POINT OF CARE ULTRASOUND IN CLINICAL PRACTICE

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Objectives

Upon completion of this lecture, participants should be able to:

1. Understand the evidence that supports the use of point of care ultrasound (POCUS) in clinical practice
2. Understand the basics of cardiac and lung POCUS
3. Review clinical situations that may benefit from the use of POCUS

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What is Point of Care Ultrasound (POCUS)?

- Ultrasound performed and interpreted by the provider at the bedside
- POCUS is NOT echocardiography

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Why use Point of Care Ultrasound?

- Cost effective
- No radiation
- Can be completed at the bedside
- Immediate information

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POCUS Improves Your Clinical Exam

- Assessing JVD is difficult
  - Clinicians can identify the jugular veins in 72-94% of patients and only accurately assess CVP as low, normal, or high about half of the time[1]
- POCUS by first-year medical student vs cardiologist's physical exam[2]
  - Students correctly identified **75%** of pathologies vs **49%** by cardiologists
  - Sensitivity for lesions that cause systolic murmur
    - **93%** students, **62%** cardiologists
  - Sensitivity for lesions that cause diastolic murmur
    - **75%** students, **16%** cardiologists
- In a multicenter ICU study including 1,215 POCUS studies, the addition of POCUS led to a change in diagnosis in **24.9%** of time and a change in management **44.0%** of time[3]

[1]McGee American Heart Journal 1998
[2]Kobal et al. American Journal of Cardiology 2005
[3]Bernier-Jean et al. Journal Intensive Care Med 2017

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Cardiogenic vs Non-Cardiogenic Etiology of Dyspnea

Study enrolled 1,005 patients presenting to ED with dyspnea[1]

- ED physician categorized as cardiogenic vs non-cardiogenic etiology

	Sensitivity	Specificity
Clinical work up	85.3%	90%
Lung ultrasound	**90.5%**	93.5%
Lung ultrasound + clinical	97%	97.4%
CXR	**69.5%**	82.1%

[1]Pivetta et al. Chest 2015. Chest

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Lung Ultrasound vs CXR compared to "Gold Standard" CT

Study at Abbott Northwestern Hospital comparing lung US and portable CXR to CT on 67 intubated patients in the ICU[1]

Lobe Specific Agreement By Finding

Variable	Ultrasound	Portable CXR	p
Normal	78.8%	59.5%	0.005
Interstitial	86.2%	28.6%	<0.001
Ground Glass	89.9%	72.5%	<0.001
Atelectasis/consolidation	95.6%	72.5%	<0.001
Effusion	100.0%	74.5%	<0.001
Overall	**88.9%**	**66.3%**	<0.001

[1]Tierney et al. Critical Care Medicine Journal 2020

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Lung Ultrasound for Pneumothorax

- Systematic review and meta-analysis of 1048 patients
  - Ultrasound
    - **90.9% sensitive**
    - 98.2% specific
  - Supine CXR
    - **50.2% sensitive**
    - 99.4% specific

Alrajhi et al. 2012 Chest

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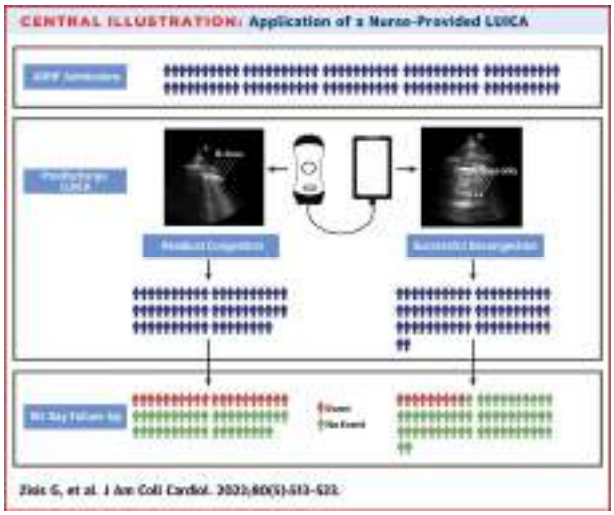
POCUS by Heart Failure Nurses

- Heart failure nurses performed POCUS of lungs and IVC to assess for residual congestion prior to patients discharging after being admitted for acutely decompensated heart failure
- 240 patients
- Pulmonary congestion increased the 90 day odds of HF readmission and/or death by 3.3- to 4.2 fold (p<0.01)



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The Probe is an Emitter and Receiver

- Crystals in the probe vibrate and send out sound
- Some of the sound gets absorbed and some of it gets reflected back to the probe
- The sound that reflects back to the probe is what is interpreted by the machine to create your ultrasound image
  - **Echogenicity**: determined by how much sound was reflected back to the probe in comparison to what was emitted from the probe
  - **Depth**: determined by how long it took for a sound to come back the probe in comparison to when the sound was sent

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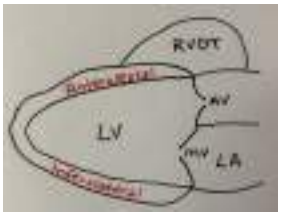
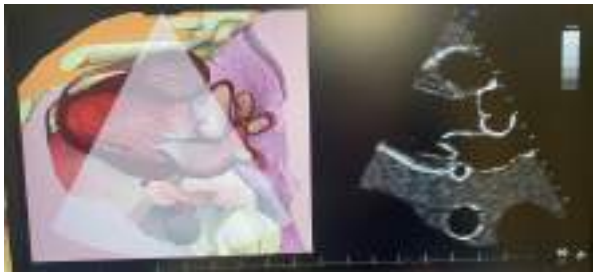
Parasternal Long Axis





Preserved LVEF

Reduced LVEF

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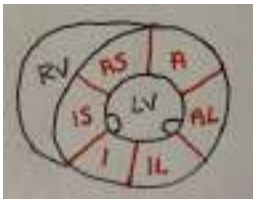
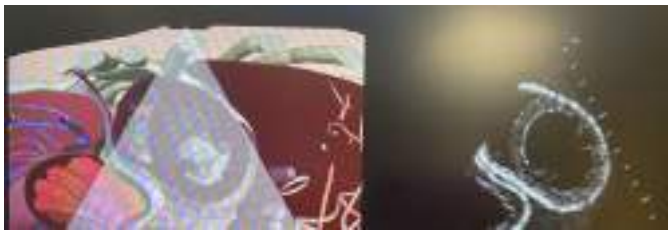
Parasternal Short Axis





Preserved LVEF

Reduced LVEF

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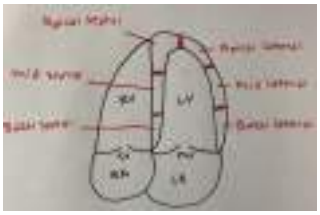
Apical Four Chamber



Preserved LVEF

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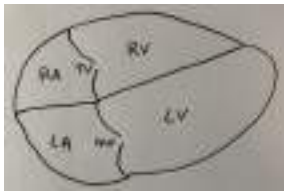
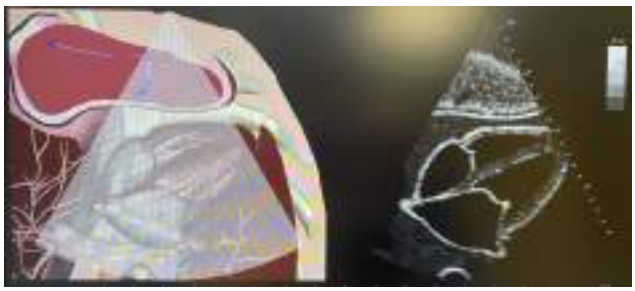
Subcostal Four Chamber





Preserved LVEF

Reduced LVEF

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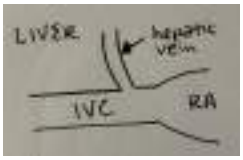
Inferior Vena Cava



- Normal IVC size: 1.5-2.1 cm
- Small IVC with >50% resp. variation = RAP low
- Normal sized IVC with >50% resp. variation = RAP about normal
- Normal sized IVC with <50% resp. variation = RAP mildly elevated
- Dilated IVC with >50% resp. variation = RAP mildly elevated
- Dilated IVC with <50% resp. variation = RAP elevated

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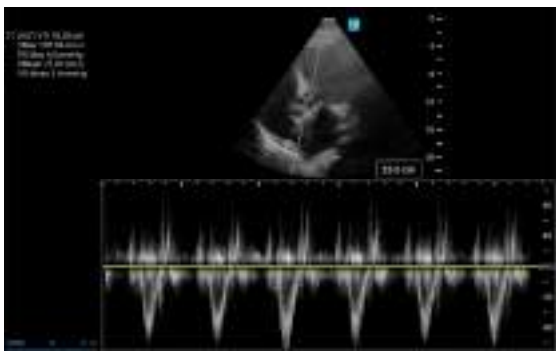
Left Ventricular Outflow Tract Velocity Time Integral

- LVOT VTI: Left ventricular outflow tract velocity time integral
- Advanced POCUS skill that is good for estimating stroke volume
  - Helps answer the question on if your patient is in cardiogenic shock or not
- VTI measures how far the blood moves in one cardiac cycle



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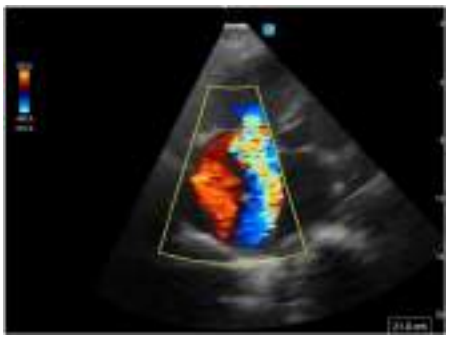
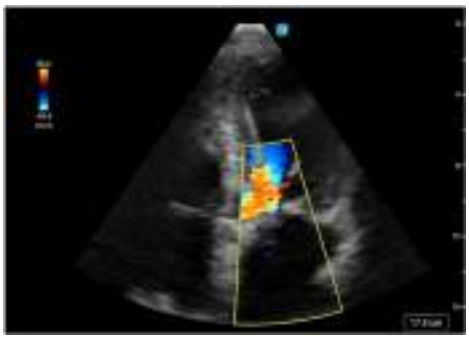
Valve Assessment

- Limited valve assessment can also be done with POCUS



Tricuspid regurgitation



Mitral regurgitation

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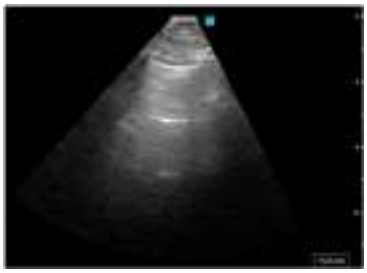
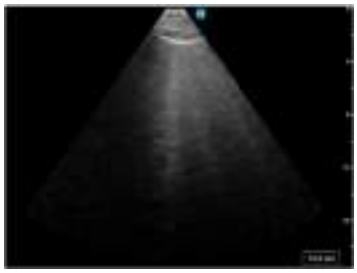
Brief Lung Ultrasound Overview

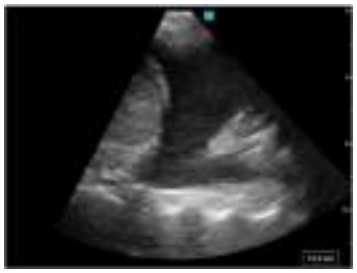
A lines = “Dry Lungs”



B lines = Interstitial Process



Pleural Effusion



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Brief Lung Ultrasound Overview

Consolidation

Lung Sliding

No Lung Sliding

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POCUS During Codes

- **Hypovolemic?**
  - Check IVC
- **Tension Pneumothorax?**
  - Check for lung sliding
- **Tamponade?**
  - Cardiac ultrasound to look for pericardial effusion
- **PE?**
  - Cardiac ultrasound to assess RV. If RV large with decreased function, should make you suspicious in the right context
  - Could assess for saddle PE by looking at the main pulmonary artery to level of bifurcation (advanced view) or quick ultrasound legs for DVT
- **Cardiogenic?**
  - Assess biventricular function

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Case #1

- 72 yo F with PMH significant for lung cancer, HTN, and CKD stage 4 admitted for dyspnea
- D-dimer negative, Cr 2.3, WBC 9, Hgb 10, CXR unremarkable
- Shortly after coming up to the floor, becomes hypotensive with BP 78/50

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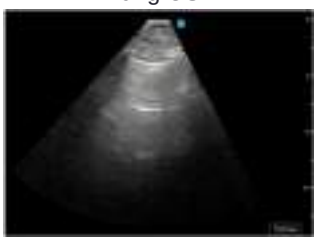
Case #1

Lung US



IVC

Tamponade!

IV fluids and consult cardiology for emergent pericardiocentesis!

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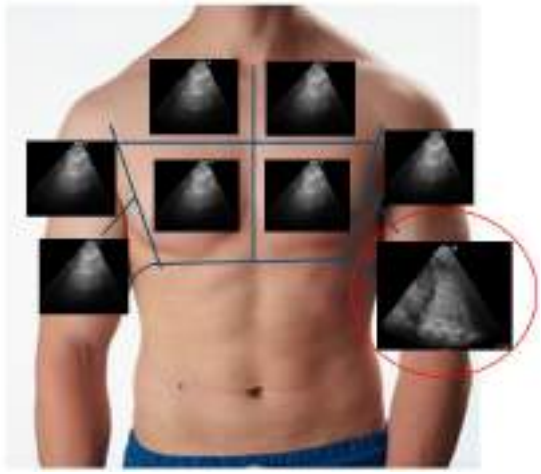
Case #2

- 65 yo M with PMH significant for chronic HFrEF presents with shortness of breath



- Dry lungs with consolidation at left base
- Diagnosis = Pneumonia

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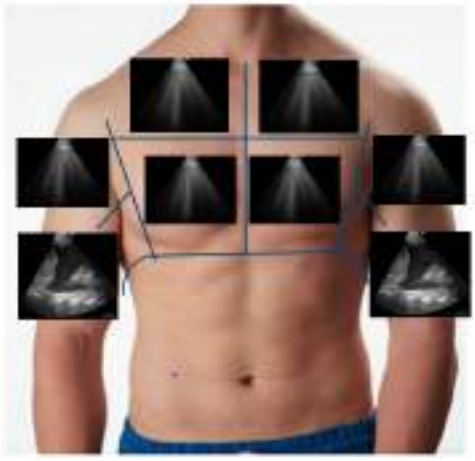
Case #3

- 55 yo M presents to ED with shortness of breath

Apical 4 Chamber

IVC



- Diagnosis = Acute HFrEF
- Admit for IV diuresis, order formal echo, start GDMT, consult cardiology

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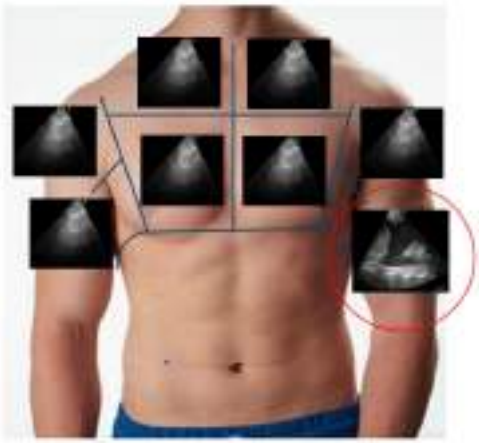
Case #3 – Continued

- Patient successfully diuresed. Weight down, Cr bumped, but still requiring supplemental O2 (not on PTA)

IVC



- Moderate-large left sided pleural effusion persists despite patient now being intravascularly dry
- Proceed with thoracentesis

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Conclusion

Point of care ultrasound – It is not just a bunch of Hocus POCUS

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