Point of Care Ultrasound: Pearls for Heart Failure Management

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Conflict of Interest Disclosures

- **Grants/research support**:
- **Consulting fees**: Lantheus Medical Imaging
- **Speaker fees**:
- **Other**: Steering Committee: NovoNordisk (SOUL trial)

- I will not discuss off-label uses

OBJECTIVES

1) Understand the purpose and basic components of point of care ultrasound (POCUS)
2) Describe typical POCUS findings associated with Heart Failure
3) Understand the pitfalls of POCUS technology and interpretation
4) BONUS: role of POCUS in COVID19

POLL: My exposure to POCUS would be best characterized by which of the following statements:

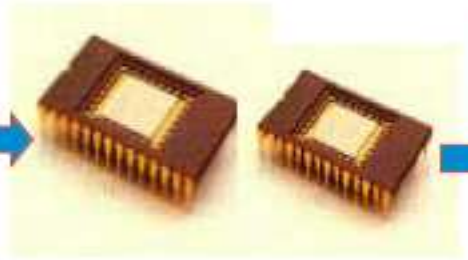
1) I regularly use POCUS in clinical assessments with confidence
2) I am occasionally using POCUS, and feel confident in my skills
3) I am occasionally using POCUS, but do not feel confident in my skills
4) I have limited prior echo experience and am contemplating getting a POCUS device
5) I have access to a POCUS device, but have no idea how to use it
6) I don't have access to a POCUS device, but wish I did, and want to learn how to use it
7) POCUS? It's just HOCUS-POCUS. Why do we need it?
8) None of the above

What is Point-of-Care Ultrasound?

- **Ultrasonography performed and interpreted by the clinician at the bedside and integrated in to patient care in real time**

-goal directed workflow
-diverse specialties
-multi-system interrogation
-24/7 availability
-repeatable

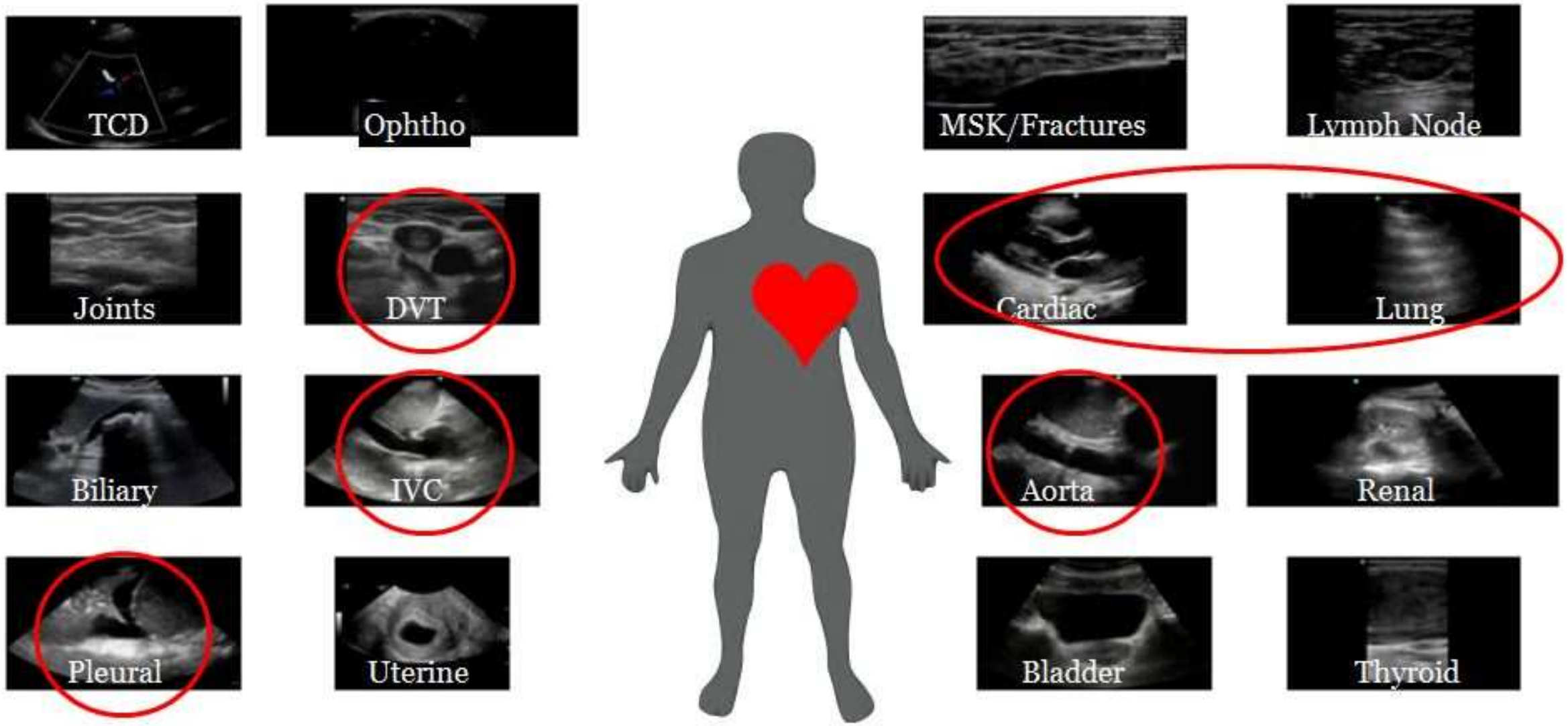
Portability and Miniaturization of Ultrasound Systems



THEN

NOW

POCUS Scope


TCD
Ophtho
MSK/Fractures
Lymph Node
Joints
DVT
Cardiac
Lung
Biliary
IVC
Aorta
Renal
Pleural
Uterine
Bladder
Thyroid

The NEW ENGLAND JOURNAL of MEDICINE

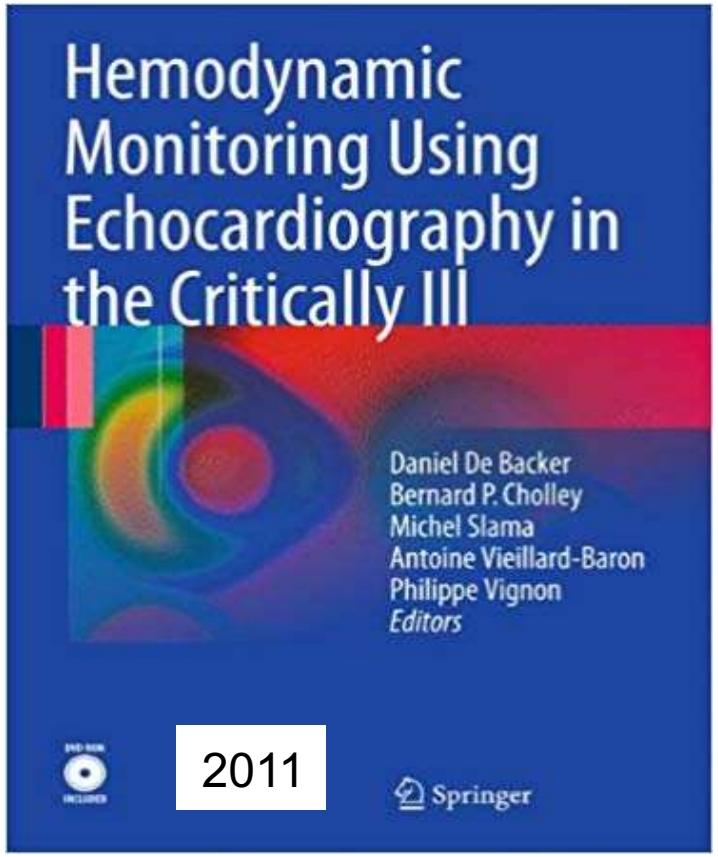
2011

REVIEW ARTICLE

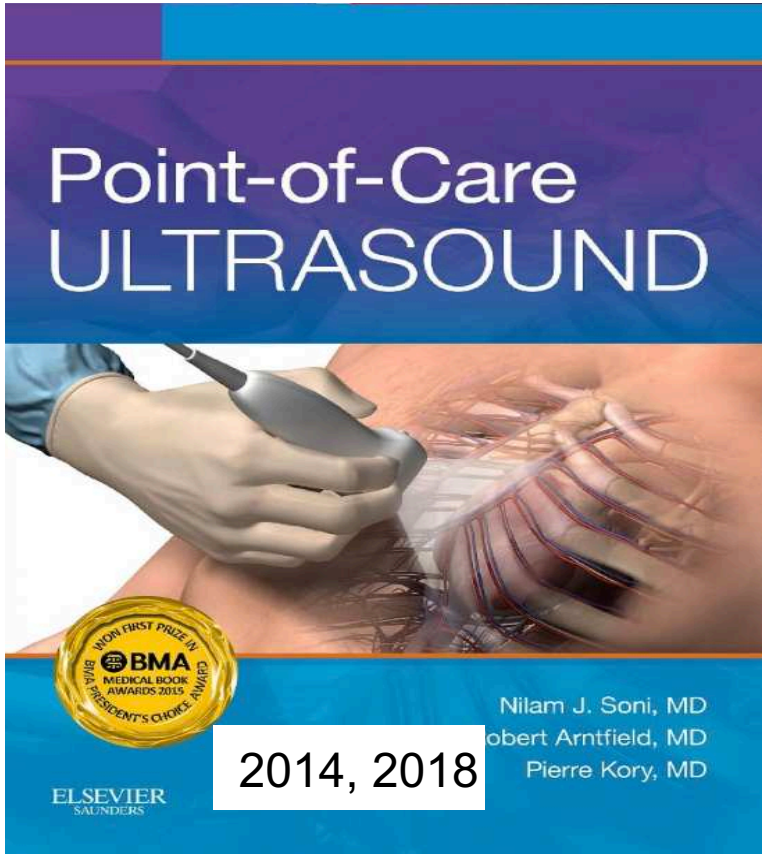
CURRENT CONCEPTS

Point-of-Care Ultrasonography

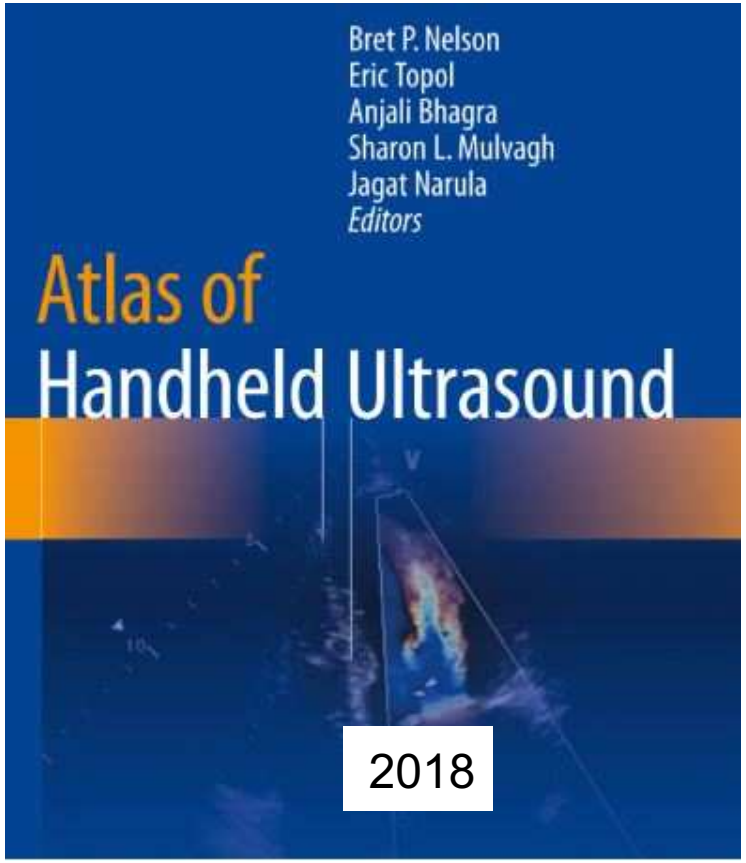
Christopher L. Moore, M.D., and Joshua A. Copel, M.D.



2011



2014, 2018



2018

Purpose: Expedite care

A tale of 2 Cases

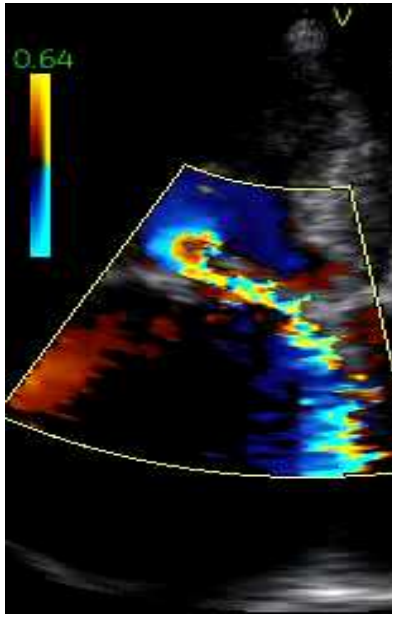
CASE 1: 69 yo female, no prior cardiac history new onset dyspnea NYHA II

- Clinical assessment: (hx, physical findings, CXR, BNP)
  - **ED Dx: left heart failure, murmur**
- Managed w/ IV diuresis; Discharged: furosemide 40 mg od
- ***Out-pt Echo , Cards clinic (3 mos)***
- **BUT: one month later: severe dyspnea**; tried increasing furosemide
- **Returns to ED:** rales, murmur; hypokalemia and mild renal dysfunction
- ***Echo-pending***. No clinical follow-up has occurred
- Admitted for Dx (**TTE**), Rx

69 year old female with dyspnea
–*TTE one month after* symptom onset

TTE: flail mitral leaflet, severe MR, normal EF

Case 2: 63 yo male , mild progressive dyspnea, sudden worsening, presyncope



- ED: murmur -CV consult - POCUS

  POCUS: flail mitral leaflet, severe MR, normal LV function

  - Admitted: intraop TEE, MV repair
  - Back to work within 3 weeks

Case 1 vs Case 2????

POCUS *made a difference* in management & outcome


DISRUPTION

Basic Ultrasound controls ("Knobology")

- Probe selection

  -**low** frequency: (2-5 MHz): **deep** structures: cardiac, abdomen

  -**high** frequency: (8-10 MHz): **shallow** structures: vascular, lung

US penetration is inversely proportional to the frequency

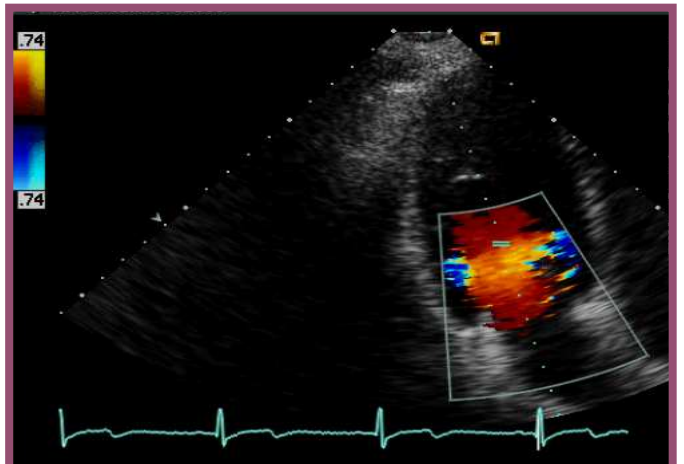
- 2-D controls

  - depth
  - overall gain (brightness)

- Color Flow Doppler

  -red: towards

  - blue: away



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Ultrasound Tissue Characteristics

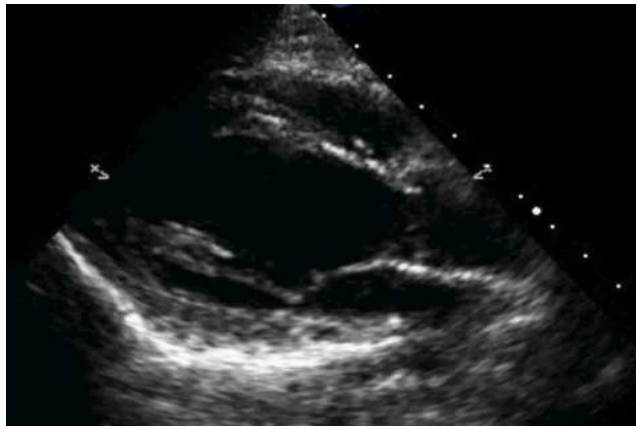
- *Echogenic structures are white*
  - Bone
  - Tissue
  - Air

Ultrasound reflection

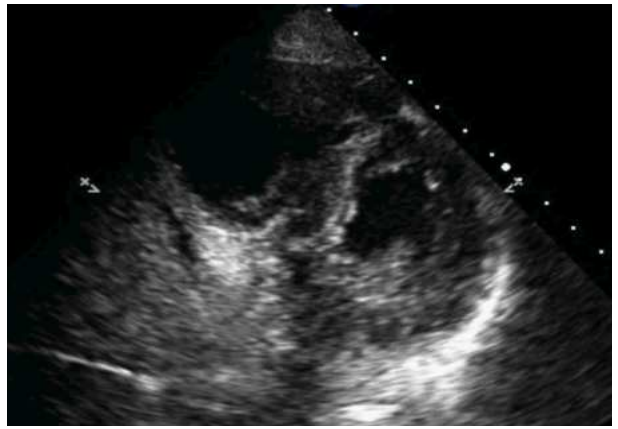
- ***Echolucent fluid is black***
  - **blood**
  - **effusions**

Ultrasound transmission

Basic Point of Care Echocardiography for Heart Failure

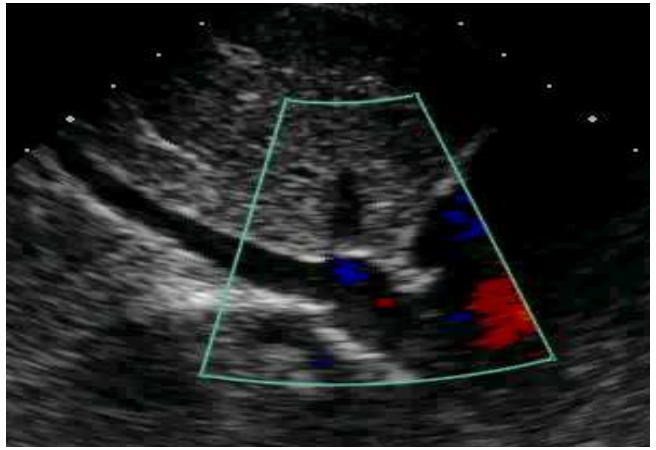


LV size/function



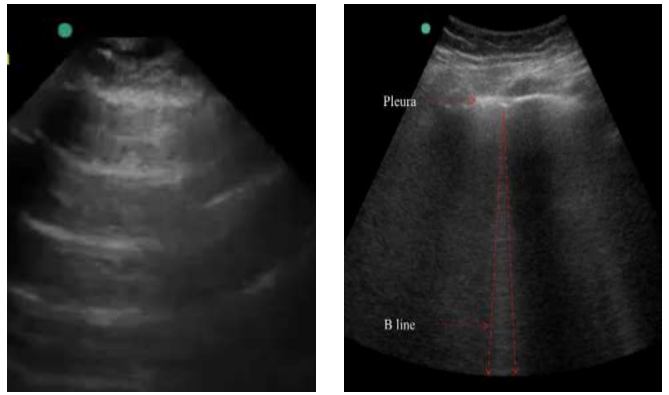
RV size/function

Pericardial Effusion



IVC - Volume Status

Significant Valvulopathy



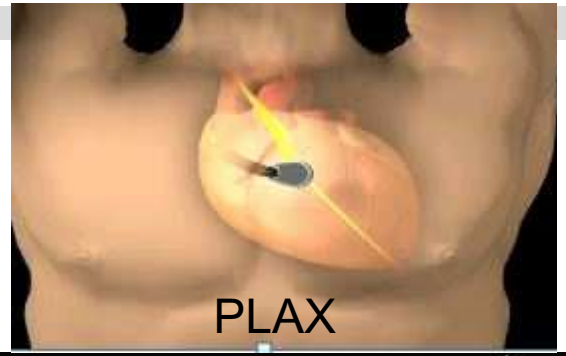
A-lines B-lines

Lung Exam

Basic Exam: Cardiac

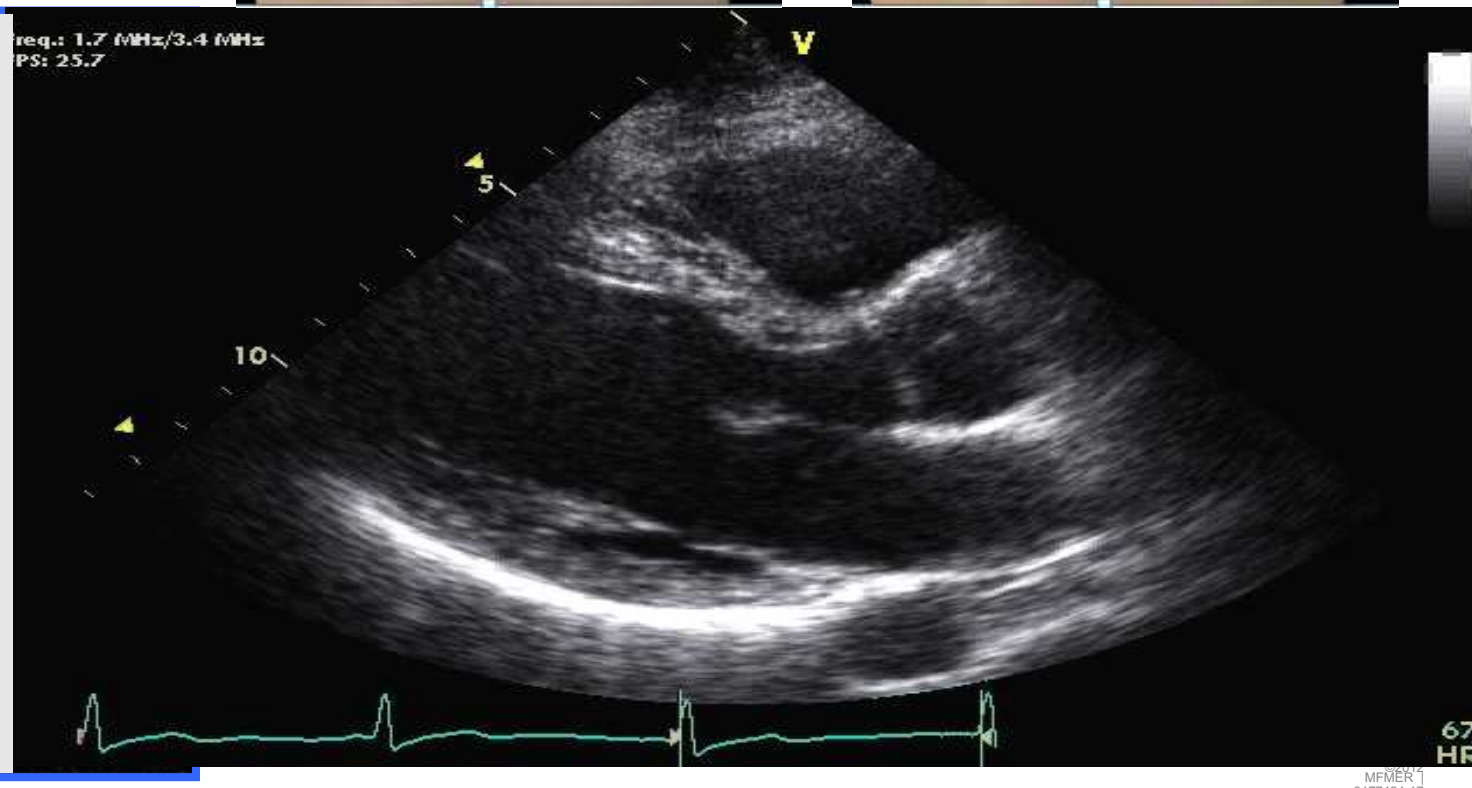
Majority of info can be obtained from PLAX, Subcostal

- ***Parasternal: Long Axis (PLAX)*, Short Axis**
- **Apical**
- **Subcostal**



PLAX

- LV size
- LV function
- RV size, function
- Pericardial fluid?
- Asc aorta size
- MV, AV



Basic Exam: Cardiac

Majority of info can be obtained from PLAX, Subcostal

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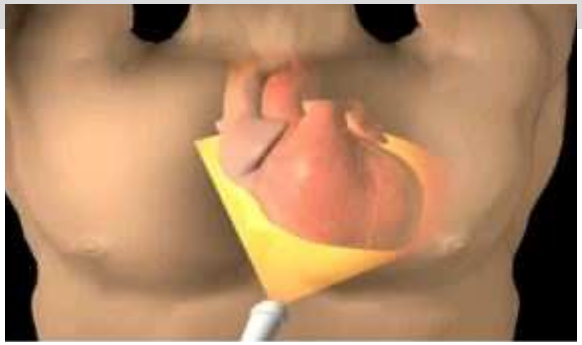
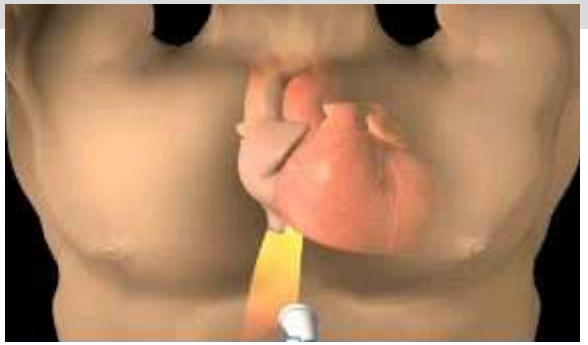
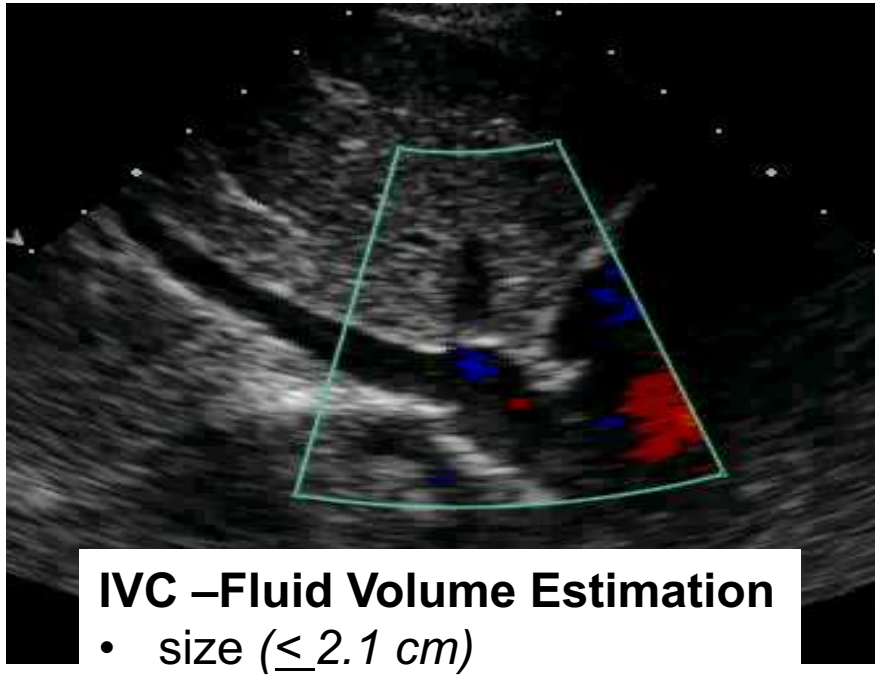
- ***Subcostal***



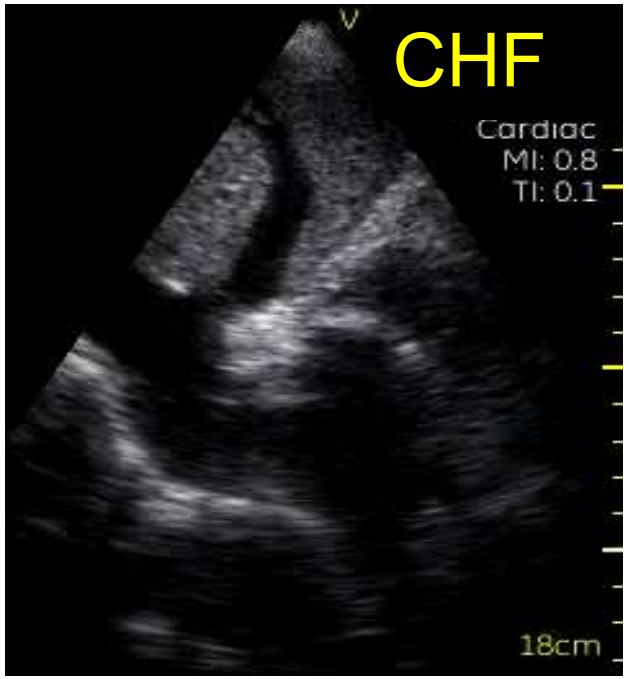


4-chamber view
-assess pericardial effusion



IVC –Fluid Volume Estimation
- size *(≤ 2.1 cm)*
- respiratory variation:

decreases > 50% with sniff



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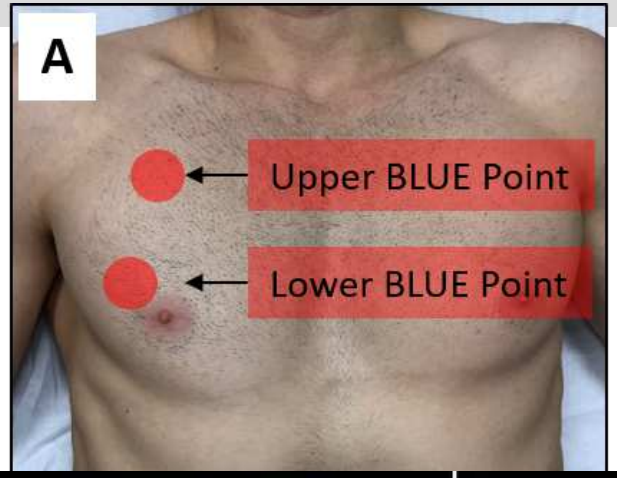
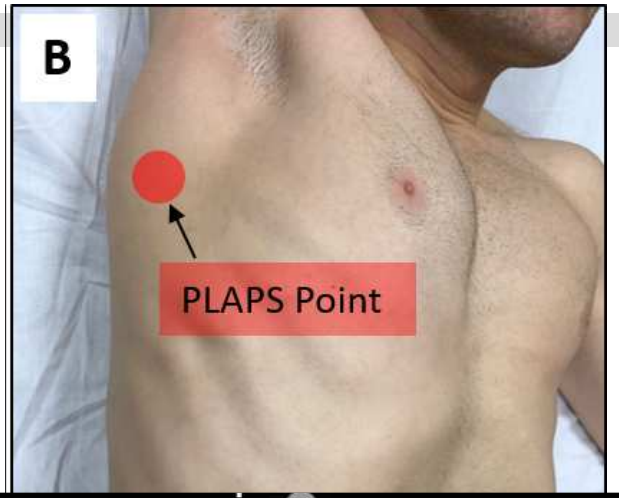
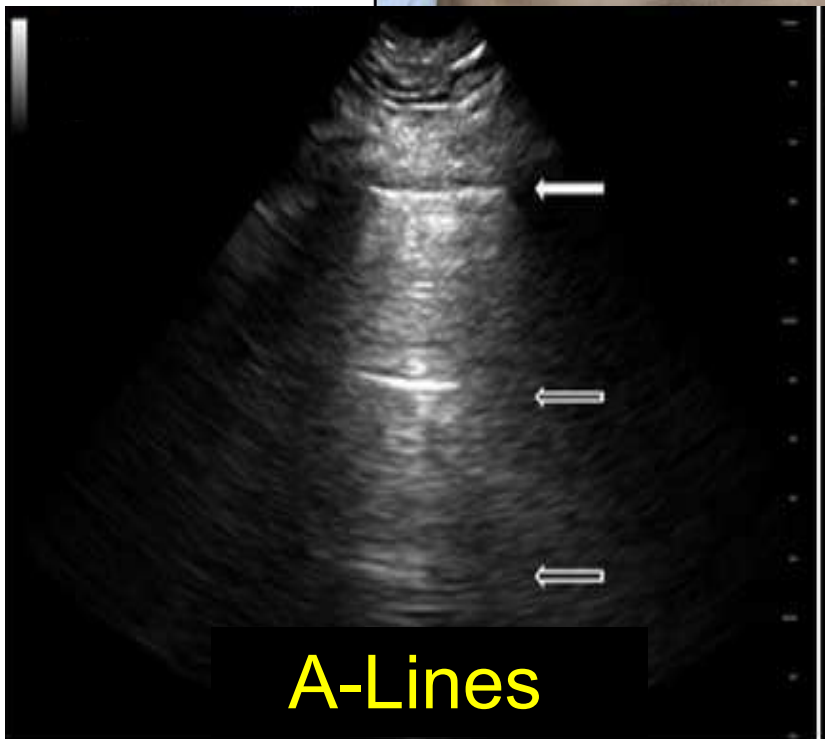
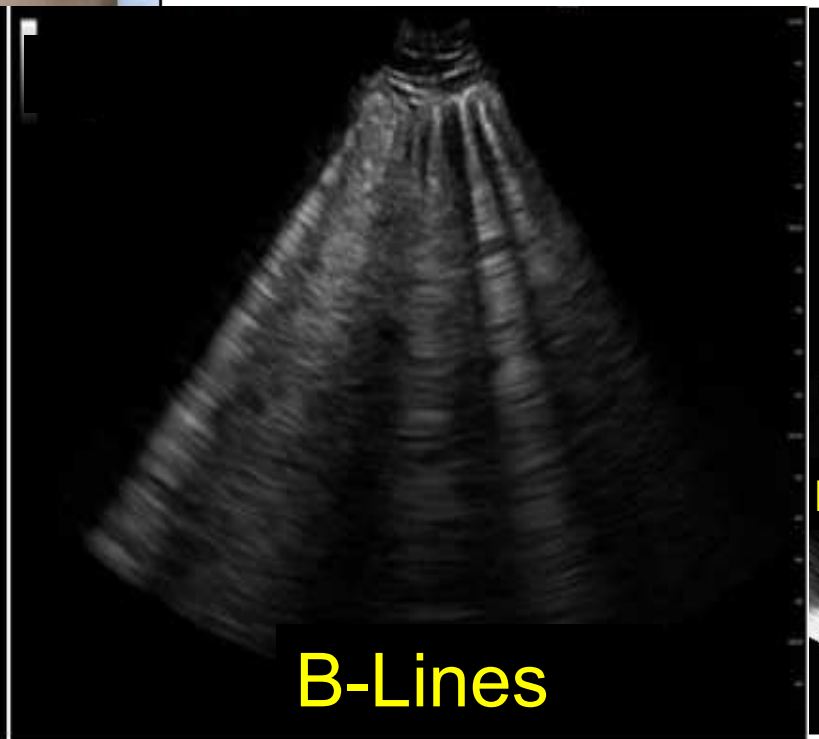
Basic Exam: Lung

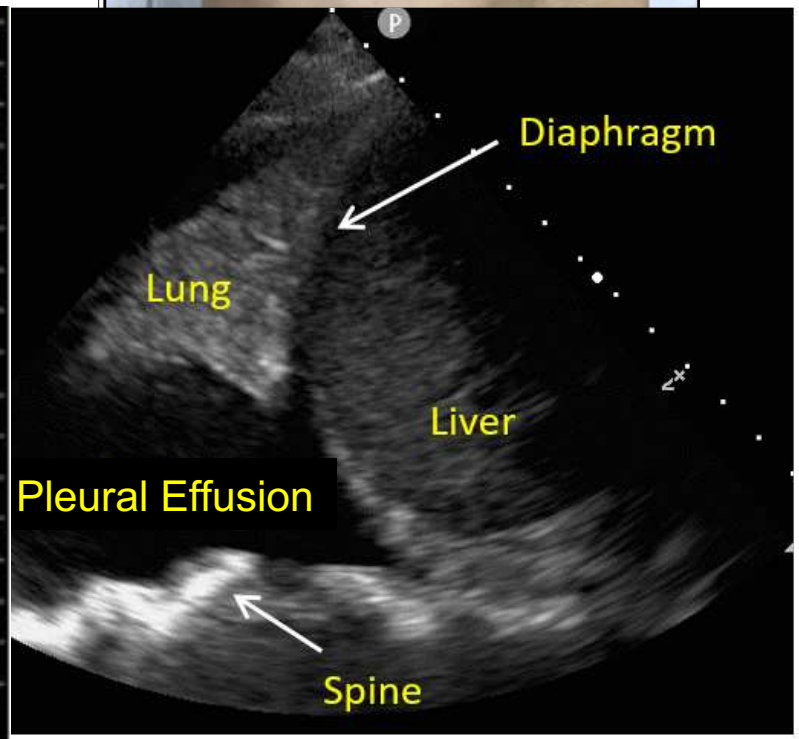
Lungs just don't get in the way!
Valuable info in the *artifacts* observed









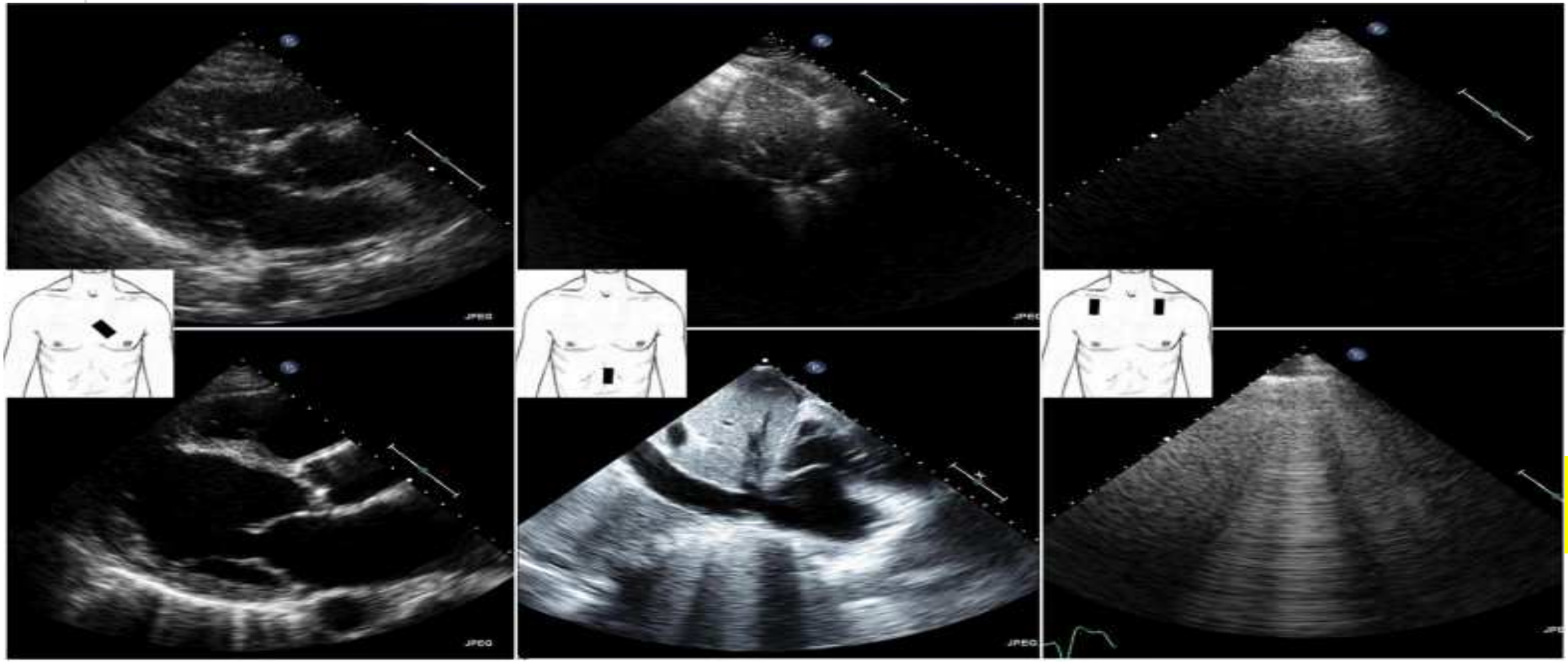


Integration: Cardiopulmonary Limited US Exam (CLUE) in the diagnosis and management of CHF

PLAX- LV, RV, valves

Subcostal- IVC

Lung



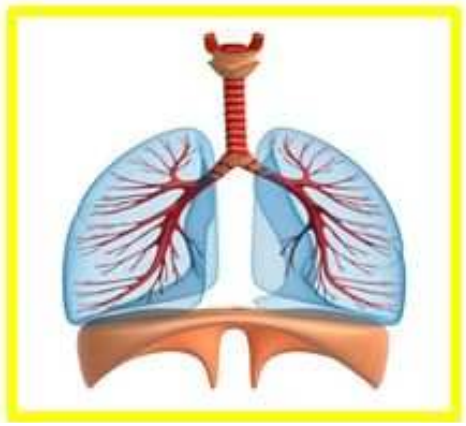
Normal

CHF

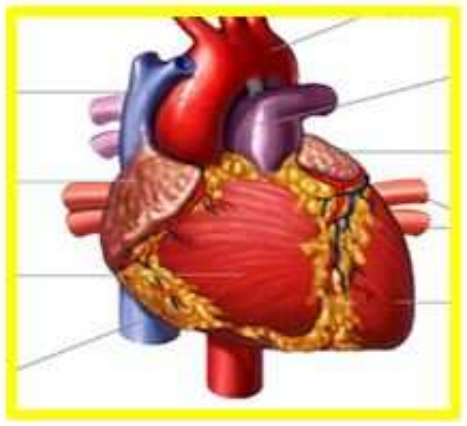
Kimura BJ Am J Cardiol 2011: 108:586-590

Clinical Integration:

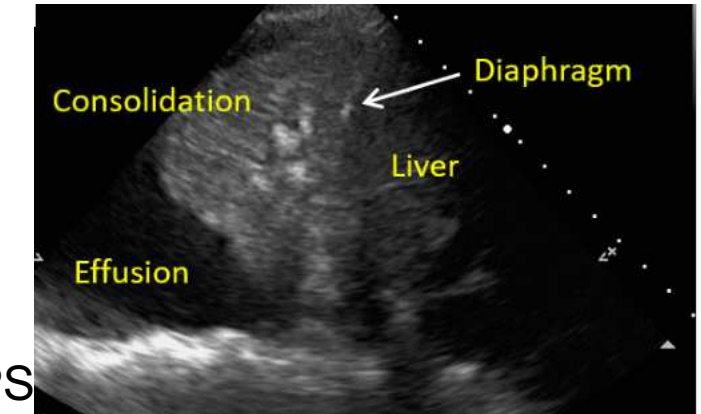
Differentiating the typical symptom of Heart Failure: Dyspnea



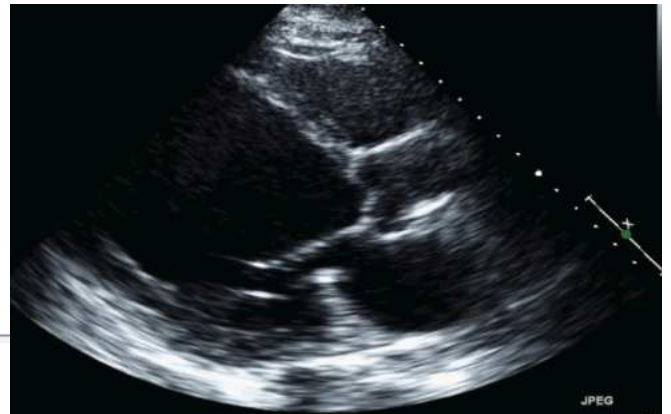
- **Pneumonia**
- Pulmonary Embolism
- COPD



- **CHF**
- Pericardial Effusion
- Valvular Heart Disease



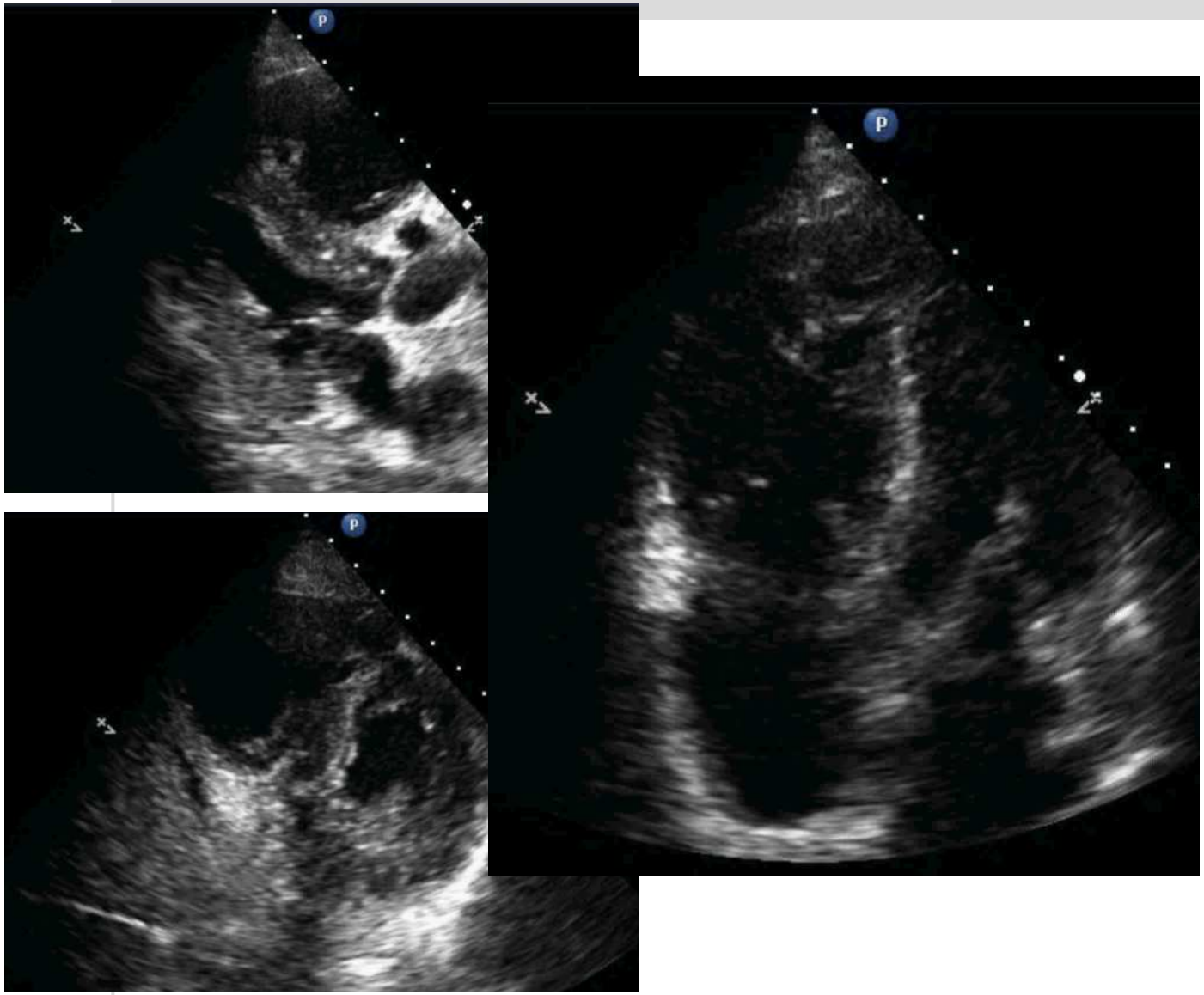
PLAPS



PLAX

POCUS in the differential diagnosis of Dyspnea

Pulmonary Embolism



Pericardial Effusion

Validation & Reliability

A growing literature indicates that POCUS:

- provides more accurate diagnosis than physical exam for majority of common CV abnormalities, including CHF
- results in less downstream testing; potentially reducing overall cost for patients being evaluated for a CV diagnosis
- predicts mortality outcomes in discharged hospitalized patients
- may reduce readmissions in CHF patients

Marbach JA et al. Ann Intern Med. 2019;171:264-272
Razi R et al. J Am Soc Echocardiogr 2011:24:1319-24
Kobal S et al. Am J Cardiol 2005; 96: 1002-1006
Mehta M et al. J Am Coll Cardiol Img 2014;7:983–90
Wooten J Ultrasound Med 2019; 38:967–973.
Garibyan J UltrasoundMed 2018; 37:1641–1648
Gordon, M et al. ACEP Sept, 2019

LUNG US findings:

-more accurate than CXR for dx Pulm Edema

-predict early and late mortality

Figure 1. Ultrasound scan from a patient with a discharge diagnosis of pulmonary edema. The B-line arrow points to vertical lines extending from the pleura to the edge of the visualized field and indicates the presence of pulmonary edema.

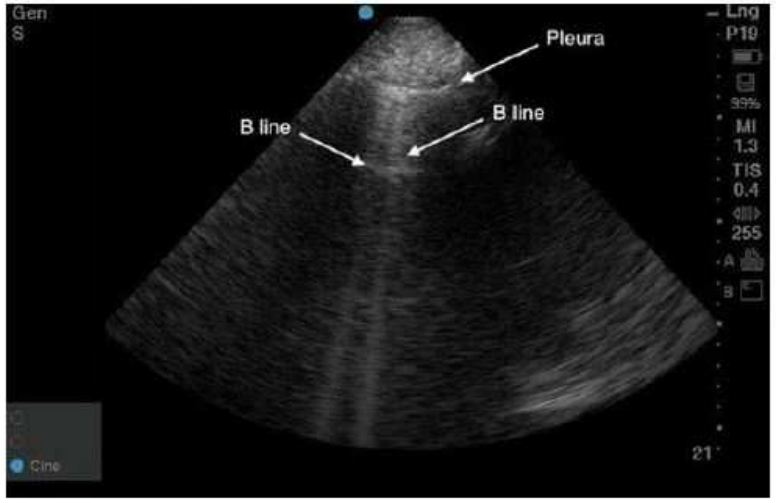


Figure 2. Ultrasound scan from a patient discharged without a diagnosis of pulmonary edema. The A-line arrow points to multiple repeating horizontal lines distinct from the pleura and seen in lungs without edema.

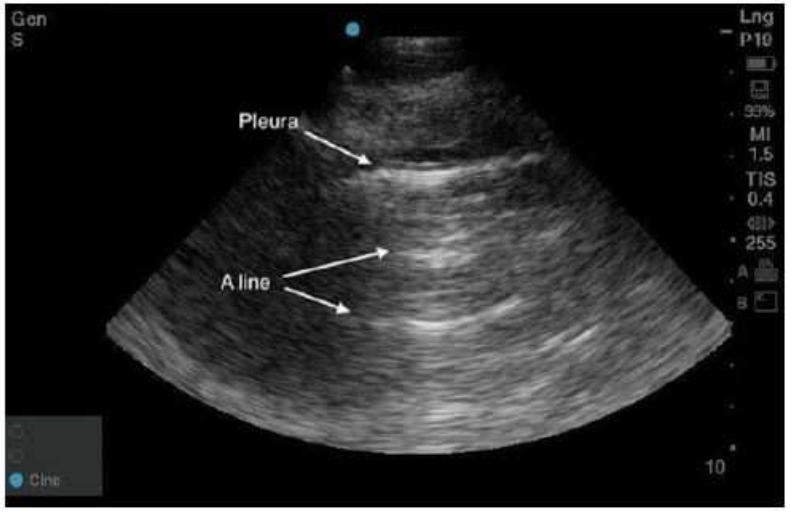


Figure 3. Kaplan-Meier mortality graph of abnormal lung findings versus no lung findings. Curves are significantly different ($P < .0001$).

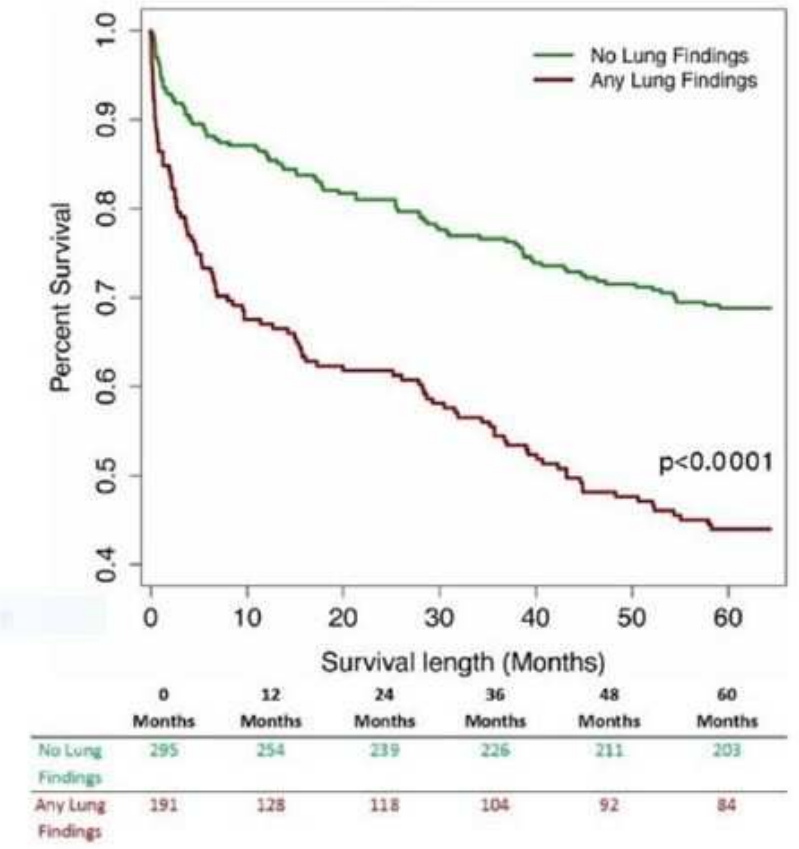


Table 3. Diagnostic Performance of Chest Radiography and Bedside US Using the Discharge Diagnosis as a Reference Standard

Parameter	Radiography	US	*P*
Overall			
Sensitivity	33/51 (65) 51–76	49/51 (96) 86–100	<.001
Specificity	46/48 (96) 85–100	43/48 (90) 77–96	.26

Wooten *J Ultrasound Med 2019; 38:967–973.*

Garibyan *J UltrasoundMed 2018; 37:1641–1648*

POCUS - Advantages

- Real time imaging
- Portable
- Noninvasive
- Widely available
- No ionizing radiation
- Inexpensive
- ***Extension of physical exam***

POCUS - *Insonation*: The Fifth Pillar
Of the Modern Physical Examination

"It is time to add a fifth pillar to the armamentarium of modern physical examination, ***insonation***, with a miniaturized, portable handheld device."

Narula J, Chandrashekhar Y, Braunwald E. JAMA Cardiol 2018

Limitations

- Poor penetration of bone
- Poor imaging behind bones or air-filled regions (shadowing)

- Mechanical (breakability/power source); Cost
- Infection Control; Billing; Archiving

- ***SKILL REQUIRED = TRAINING***
  - **acquisition**
  - **interpretation**
  - **integration**

Online learning and hands-on experience (simulators, patients)

Seek proper training! Know your limitations!

Cardiovascular POCUS for the Medical Student and Novel User

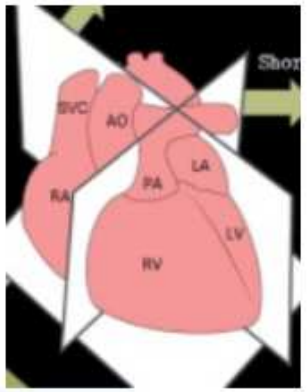
ASE POCUS TASK FORCE - released October 2018 – FREE access

ASE AMERICAN SOCIETY OF ECHOCARDIOGRAPHY
Sound Saves Lives

Search

https://aseuniversity.org/ase/lessons/47

Courses / Cardiovascular Point-of-Care Imaging for the Medical Student and Novice User



Cardiovascular Point-of-Care Imaging for the Medical Student and Novice User

Standard: Free

Access Content

Cardiovascular Point-of-Care Imaging for the Medical Student and Novice User introduces basic cardiac point-of-care ultrasound concepts for all stages of medical school. The curriculum is **modular** in format, allowing **educators** and **learners** to select the components needed to either enhance their existing ultrasound programming, or to use the modules as a **starting point to deliver cardiovascular point-of-care education**. Modules include anatomy, integration with the physical exam, pathology, 'teach the teacher', and testing themes.
The *Cardiovascular Point-of-Care Imaging for the Medical Student and Novice User* is endorsed by ASE's partners WINFOCUS and the Canadian Society of Echocardiography.

- **Intro: Cardiac POCUS – Views, Correlation to Basic Anatomy**
- **Complete Cardiac POCUS Scan**
- **Integrated Cardiac POCUS and Physical Examination**
- **Pathology**
- **Teaching the Teacher - How and What to Teach Medical Students**
- **Standards and Testing**

Cardiac POCUS: Training and Goals

CARDIAC POCUS

- Medical Student/Novice Curriculum
- ≥1-2 weeks training
- Cardiac POCUS Portfolio
  - 30-50 proctored cardiac POCUS scans with image review and interpretation in comparison with full feature echo
- Cardiac POCUS Refresher
  - 10 proctored scans

GUIDELINES AND STANDARDS

Recommendations for Echocardiography Laboratories Participating in Cardiac Point of Care Cardiac Ultrasound (POCUS) and Critical Care Echocardiography Training: Report from the American Society of Echocardiography

James N. Kirkpatrick, MD, FASE, Richard Grimm, DO, FASE, Amer M. Johri, MD, FASE, Bruce J. Kimura, MD, Smadar Kort, MD, FASE, Arthur J. Labovitz, MD, FASE, Michael Lanspa, MD, FASE, Sue Phillip, RCS, FASE, Samreen Raza, MD, Kelly Thorson, MSRS, ACS, RDCS, RCCS, FASE, and Joel Turner, MD, FRCP, *Seattle, Washington; Cleveland, Ohio; Kingston, Ontario and Montreal, Quebec, Canada; San Diego and Palo Alto, California; Stony Brook, New York, Tampa and Naples, Florida; Salt Lake City, Utah; Baltimore, Maryland; Plano, Texas*

Keywords: Cardiac POCUS, Critical care echocardiography, Training, Echocardiography laboratory

Kirkpatrick JN et al. J Am Soc Echocardiogr. 2020; 33:409-22

Table 2 Sample objectives for cardiac POCUS

1) List the views that should be acquired as part of the cardiac POCUS examination.
2) Obtain all of the views that should be acquired as part of the cardiac POCUS examination.
3) Perform an interpretation of a cardiac POCUS examination to include interpretation of left and right ventricular function, left ventricular wall thickness, left atrial size, presence of pleural and/or pericardial effusion, IVC size and collapsibility.
4) Describe tamponade physiology findings as they will appear on cardiac POCUS.
5) Describe cardiac POCUS examination findings associated with pulmonary embolism.
6) Describe cardiac POCUS examination findings associated with heart failure with reduced ejection fraction.
7) Describe cardiac POCUS examination findings associated with heart failure with preserved ejection fraction.

IVC, inferior vena cava; *POCUS*, point of care ultrasound.

POCUS: CLOUD-BASED LEARNING & AI

- **Lumify: REACTS-** integrated “tele-ultrasound”
- **Butterfly: Augmented Reality Telemedicine Technology “**Tele-Guidance technology”

https://www.usa.philips.com

https://www.youtube.com/watch?v=GpJYzfn1J5Y

www.butterflynetwork.com

https://www.youtube.com/watch?v=dIIOTFyKMVU

POCUS and COVID19

ASE AMERICAN SOCIETY OF ECHOCARDIOGRAPHY

Sound Saves Lives

ASE Statement on Point-of-Care Ultrasound (POCUS) During the 2019 Novel Coronavirus Pandemic

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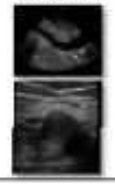
Amer M. Johri, MD, MSc, FRCPC, FASE (Chair), Benjamin Galen, MD, FACP, James N. Kirkpatrick, MD, FASE, Michael Lanspa, MD, FASE, FCCM, Sharon Mulvagh, MD, FASE, FRCPC, Ritu Thamman, MD, FASE, *Kingston, Ontario, Canada; Bronx, New York; Seattle, Washington; Salt Lake City, Utah; Halifax, Nova Scotia, Canada; Pittsburgh, Pennsylvania*

J Am Soc Echocardiogr. 2020; in press

Table 1. ASE POCUS Protocol in Suspected or Confirmed COVID-19 Infection. A modified POCUS protocol to assist in the assessment of COVID-19 patients includes heart, chest and vessel views.

COVID19 POCUS Protocol	Structure Imaged	Assessment	Disease Associations
Cardiac 	**Left Ventricle**	Size, Global and Regional Function	Myocarditis ACS Cardiomyopathy Shock
	Right Ventricle	Size and Function; TR for PASP if available	PE Cardiomyopathy
	Pericardium	Effusion	Tamponade
	Valves	Gross Regurgitation or stenosis	Pre-existing CV disease
Lung 	**8 or 12 point exam**	B Lines (A lines, pleural sliding are normal)	Edema or Pneumonia
		Sub-pleural Consolidation Thickened Pleura	Pneumonia ARDS
		Lobar consolidation with air Bronchograms	Pneumonia ARDS
		Effusion	CHF
Vascular 	**JVP or Subcostal IVC**	Fluid Status	CHF, hypovolemia
	+/- Leg Veins*	2 point compression*	DVT

Take Home  : POCUS and CHF management

- POCUS is a disruptive innovation that is here to stay
- Newer devices, less cost, interactive guidance
- Challenges our conventional CV approaches with potential for added value – immediate results, integrated into patient care
- Basic assessment: cardiac, lung, vascular (IVC)
  - rapid, repeatable
- CHF practice:
  - differential diagnosis of dyspneic patients
  - serial monitoring, dismissal timing
  - follow-up, Rx guidance
- *Requires appropriate training*

Additional POCUS Online Learning Resources

- https://aseuniversity.org/ase/lessons/47
- http://www.susme.org/learning-modules
- http://www.sonomojo.org/complete-foamed-ultrasound-curriculum/
- http://imbus.anwresidency.com/core.html
- http://imbus.anwresidency.com/advanced.html
- http://pie.med.utoronto.ca/TTE/index.htm
- http://pocusjournal.com/
- https://sites.google.com/site/calgaryimus/home

Thank You! Q & A

Submit your questions by clicking on the Q&A icon on your screen