“You saw what?”

Findings on Bedside Ultrasound That Change Patient Management

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Objectives:

• To discuss the literature that supports bedside imaging
• To discuss common bedside ultrasound exams
• To discuss pathology easily identified on those exams
• To spark an interest in bedside imaging
# Bedside Ultrasound

## Advantages
- Safer procedures
- Rapid
- Bedside
- Repeatable
- No radiation or contrast
- More accurate, timely diagnoses

## Disadvantages
- User dependent
- Image acquisition may be limited
Support for Bedside Ultrasound: The Evidence
(1) AMA affirms that ultrasound imaging is within the scope of practice of appropriately trained physicians;

(2) AMA policy on ultrasound acknowledges that broad and diverse use and application of ultrasound imaging technologies exist in medical practice;

(3) AMA policy on ultrasound imaging affirms that privileging of the physician to perform ultrasound imaging procedures in a hospital setting should be a function of hospital medical staffs and should be specifically delineated on the Department's Delineation of Privileges form; and

(4) AMA policy on ultrasound imaging states that each hospital medical staff should review and approve criteria for granting ultrasound privileges based upon background and training for the use of ultrasound technology and strongly recommends that these criteria are in accordance with recommended training and education standards developed by each physician's respective specialty.
American College of Radiology

• Practice Parameter for Performing and Interpreting Diagnostic Ultrasound Examinations. 2017.

“...physicians should be able to provide evidence of the training and competence needed to perform diagnostic ultrasound examinations successfully.”
American College of Emergency Physicians


- “It (EUS, POCUS) is utilized for diagnosis of any emergency condition, resuscitation of the acutely ill, critically ill or injured, guidance of procedures, monitoring of certain pathologic states and as an adjunct to therapy.”
POCUS for Hospitalists


- Applications: Ascites, AAA, Hydronephrosis, Heart, Lungs (PTX, PNA, effusion, edema), Venous (volume, thromboembolism)

- “Hospitalists and other frontline providers, as well as physician trainees at various levels of training, have moderate to excellent diagnostic accuracy after brief training programs for most of these applications.”

- “...point-of-care ultrasound exams are aimed at making specific diagnoses for well-defined clinical scenarios.”

A Step Further...
The Society of Hospital Medicine


“The purpose of this position statement is to inform a broad audience about how hospitalists are using diagnostic and procedural applications of POCUS.”

“...is intended to provide guidance on the safe and effective use of POCUS by the hospitalists who use it and the administrators who oversee its use.”


West Virginia University.
Applications in Position Statement

- **Cardiac**
  - LV and RV assessment, Atrial size, CVP (IJ/IVC), Pericardial Effusion, Hypertrophy, Gross Valvular Abnormalities

- **Pulmonary**
  - Effusions, Alveolar and Interstitial Syndromes, PTX

- **Abdominal**
  - FF, Kidney Size, Hydronephrosis, Bladder Volume, Gallbladder, Spleen and Liver Size

- **Vascular**
  - DVT, AAA

- **MSK**
  - Cellulitis, Abscess, Joint Effusions, Fractures

- **Procedural**
  - Paracentesis, Thoracentesis, Central Lines, Peripheral Lines, Arterial Lines, Arthrocentesis, Abscess Drainage, LP
Even Further...

Total of 5 cases related to POCUS

“There were no reported cases of failure to interpret or misdiagnoses.”

“All reported decisions alleged a failure to perform an ultrasound study or a failure to perform it in a timely manner.”
How Can POCUS Help?
Case #1

- 74 yo male with shortness of breath
- PMHx of CAD, CHF, COPD, HTN, DM
- Vitals:
  - HR 118
  - BP 140/85
  - RR 32
  - Sat 86% on 15L via Non rebreather Mask
POCUS Echo Questions

• Is there squeeze or not?
• How is the global function?
• Is there right heart strain?
• Is there a pericardial effusion?
• Are there obvious structural abnormalities?
Differential Diagnosis in Dyspnea

- ACS
- Asthma/COPD exacerbation
- CHF exacerbation
- PE
- Pleural effusions
- Pericardial effusion
- Pneumonia
- Cardiomyopathy
- Pneumothorax
- Allergic response
- Anemia
- Anxiety
Pocus Affected Differential Diagnosis in Dyspnea

- ACS
- Asthma/COPD exacerbation
- CHF exacerbation
- PE
- Pleural effusions
- Pericardial effusion

- Pneumonia
- Cardiomyopathy
- Pneumothorax
- Allergic response
- Anemia
- Anxiety
Bedside Echo

"...focused cardiac ultrasound has become a fundamental tool to expedite the diagnostic evaluation of the patient at the bedside and to initiate emergent treatment..."
Evidence


130 patients analyzed with dyspnea

• Standard of Care performed (EKG, XR, Labs). Diagnosis based on 2 separate independent physicians

• Based on initial US, physician was asked diagnosis.
  • CHF accuracy of 90%
  • PNA or Pleural effusion accuracy of 86%
  • COPD/Asthma exacerbation accuracy of 96%

Evidence


• 314 patients compared standard echo to POC echo

• 27 hour course for hospitalist for LV systolic function, Severe MV regurg, LA enlargement, LV hypertrophy, Pericardial effusion, IVC dilatation

• “Accuracy of POC was moderate to excellent in all areas evaluated”
The Exam

• 4 views using phased array or low frequency transducer
• Work in a clockwise fashion
• Left lateral decubitus may aid in views
The Exam

- 4 views using phased array or low frequency transducer
- Work in a clockwise fashion
- Left lateral decubitus may aid in views
To Know Abnormal...
To Know Abnormal...
Our Patient

• 74 yo male with shortness of breath
• PMHx of CAD, CHF, COPD, HTN, DM
• Vitals:
  • HR 118
  • BP 140/85
  • RR 32
  • Sat 86% on 15L via Non rebreather Mask
Low EF

Normal

Reduced EF
Low EF

• Pearls and Pitfalls
  • Body habitus, patient positioning may limit views
  • Tachycardia, dysrhythmia and bradycardia can cause over/under-estimation of EF
Lung Ultrasound
POCUS Lung Questions?

- Is there sliding?
- Are there B-Lines?
- Is there an effusion?
- Are there consolidations?
Evidence

- Diagnostic Accuracy of Point-of-Care Lung Ultrasonography and Chest Radiography in Adults With Symptoms Suggestive of Acute Decompensated Heart Failure: A Systematic Review and Meta-analysis. Maw AM et al. JAMA Netw Open. 2019

- Six studies with total of 1827 patients

- LUS 88% sensitive and 90% specific

- CXR 73% sensitive and 90% specific

- “The findings suggest that LUS is more sensitive than CXR in detecting pulmonary edema in ADHF”
Lung Ultrasound

- Low frequency transducer
- Depth dependent on what you are looking to find
- Divide the anterior and posterior thorax into 4 quadrants each

Pulmonary Edema

Normal

Edema
Pulmonary Edema

Normal

Edema
Pulmonary Edema

• Pearls and Pitfalls
  • Look in several lung fields
  • Look for pleural effusions
  • Must use in context with patient presentation
Take Home Points Case 1

• POCUS of heart and lungs can provide critical information in the evaluation of the dyspneic patient
• Focused echo evaluating global function is within the scope of practice for Hospitalists
• Lung ultrasound can be quickly and accurately be used to evaluate for alveolar fluid
• Symmetric B lines = Edema
• Patchy or Focal B Lines = Infectious/Inflammatory
Case #2

• 54 yo male with dyspnea on exertion and right leg pain with ambulation
• PMHx of HTN, Asthma, DVT/PE, GI bleed
• Vitals:
  • HR 104
  • BP 108/68
  • RR 21
  • Sat 90% on RA
POCUS Echo Questions

• Is there squeeze or not?
• How is the global function?
• Is there right heart strain?
• Is there a pericardial effusion?
• Are there obvious structural abnormalities?
POCUS Echo Questions

• Is there squeeze or not?
• How is the global function?
• **Is there right heart strain?**
• Is there a pericardial effusion?
• Are there obvious structural abnormalities?
Evidence


- Prospective observational study Investigators were blinded
  - 116 patient’s with confirmed PE had focused US looking for RV strain
  - 5 investigators (1 Staff US director, 1 US Fellow, 3 EM Residents)
  - 100% Sensitivity and 99% Specificity for RV strain compared to comprehensive echo

- “Goal-directed echocardiography was highly accurate for early severe right ventricular dysfunction identification and pulmonary embolism risk-stratification.”

Evidence

• Diagnostic Accuracy of Point-of-Care Ultrasound Performed by Pulmonary Critical Care Physicians for Right Ventricle Assessment in Patients With Acute Pulmonary Embolism. Filopei J. et al. Crit Care Med. 2017

• Prospective observational study

• 154 focused echo’s

• CC Fellows were 83% sensitive and specific, Staff was 87% sensitive and specific at diagnosing RV enlargement compared to comprehensive echo

• Median time to get comprehensive echo was 21 hours 18 minutes

• “Screening for right ventricular dysfunction using goal-directed echocardiography can and should be performed by pulmonary critical care physicians in patients with acute pulmonary embolism”

Diagnostic Accuracy of Point-of-Care Ultrasound Performed by Pulmonary Critical Care Physicians for Right Ventricle Assessment in Patients With Acute Pulmonary Embolism

Jocelyn Filopei, MD; Samuel O. Acquah, MD, FCCP; Eric R. Bondardery, MD; David J. Stieger, MD, FCCP; Navitha Ramani, MD; Madhineh Ehrlich, MD; Pam Patranella, MD, FCCP

Objective: To report the feasibility of real-time focused ultrasound and correlate the findings with the RV size and function obtained on a comprehensive echocardiogram in patients with PE. Methods: A prospective observational study of all patients admitted to the medical ICU with PE during a 6-month period was performed. All patients received focused ultrasound immediately upon arrival, and comprehensive echocardiography was performed within 48 hours. Results: A total of 154 ultrasound examinations were performed. All RV measurements were obtained in <2 min. The measured RV size was compared with comprehensive echocardiography and compared to the medical ICU outcome. Conclusion: Real-time focused ultrasound can provide quick, easy, and reliable estimates of RV size and function in patients with PE and should be a part of the initial evaluation for management, triage, and outcome prediction.

Pulmonary embolism (PE) is the third leading cause of cardiovascular death in the United States (1). Mortality...
Sometimes We Get Lucky
RV Strain

- RV enlargement to >2/3 size of the LV
- Compression of the septal wall (D Sign)
- Septal dyssynchrony
- Akinesis of the RV with hyper-dynamic apex (McConnell’s Sign)
RV Strain

Normal

RV Strain
RV Strain

- Pearls and Pitfalls:
- Absence of RV dilation does not exclude PE
- Mimicks:
  - Pulmonary HTN
    - RV hypertrophy
    - RA dilation
  - LBBB
Extremity Ultrasound for DVT
Questions for LE DVT Ultrasound

• Does the vein compress?
• Is there visible thrombosis?
Evidence


  - Prospective, cross-sectional study for proximal DVT
  - 47 physicians underwent a 10 minute training session
  - 199 Bedside 2 point compression studies performed compared to Radiology performed DVT study
  - 45 true positives, 1 false positive (had a DVT 1 wk later), 153 true negatives
  - 100% sensitivity and 99% specificity
Evidence

• Comparison between two-point and three-point compression ultrasound for the diagnosis of deep vein thrombosis. Zuker-Herman R. et al. J Thromb Thrombolysis 2018

• 195 patients enrolled and 48 were found to have DVT by complete duplex
  • 2 point
    • sensitivity 82.76%, specificity 98.52%
  • 3 point
    • sensitivity 90.57%, specificity 98.52%

“The 3PCUS examination preformed in the ED, is a noninvasive, accurate and quick diagnostic test for evaluation of patients presenting with signs and symptoms suggestive of a DVT.”
Exam for LE DVT

• Linear or Low Frequency Transducer
• 3-point compression study
  • Great Saphenous and Common Femoral Junction
  • Deep Femoral and (Superficial) Femoral Junction
  • Popliteal Vein
Thromboembolism

Normal

DVT
Thromboembolism

• Pearls and Pitfalls:
  • Find the artery!
  • Mimicks
    • Lymph Nodes
    • Superficial Thrombophlebitis
  • Always get enough depth
Take Home Points Case 2

- RV strain can be accurately and rapidly diagnosed at the bedside to guide treatment
- Use POCUS for DVT within the context of patient presentation
  - 2-point and 3-point compression studies miss calf DVT
  - In high risk, high suspicion patient, DVT can be ruled in but not out with 3-point study
Case #3

• 84 yo female with dyspnea and syncope
• PMHx of HTN, Hypothyroidism, hyperlipidemia
• Vitals:
  • HR 98
  • BP 118/88
  • RR 22
  • Sat 93% on RA
POCUS Echo Questions

- Is there squeeze or not?
- How is the global function?
- Is there right heart strain?
- Is there a pericardial effusion?
- Are there obvious structural abnormalities?
Evidence

  - Physicians had a 16 hour course with 1 hour lecture and 4 hour lab on echo
  - 515 “high risk” patients, 478 studies were considered adequate
  - 103 effusions identified
  - Sensitivity was 96% and Specificity was 98% for diagnosis of effusion

Pericardial Effusion

• Use all 4 views to evaluate
• Simple fluid is hypoechoic
  • Uremic effusion
  • Malignant effusion
  • Pericarditis
  • Early blood
• Complex fluid will have hypoechoic areas with hyperechoic inclusions
  • Clotted blood
  • Purulent effusions
Pericardial Effusion

Normal

Effusion
Pericardial Effusion

Normal

Effusion
Tamponade
Pericardial Effusion

• Pearls and Pitfalls:
  • Tamponade is a clinical diagnosis!

• Mimics:
  • Prominent epicardial fat
  • Pleural Effusion
Take Home Points Case 3

• Pericardial effusion can be accurately and rapidly identified on bedside ultrasound

• Tamponade is a clinical diagnosis, but ultrasound can indicate impending cardiovascular collapse
Case #4

• 58 yo female with fatigue, dizziness, confusion
• PMHx of HTN, DM, CAD, Hyperlipidemia, COPD
• Vitals:
  • HR 122
  • BP 80/42
  • RR 26
  • Sat 91% on 2L NC
Undifferentiated Shock Ultrasound
Etiologies of Shock

- Cardiogenic
  - Pump failure
- Hypovolemic/hemorrhagic
  - Blood loss (thoracoabdominal, GI, AAA), fluid loss
- Distributive
  - Anaphylactic, neurogenic, sepsis*
- Obstructive
  - Cardiac tamponade, PE, tension ptx
- Endocrine
Etiologies of Shock

• Cardiogenic
  • Pump failure

• Hypovolemic/hemorrhagic
  • Blood loss (thoracoabdominal, GI, AAA), fluid loss

• Distributive
  • Anaphylactic, neurogenic, sepsis

• Obstructive
  • Cardiac tamponade, PE, tension ptx

• Endocrine
Undifferentiated Shock Questions?

• How is the global heart function?
• Is there right ventricular heart strain?
• Is there a pericardial effusion?
• Are there obvious cardiac structural abnormalities?
• Is the IVC collapsed?
• Is there an AAA?
• Is there FF in abdomen or thorax?
• Is there lung sliding?
• Do the proximal deep veins compress?
• Is there an obvious infectious source?

In undifferentiated hypotension obtain the following: Heart, IVC, Aorta, RUQ, LUQ, Pelvis, Lungs, LE veins

“The RUSH exam, presented in this article, represents a comprehensive algorithm for the integration of bedside ultrasound into the care of the patient in shock.”
RUSH Exam

• Focuses on 3 main areas:
  • Pump
    • Contractility, Chamber Size, Effusion, RV Strain
  • Tank
    • IVC, Peritoneal Fluid, Thoracic Fluid/PTX/Pulmonary Edema
  • Pipes
    • Aorta and DVT
Evidence


- Prospective observational study
  - 118 patients evaluated by ultrasound trained physicians
  - “Clinical management involving the early use of ultrasound in patients with hypotension accurately guides diagnosis, significantly reduces physicians' diagnostic uncertainty, and substantially changes management and resource utilization..."
IVC Exam

- Low frequency transducer
- Mid epigastrium or right lateral view with indicator to the patient head
- Collapsing IVC can indicate hypovolemia
- Dilated IVC can indicate fluid overload
- Postulated that IVC diameter is indirect measurement of CVP which can be used to assess fluid responsiveness.
Evidence for IVC Guided Management


- Prospective clinical study
- 23 patients in ICU on PP ventilation
- Dispensability of IVC and Cardiac index measured before and after volume expansion
- At 18% dIVC CI improved by 15%


- Prospective clinical study
- 16 patient’s responded to bolus of hydroxyethylstarch by increasing cardiac index by 15%
Problem with IVC Guided Management


- 43 studies reviewed
- “There are no data to support the widespread practice of using central venous pressure to guide fluid therapy. This approach to fluid resuscitation should be abandoned.”


- 51 studies reviewed
- 1148 data sets
- Zero predictive values were above 66% for any CVPs from 0 to 20 mmHg.
IVC Debate

- Surviving Sepsis Campaign no longer includes recommendations on CVP (Prior was 8-12mmHg)
Undifferentiated Shock Questions?

- How is the global heart function?
- Is there right ventricular heart strain?
- Is there a pericardial effusion?
- Are there obvious cardiac structural abnormalities?
- Is the IVC collapsed?
- Is there an AAA?
- Is there FF in abdomen or thorax?
- Is there lung sliding?
- Do the proximal deep veins compress?
- Is there an obvious infectious source?
US for Shock

- Heart
  - Global Function, Strain, Chamber Size, Effusion, Aortic Root, Obvious Valvular Pathology
- Abdomen
  - IVC, FF, AAA, Dissection
- Thorax
  - PTX, Effusions
- Infectious
  - PNA, Endocarditis, Cholecystitis, UTI/Hydronephrosis, Cellulitis
Cardiomyopathy

Normal

Hypertrophic Cardiomyopathy
Dissection

Normal

Dissection Flap
Hemoperitoneum

Normal

Free Fluid
Hemoperitoneum

Normal

Free Fluid
Pneumothorax

Normal

PTX
Pneumonia

Normal

Infiltrate
Endocarditis

Tricuspid Vegetation

Aortic Vegetation
Hydronephrosis

Normal

Hydronephrosis
Skin and Soft Tissue

Normal Skin

Necrotizing Fasciitis
Undifferentiated Shock

• Pearls and Pitfalls:
  • Let clinical context guide the exam
  • Not all FF is blood
  • Not all AAA’s are ruptured
Take Home Points Case 4

• POCUS can be used to guide evaluation and management of undifferentiated shock

• CVP to guide fluid management is not currently supported by the literature; therefore IVC measurement as a sole guide to fluid management cannot be recommended
Conclusions

• The sicker the patient, the more useful POCUS can be at guiding evaluation and management

• Ultrasound is user dependent and skill is acquired through practice

• Practice often with normal exams or on individuals with known diagnoses to build skills for critical moments . . .
Questions

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References


References


References

24. Special thanks to Dr. Joseph Minardi (Twitter @jminardi21) (YouTube: Joseph Minardi)