td>
</tr>
</tbody>
</table>
Vascular ultrasound

• Rule out proximal lower extremity DVT
• Vascular access
  – Internal jugular
  – Femoral
  – Subclavian not recommended
• Assessed accuracy and timeliness of compression ultrasonography for proximal LE DVT by Intensivist vs. ultrasonographer
• Multi-center study at 3 university hospitals (n=128)
• Overall prevalence of DVT was 20%
• Final interpretation resulted in 88% sensitivity, 98% specificity, and diagnostic accuracy of 86%
Goal Directed Echo

- Rapid evaluation of hemodynamic failure
- Identification of life threatening process
- Categorization of shock state
- To guide management of shock state
- To follow evolution of disease and response to therapy
- Diagnosing more nuanced conditions will require a formal echo
Why not a full echo?

- Time delay in performing study
- Time delay in interpreting study
- Time delay in communicating results
- Problems with clinical disassociation
- Difficulty with repeating study
Evidence

Point of care ultrasound for basic haemodynamic assessment: novice compared with an expert operator

Randomized, controlled trial of immediate versus delayed goal-directed ultrasound to identify the cause of nontraumatic hypotension in emergency department patients*

Alan E. Jones, MD; Vivek S. Tayal, MD; D. Matthew Sullivan, MD; Jeffrey A. Kline, MD

Echocardiography

Roman Melamed, MD; Mark D. Sprenkle, MD; Valerie K. Ulstad, MD; Charles A. Herzog, MD; and James W. Leatherman, MD, FCCP
Abdominal Ultrasound

• FAST exam: Rapidly assess for abdominal free fluid or pericardial effusion
• R/O hydronephrosis
• Assess chronic renal disease
• AAA
• Ascites and guidance for paracentesis
• Diagnostic/therapeutic intervention
Protocolized Assessment

**Pump**
- Effusion
- LV failure
- RV strain

**Tank**
- IVC size, resp variation
- Volume loss ?
- Pulm Edema, PTX

**Pipes**
- DVT
- Aortic abnormalities
Case Study 1

• 56 yo F with triple negative breast CA with metastatic disease to pleura, bone, and liver
• Admitted to Oncology service for new distal left PE and femoral DVT.
• Started on heparin gtt
• Platelet count 85K
Hospital Day 2

• Pulmonary team consulted for consideration of pleurex catheter
• Diagnostic thoracentesis performed- 950 cc of serosanguinous fluid removed
• Follow-up CXR: negative PTX, persistent right pleural effusion
Decompensation

• Rapid response called 2 hours after thoracentesis for “hypotension”
• HR 113, SBP 70, pt weak but AAO x3
• NS bolus initiated, but BP refractory
• Transferred to MICU for further care
MICU

• BP remained refractory to IVF and pressors
• Differential diagnoses: PTX, septic shock, distributive shock from PE, hemorrhagic shock
• Limited ultrasound performed
Lung Ultrasound
Lung Ultrasound
What’s the likely etiology of shock?

- A. Septic
- B. Cardiogenic
- C. Hypovolemic
- D. Not enough information
Case Study 2

- Pt is 48 yo male with new ESRD s/p HD initiation, as well as HTN, DM, and osteo of right foot
- RRT called to dialysis unit for hypoxia and decreased LOC
- On arrival, CPR and BMV in progress
- Pt intubated and received 2 rounds of epinephrine before ROSC
Hospital Course

• Transferred to MICU once stabilized
• Differential diagnoses:
  – PE
  – volume overload
  – cardiac failure
• Whole body ultrasound completed
Lung Assessment
What’s the etiology of shock?

- A. PE
- B. LV failure
- C. Pneumothorax
- D. Do not have enough information
Limitations

• Inability to obtain adequate images
• Limited image set
• Failure of training
• Difficulty with documentation
• Over emphasis on bedside ultrasound
Training Resources

• Your own institution
• Society of Critical Care Medicine: live and self-directed courses
• American College of Chest Physicians: live course
Training Resources

- http://www.ultrasoundoftheweek.com/tools/
- http://maryland.ccproject.com
- www.critcaresono.com
- http://www.ultrasoundpodcast.com
- https://www.youtube.com/user/SonoSite/videos
- http://www.criticalecho.com/content/icu-echo-tutorials
- https://www.youtube.com/watch?v=d8VFgb9Edfw
- https://www.stanford.edu/group/ccm_echocardio/cgi-bin/mediawiki/index.php/Main_Page
Summary

• All frontline intensivists should have skill in basic critical care echocardiography
• Skill has to be used in line with history, physical exam, and laboratory analysis
• Obtaining and interpreting images requires extensive training and continual practice
• Use your brain
References

• Expert Round Table on Ultrasound in ICU Intensive Care Med (2011).
• Korey, et al. Accuracy of Ultrasonography Performed by Critical Care Physicians for the Diagnosis of DVT. CHEST 2011;139;538-542