



Brigham and Women's Hospital

Founding Member, Mass General Brigham

State of the art: POCUS

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General and Interventional Nephrologist

Director of Ultrasound in Nephrology

Assistant Professor of Medicine@ HMS

- Clinical focus: Ultrasound/Interventional Nephrology
- Research focus: Imaging and Hemodynamics

Disclosures

NAMSA – Clinical Event Committee



Question

I have never learned how to use POCUS

POCUS was part of my medical school curriculum only

POCUS was taught during residency – limited

POCUS was taught during residency – comprehensive program

I learned POCUS during a dedicated POCUS fellowship

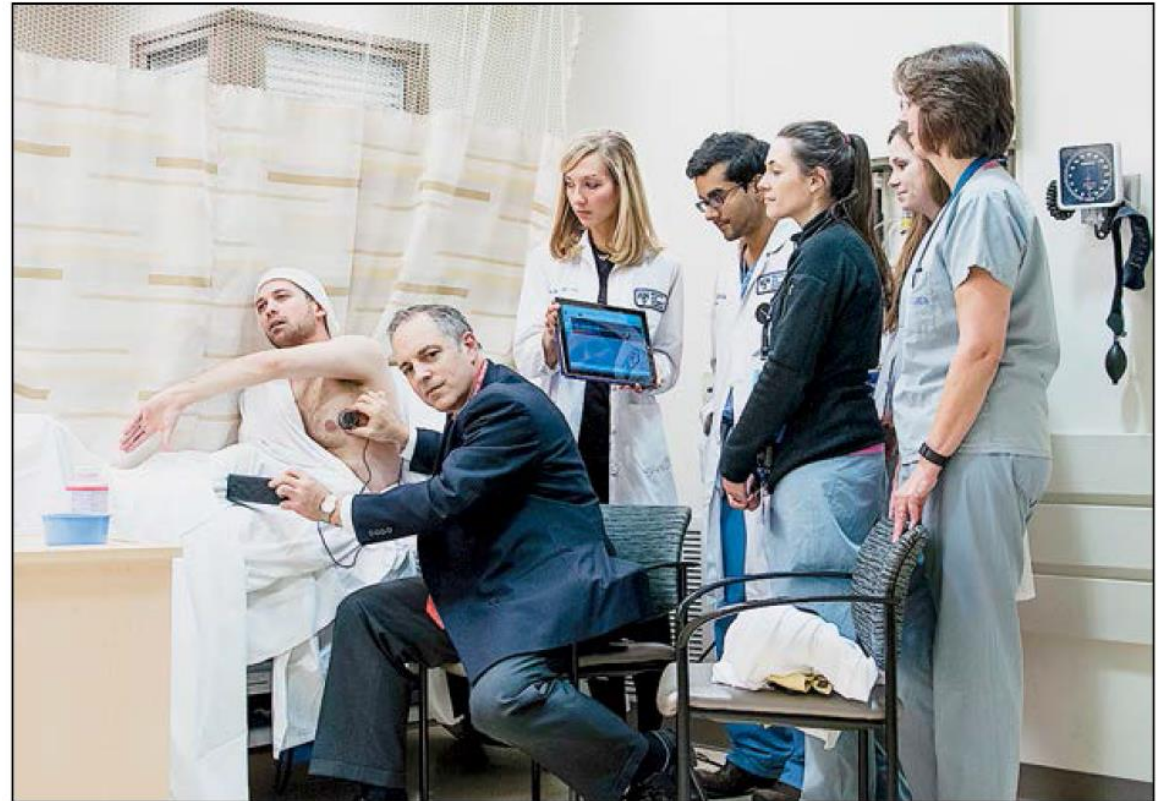


POCUS –extension of the physical exam



Laennec at a Patient's Bedside, by Théobald Chartran, 1816.

"Laennec à l'hôpital Necker ausculte un phthisique devant ses élèves" ("Laennec examines a consumptive patient with a stethoscope in front of his students at the Necker Hospital," monaural stethoscope in his hand).

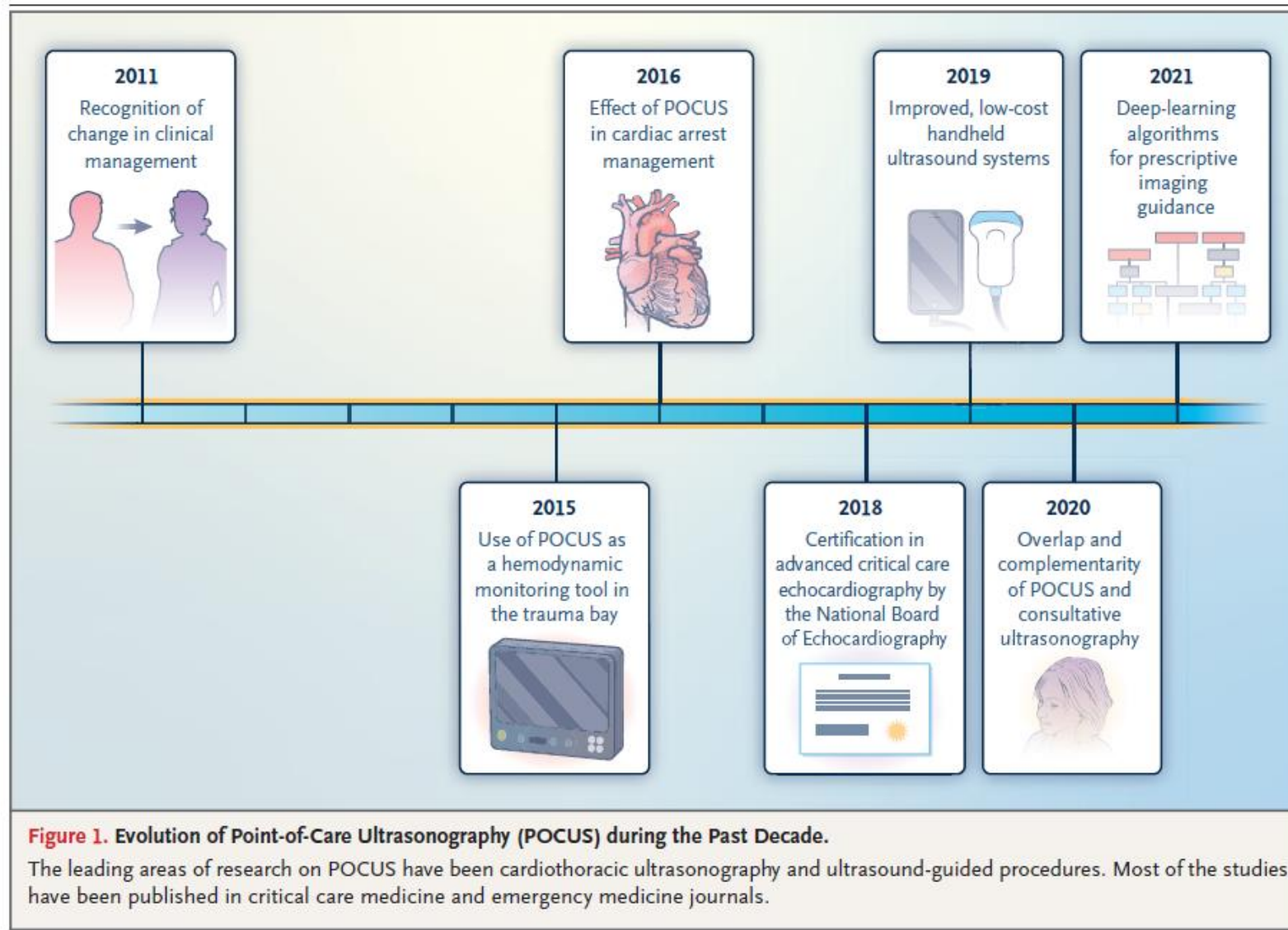


The Authors Demonstrating Modern Electronic Auscultation, 2015.

The technology involved is a ThinkLabs One stethoscope, linked to a Jambox speaker and a Microsoft Pro3 tablet with the displayed and annotated phonocardiogram. Photo taken at Brigham and Women's Hospital, Boston.



POCUS – evolution during last decade



Objectives



Definition of POCUS



Clinical applications



Training and certification



Limitations and challenges



Future directions



Let talk about POCUS



Definition: POCUS is a bedside ultrasound performed by healthcare providers to aid clinical decision-making.



Key Features: It is portable, allows real-time imaging, and direct application in patient care.

Key differences from comprehensive ultrasound

Focused questions

Performed by same clinician who generates clinical question and ultimately integrates findings

Often evaluates multiple body systems

Can be performed as serial exams to investigate changes in clinical status



Why POCUS



Consult Called

7 am

3 pm

Next day



Other Advantages of POCUS



PATIENT SAFETY: Reduced need for patient transport and radiation exposure compared to traditional imaging methods.



COST-EFFECTIVENESS: potential cost savings and efficiency gains in patient management.

Why POCUS

Ferrada P et al: J Trauma Acute Care Surg 2014 – **POCUS reduced mortality** and time to operative intervention

Alherbish et al: J Crit Care 2015 – ECHO by intensivist **decreased number of comprehensive ECHOS**
- **no adverse outcomes**

Kobal et al: Am J Cardiol 2016 – Impact of POCUS on triage of patients with cardiac disease
- useful in telemedicine and triage **and directly affect length of stay**

Zanobetti M et al: Chest 2017 – no difference in **accuracy between POCUS** and standard evaluation
(including CXR) for diagnosis of ACS, PNA, pleural and pericardial effusion, PNTX

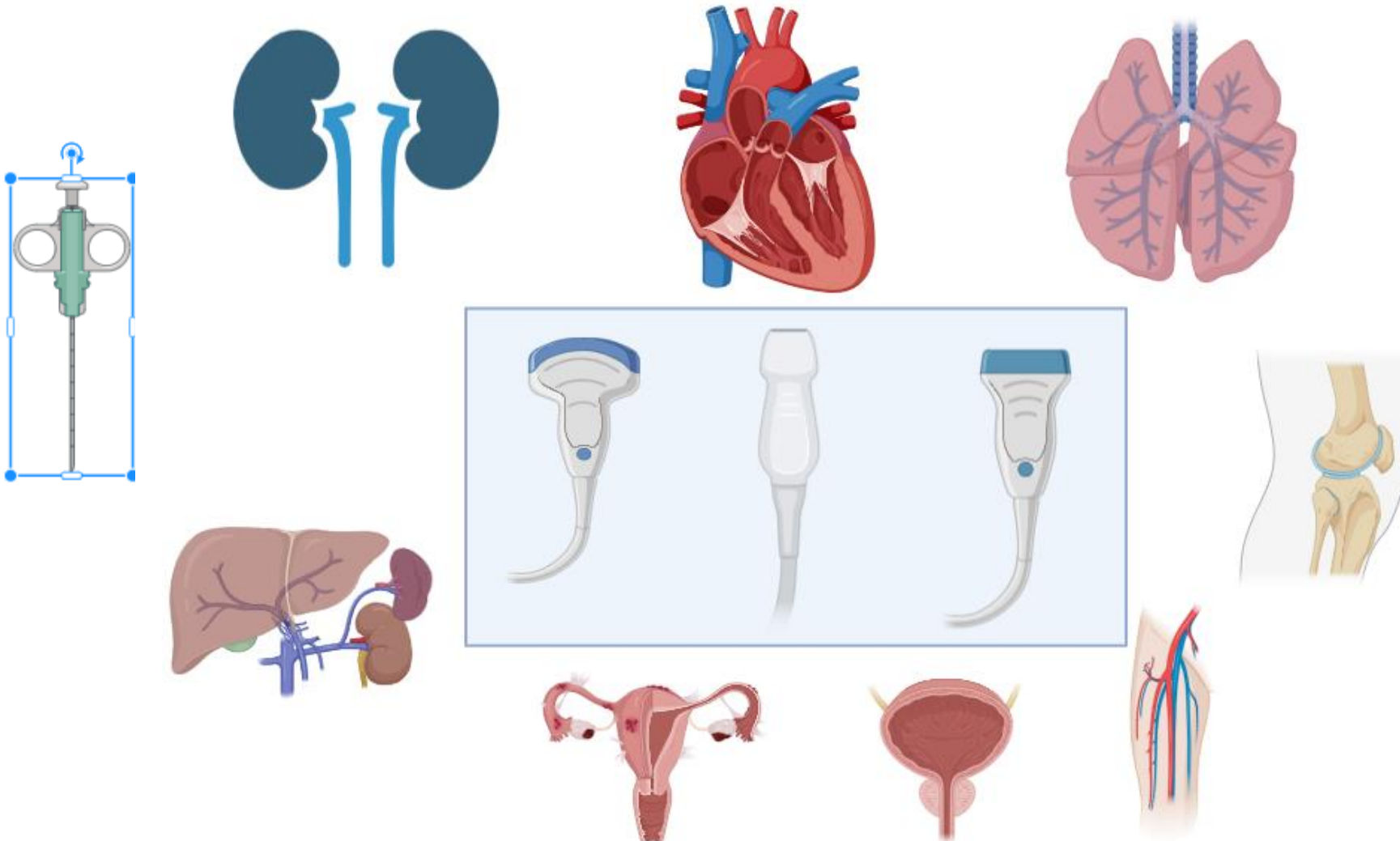
Clattenburg EJ et al: Resuscitation 2018 - Pocus use during Cardiac arrest **reduced duration of pulse checks**

Hussain A et al: Critical Care 2020 – **Multi organ POCUS for management of Covid-19.** Useful in
SARS-CoV-2 infection detection, diagnosis of CV disease, respiratory support
strategies, management of fluid therapy and reduction of spread of infection



And many other

Clinical Applications



Clinical Applications



Emergency Medicine: POCUS for trauma assessment, FAST, CPR



Critical Care: POCUS aids in assessing fluid status, cardiac function, pneumothorax, procedural guidance



Subspecialties: Nephrology – acute kidney injury, volume status assessment



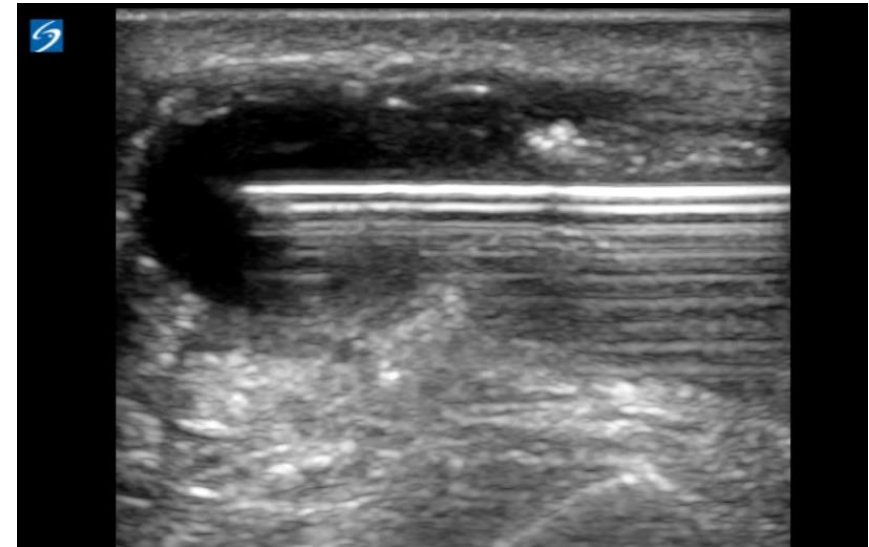
Primary Care: basic abdominal, cardiac, vascular and musculoskeletal assessments



POCUS – Procedural Guidance

Imaging guided diagnostic and therapeutic procedures reduce morbidity and improve safety, operator effectiveness

- Thoracentesis/ Paracentesis
- Lumbar puncture
- Central venous access
- Peripheral venous and arterial access
- Pericardiocentesis
- Abscess drainage
- Joint aspiration



Office, hospital, emergency room, operating room, intensive care units, in the field



POCUS – Clinical monitoring

Track clinical conditions

- respiratory failure
- hemodynamic failure
- infectious conditions



Common POCUS applications for hospitalists

Cardiac	Pulmonary	Abdominal	Vascular	MSK
EF Equality – RV size Effusion Atrial size CVP Hypertrophy Gross valvular abnormality	Effusion Interstitial syndromes Alveolar syndromes Pneumothorax	Free fluid Kidney size Hydronephrosis Bladder volume Gallbladder Spleen size Liver size	DVT AAA	Cellulitis Abscess Joint effusions Fractures
Multisystem Hypotension and shock: Heart, CVP, lung, DVT, abdominal free fluid Resuscitation: heart, lung, CVP Dyspnea: lung, CVP, DVT AKI: renal bladder, CVP, lung				



POCUS – Volume status

Abdominal Ultrasound

IVC Diameter and collapsibility

Pleural effusion

Ascites

Cardiac Ultrasound

EF, chamber size, pericardial effusion

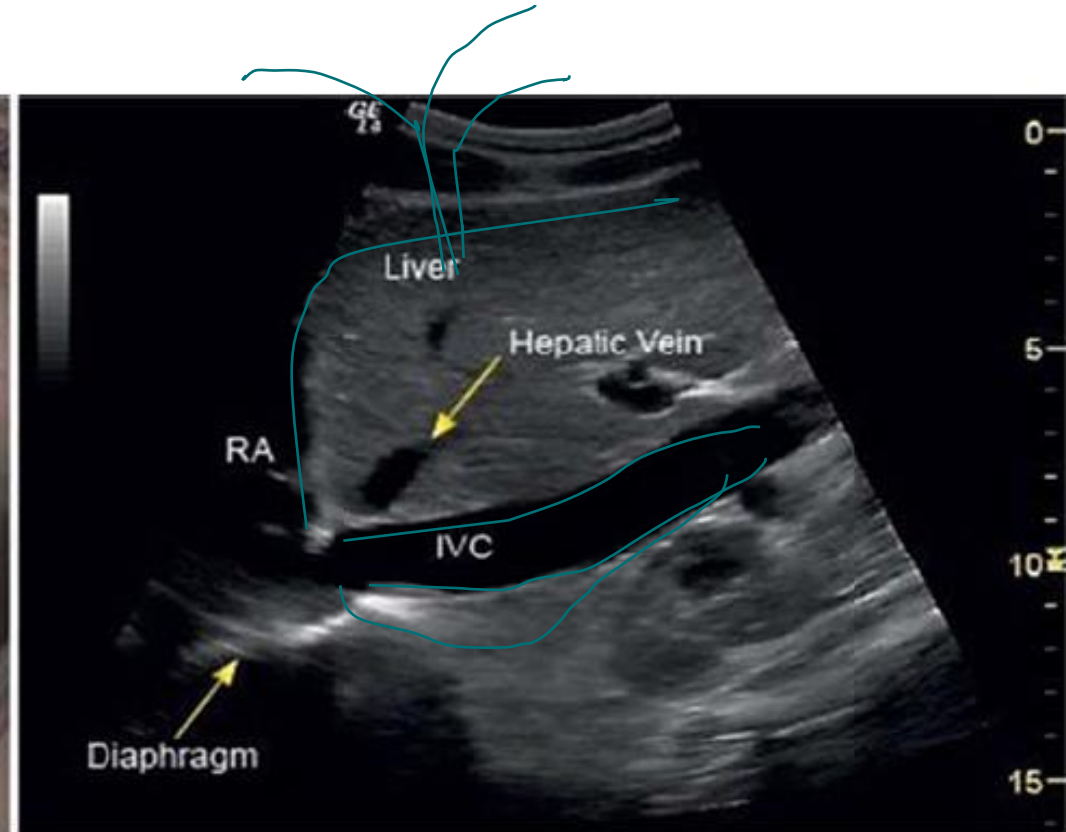
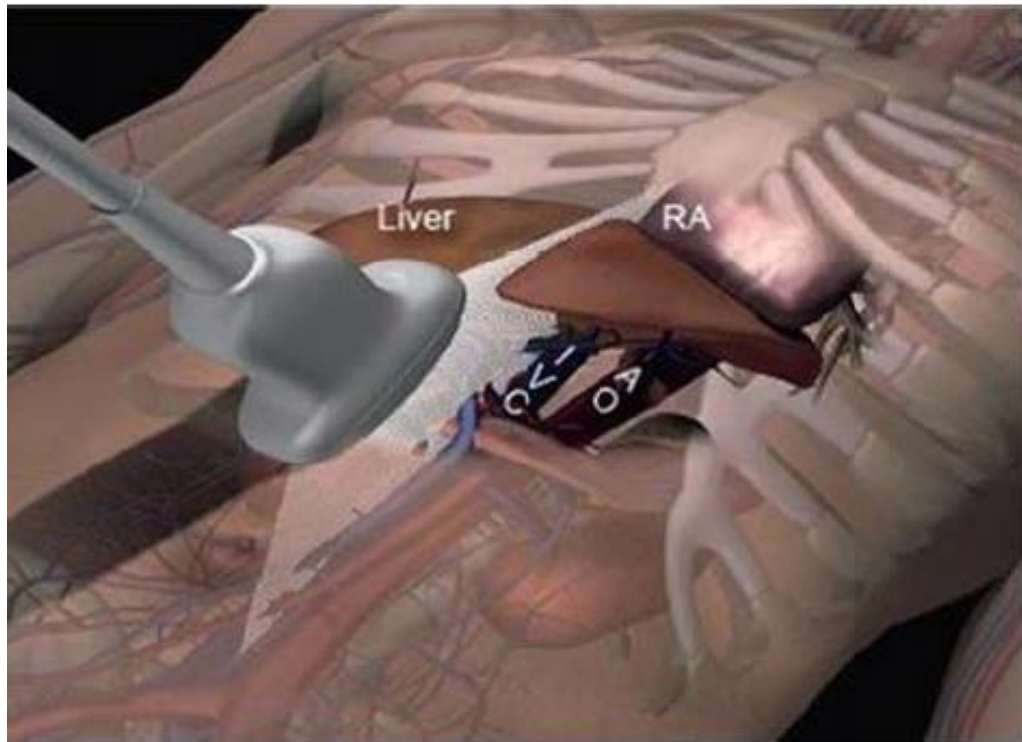
Lung Ultrasound

B lines

A lines



IVC Ultrasound

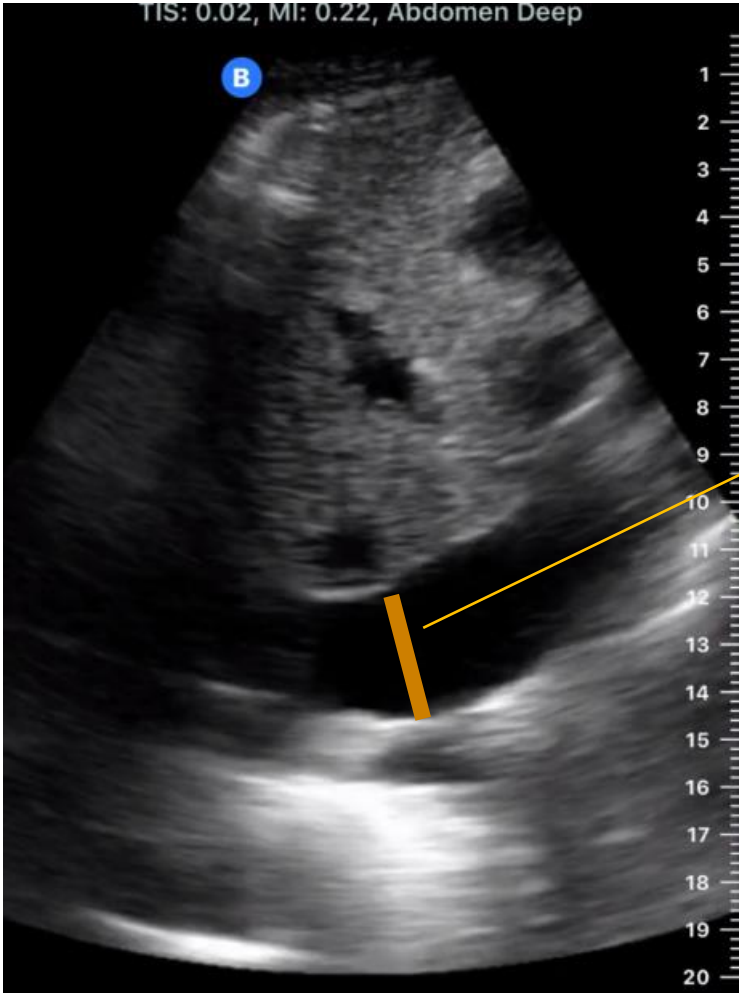


Happy Whale Sign

IVC Ultrasound



IVC Ultrasound



Wide + non collapsing = elevated CPV

Measured at 2-3 cm from RA

IVC Size cm	Percent collapse %	RA Pressure, mm Hg
< 1.5	Total collapse	0-5
1.5-2.5	> 50%	6-10
1.5-2.5	< 50%	10-15
> 2.5	No collapse	> 15



Lung Ultrasound: Pleural effusion



Mirror Image Artifact



No Pleural effusion

Positive spine sign



Pleural effusion

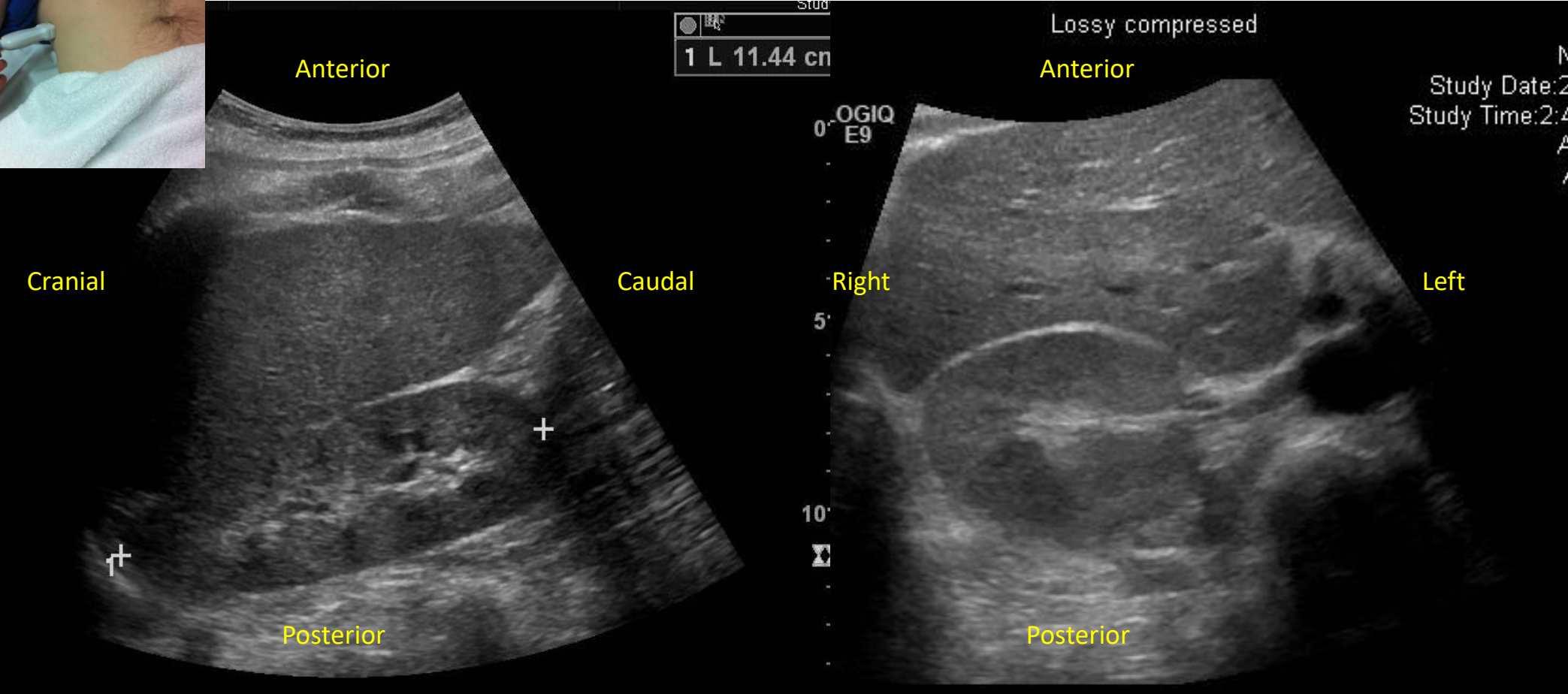


Kidney Ultrasound

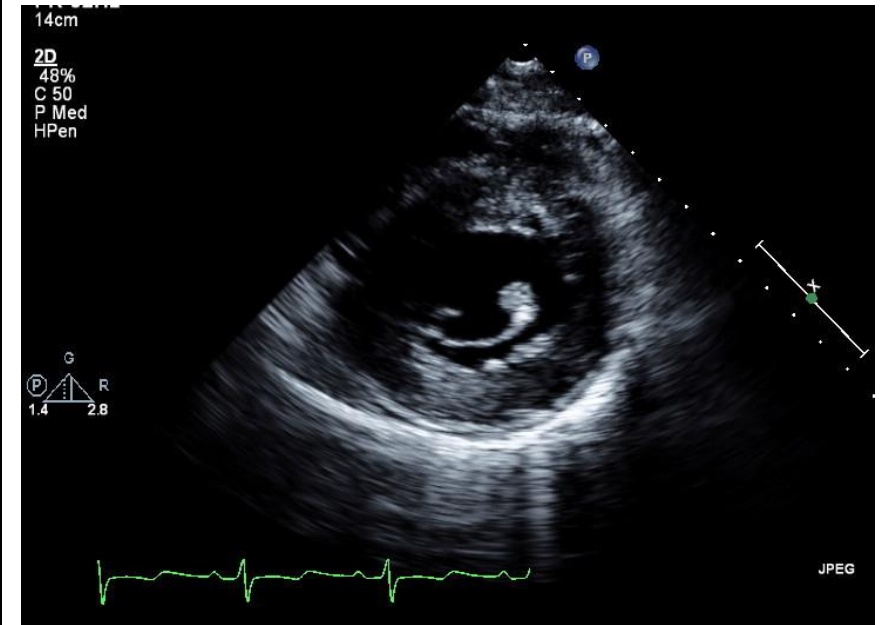
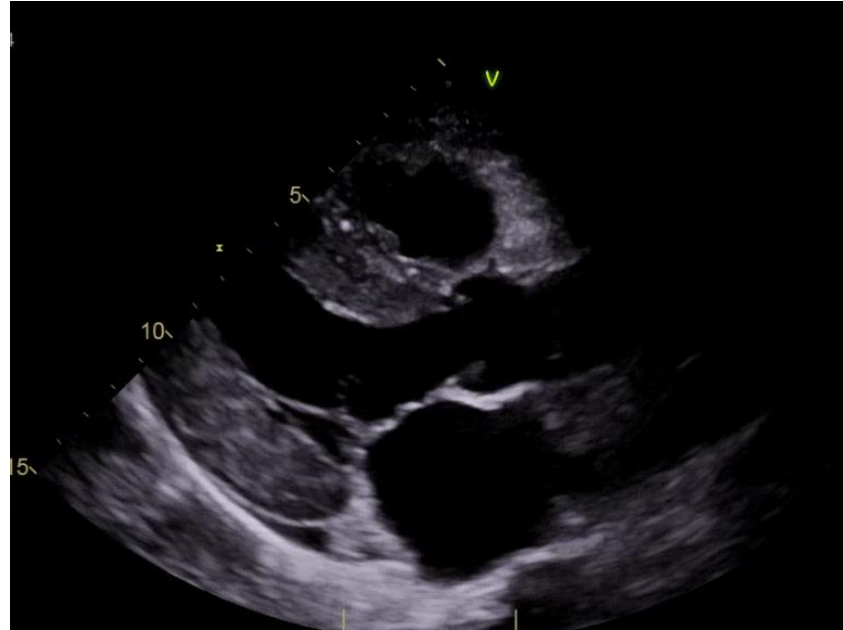


Longitudinal

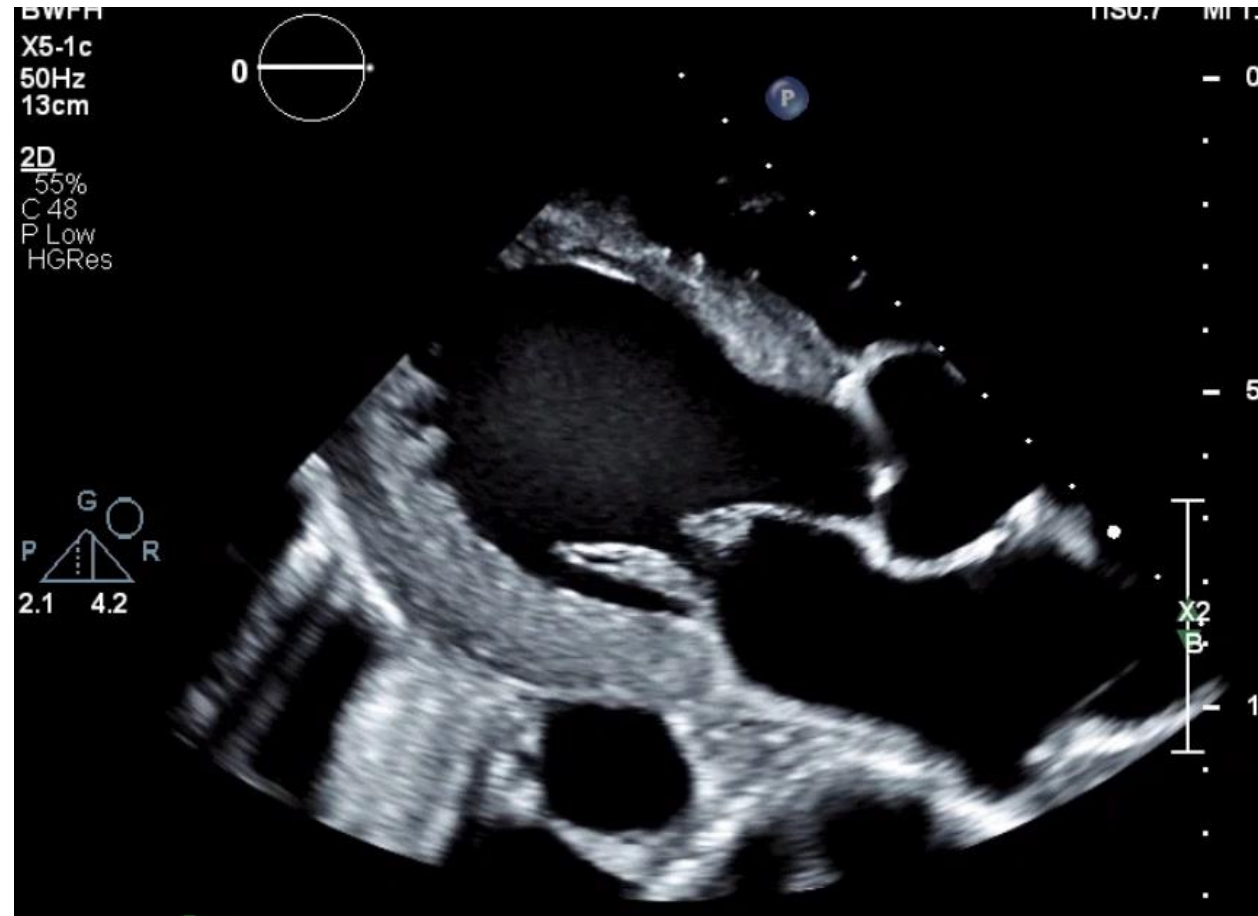
Transverse



Echo: Parasternal long and short axis

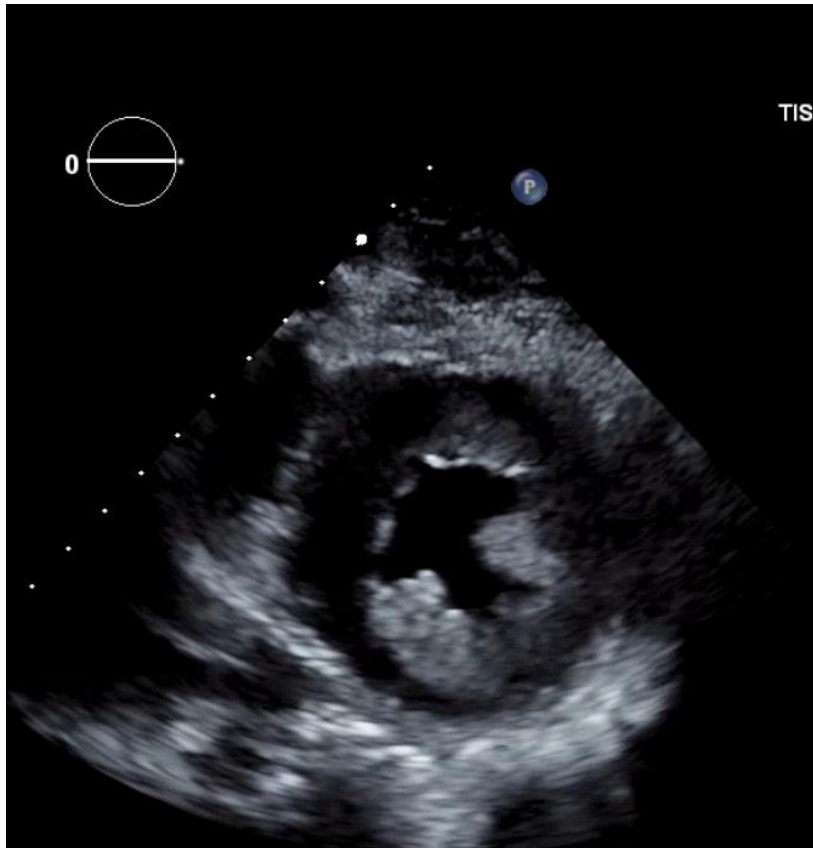


Echo: Parasternal long – EF Normal? Decreased?

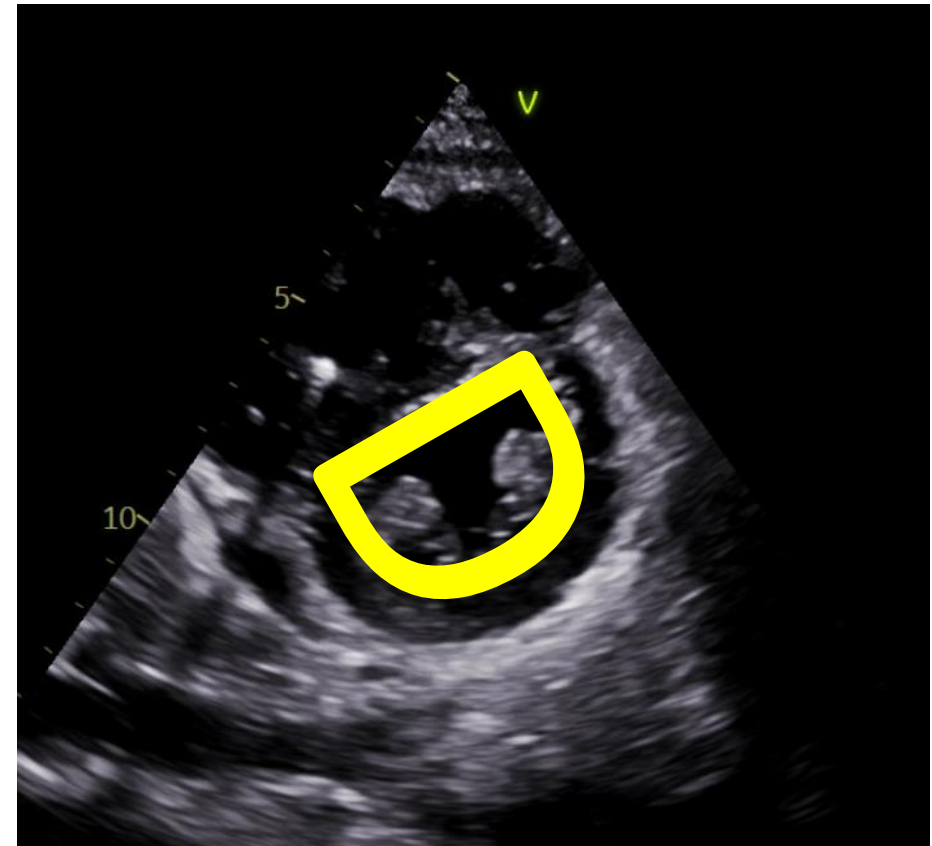


Echo: Parasternal short axis

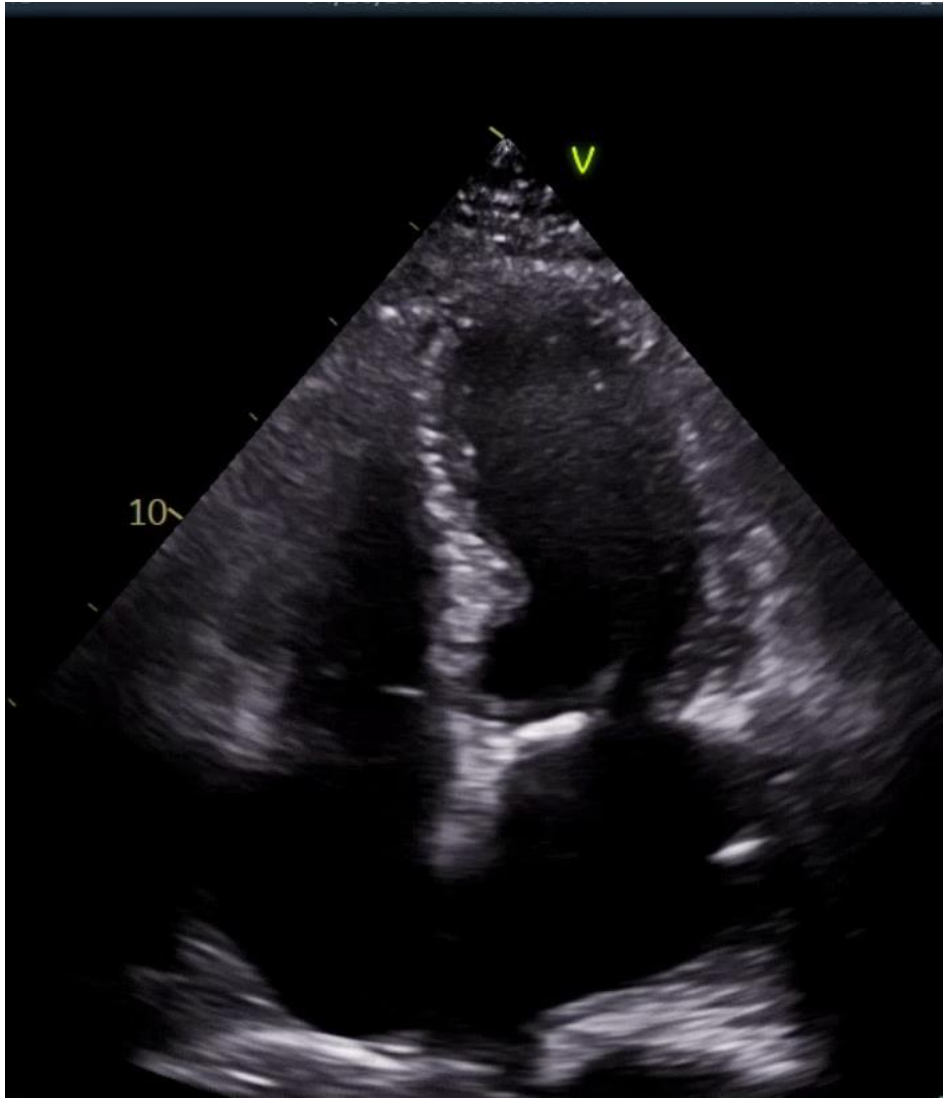
Normal aspect



D – sign – septal flattening – systolic and diastolic
= right ventricular pressure and volume overload

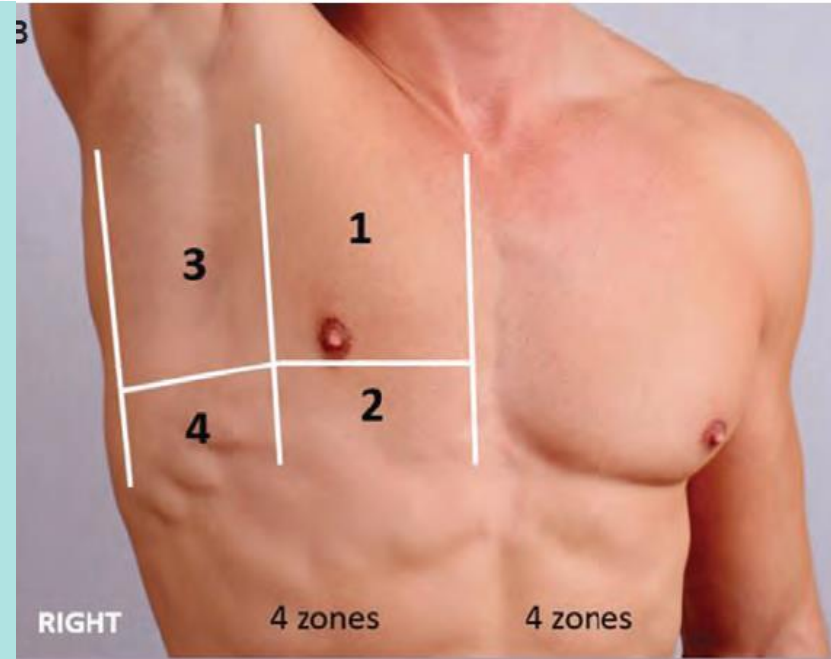


Echo: Equality – 4 chamber view



Lung Ultrasound

8 Zone Lung Ultrasound



Lung Ultrasound – Interstitial fluid

A- Lines



Aerated lung

B- Lines



Interstitial thickening
Most frequently fluid



POCUS – diagnostic accuracy

Acute Pulmonary Edema

Sensitivity: 88%

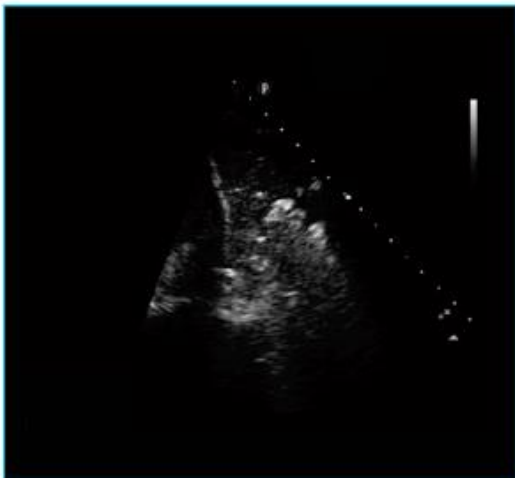
Specificity: 90%



Pneumonia

Sensitivity: 88%

Specificity: 93%

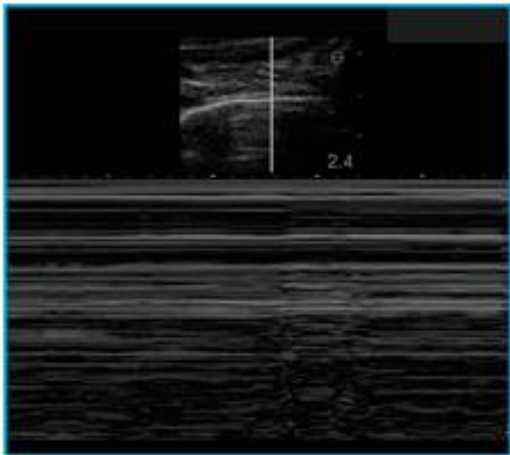


Sensitivity: 81%
Specificity: 100%

Sensitivity: 69 - 94%
Specificity: 88-96%

Pneumothorax

Sensitivity: 81%
Specificity: 100%



Left Ventricular Dysfunction

Sensitivity: 69–94%
Specificity: 88–96%



Sensitivity: 88%
Specificity: 90%

Sensitivity: 88%
Specificity: 93%



Clinical case scenario

59 y o M with DM/HT, CKD 4, foot osteomyelitis on 6 weeks course of antibiotics

HPI

Admission for weakness, lethargy, nausea

Physical exam

BP 100/75, HR 88, Temp 98.8

Heart RRR

Lungs clear

Edema ++

Labs:

Creatinine 7.2 mg/dl, BUN 155, Bicarb 12

Plan

Placed tunneled catheter right IJ

First dialysis: 2 hours, 200 Qb, 400 Qd, no

UF

Blood pressure drops to 70s-80s mmHg,

HR 100-110/min

Patient is restless, breathing harder



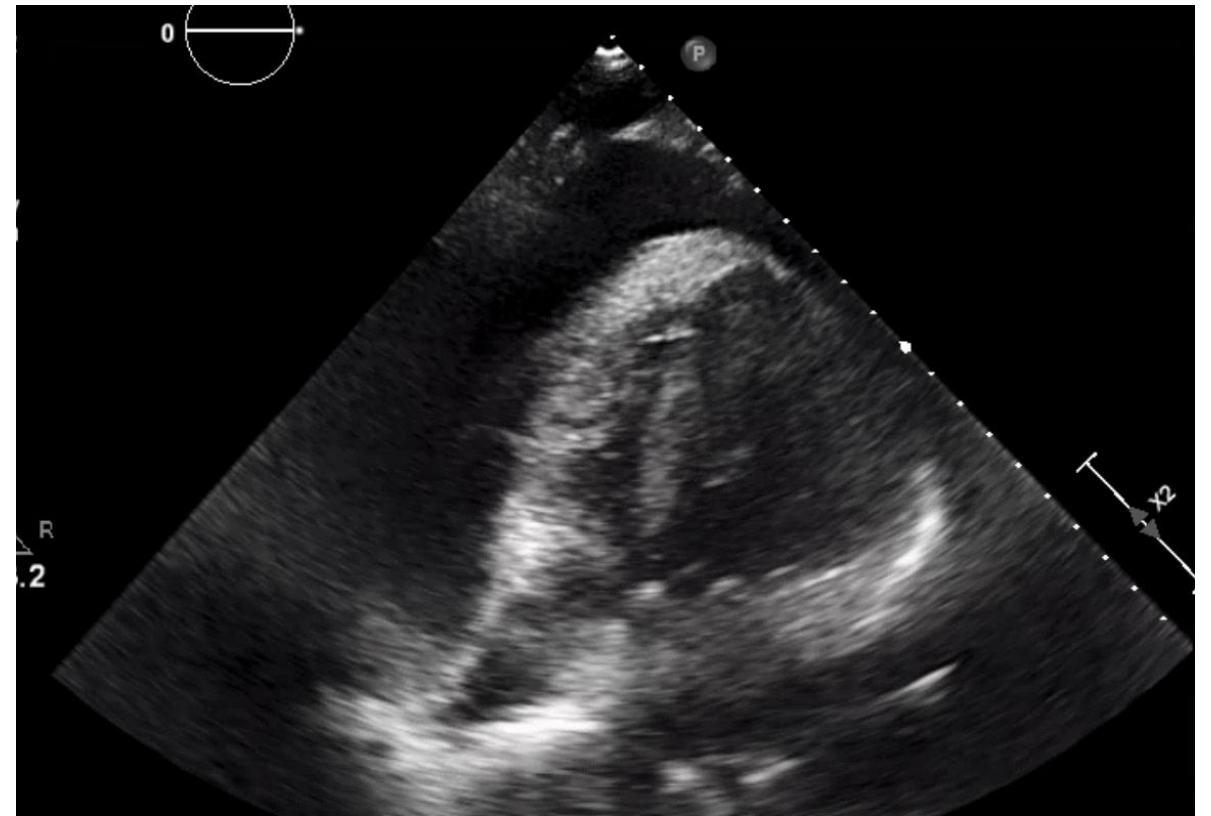
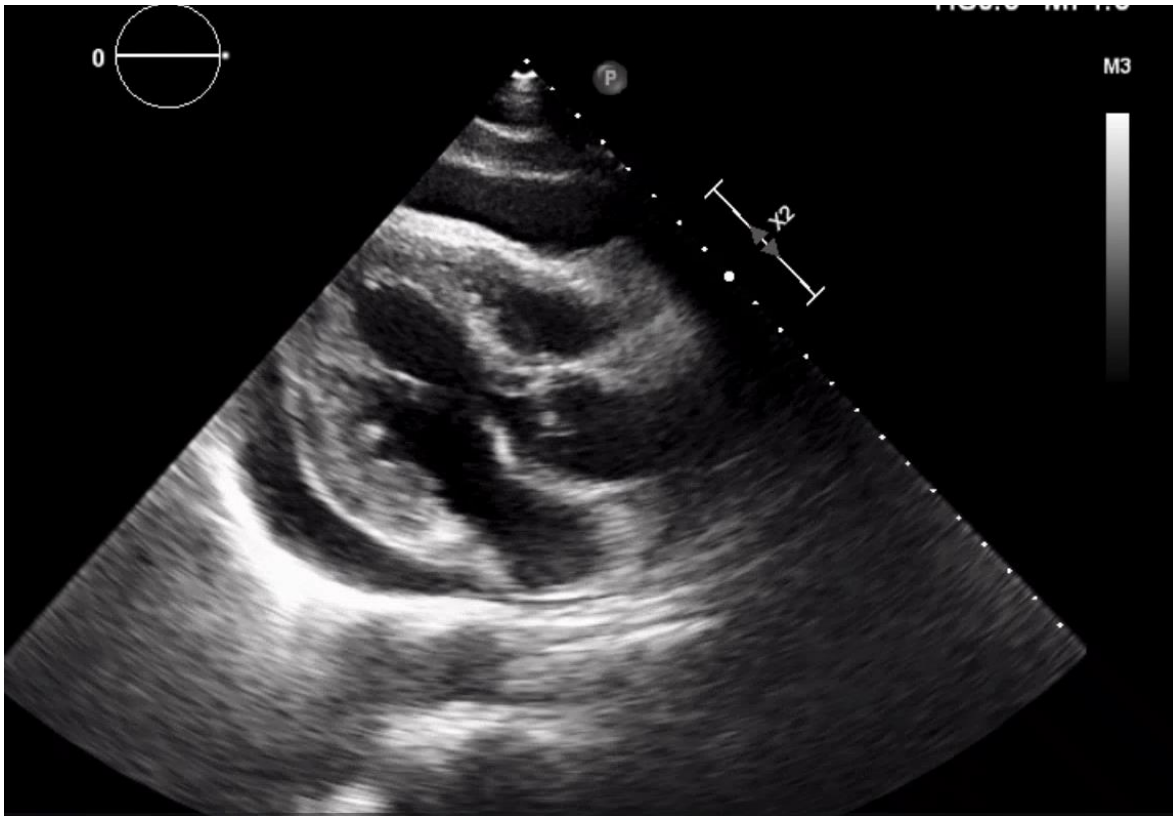
Clinical case scenario

What is your action plan

- 1 Give bolus for 200 cc NS, continue dialysis
 2. Give bolus of 200 cc NS, draw blood cultures, start antibiotics, continue dialysis
 3. Give bolus of 200 cc NS, draw blood cultures, start antibiotics, stop dialysis
 4. Give bolus of 200 cc NS, perform cardiac POCUS, draw blood cultures
 5. Cardiac Pocus, 200 cc NS depending on IVC diameter, continue dialysis
-



Point of Care Echo during dialysis



Training and Competency



**IMPORTANCE OF
ADEQUATE TRAINING**



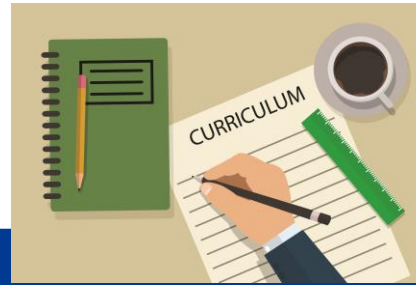
**CERTIFICATION AND
ONGOING EDUCATION**



**RESOURCES AND
COURSES AVAILABLE**



POCUS
Trainers



Curriculum



Ultrasound
Machines

Storage of
images

Lots of time

Continued
quality control

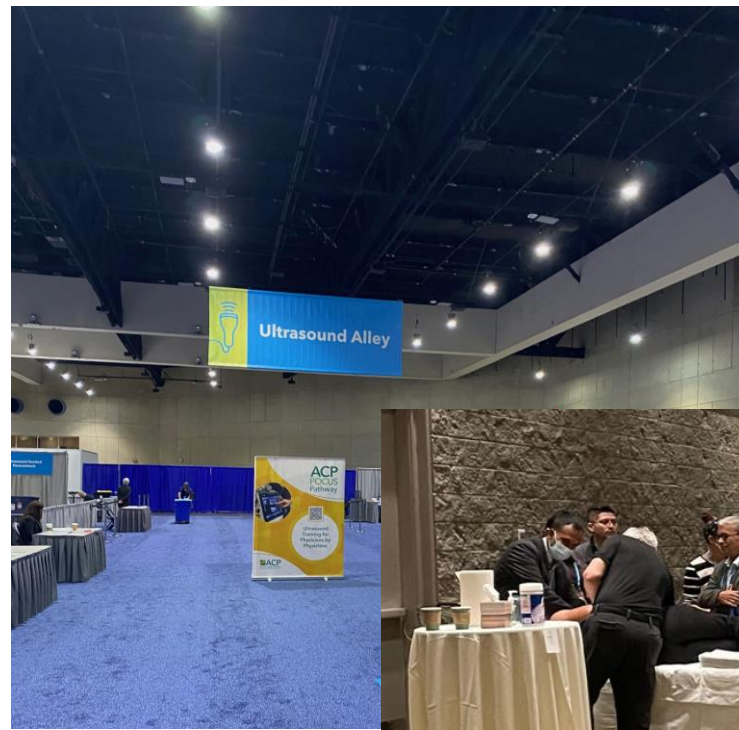


Training

Didactic Training Lectures- Hours
Day Courses – 2-3 Days

Image acquisition practice – Months

- Residency based POCUS training pathways
- Ultrasound fellowships
- Ultrasound electives



Training and Competency

Content/Skill	Training method	Time
Basic knowledge: fundamentals of ultrasound physics, anatomy, physiology, safety, device operation, maintenance and cleaning	Didactic material: Live or recorded lectures, online modules, directed readings. Organ specific lecture	~ 10-20 hours
Image acquisition	Hands-on: different type of patients, different settings. Real time bedside training. Virtual reality ultrasound simulators - Can help expand exposure to pathologies. Skills involving integration of 3D anatomy with spatial manipulation, hand eye coordination and fine motor movements.	Months to years
Image interpretation	Didactic sessions, image review session, review teaching files with annotated images Allows for exposure to many pathologies	Weeks to months
Clinical integration	Interpret and integrate image findings with clinical data, consider image quality, patient characteristics	Weeks to months

Training

Based on expert consensus – **minimum numbers needed**

25-50 examinations are required to ensure basic competence

10 for procedure guidance

If more applications utilized, a minimum benchmark of 150-300 total clinical US exams may be needed

**Important to create and maintain a PORTFOLIO
with adequate documentation and high-quality images**

Frankel HL, Crit Care Med 2015

Blehar DJ, et al Acad Emerg Med 2015

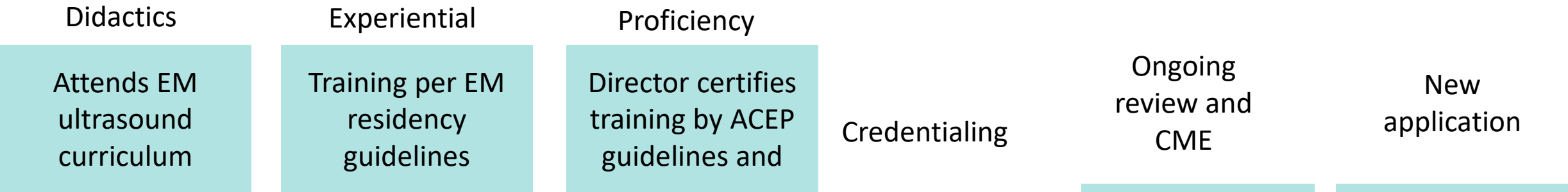
Arbelot C et al Anesthesiology 2020

American College of Emergency Physicians: Ultrasound guidelines 2023

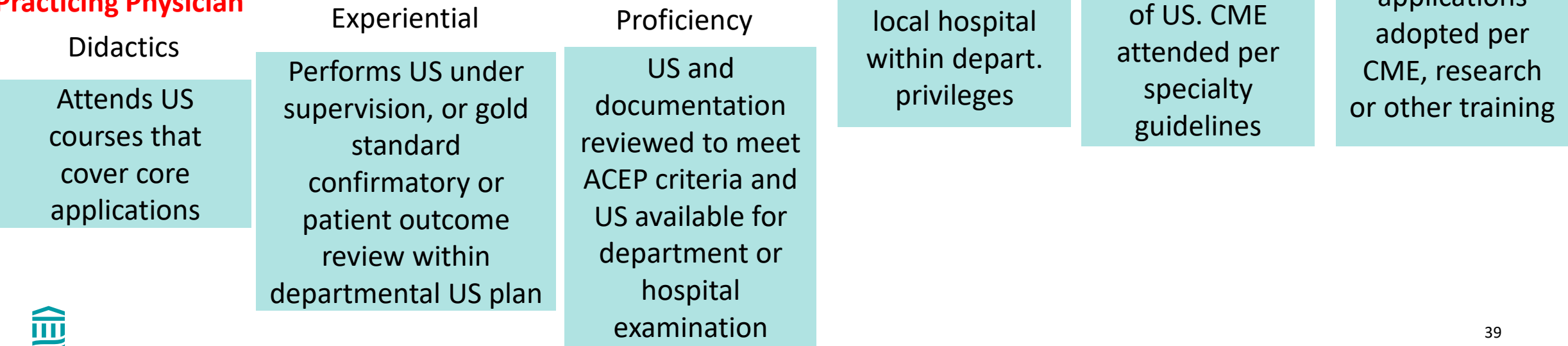


Pathways for clinical ultrasound training credentialing and incorporation of new applications

Residency Pathway



Practicing Physician



Certification of Competency

No national board certification in POCUS
External Certifications available

- Society of Hospital Medicine (SHM) in collaboration with American College of Chest Physicians (CHEST)
- American College of Emergency physicians (ACEP)
- Alliance for Physician Certification and Advancement (APCA)
- American Society for Diagnostic and Interventional Nephrology (ASDIN)
- National Board of Echocardiography (NBE)



Reporting

- **Written Report/Interpretation** - minimum content include
 - the study being performed
 - the views obtained
 - the respective findings
 - separate final interpretation of the study
 - Ideally, distinction between a complete or limited exam should be noted
- **Medical Necessity** -
 - indications for the study
 - CPT codes with the associated ICD-10 diagnosis
- **Image Retention** - images must be permanently stored and retrievable
 - within the chart, a middleware program, or another archival system
 - The number of images, type (dynamic vs static), views, and storage medium may vary from facility to facility and have not been mandated by CPT or CMS
 - a minimum of one image demonstrating relevant anatomy/pathology (with measurements, if applicable) for each procedure coded should be retained and readily available
 - **Note that a stored image is mandatory to report CPT codes for all diagnostic and procedure guidance ultrasounds.**



Reporting

- (1) patient demographics
- (2) an indication for the exam
- (3) views
- (4) findings
- (5) Interpretation
- (6) quality assurance
- (7) identify who performed and interpreted the procedure
- (8) The scope of the study
Include whether the study was complete or limited, a repeat examination by the same physician/QHP, a repeat examination by a second physician/QHP, and/or a reduced level of service.

Bedside Ultrasound

Date/Time: 7/4/2024 3:19 PM

Performed by: Voiculescu, Adina S, MD, PhD

Authorized by: Voiculescu, Adina S, MD, PhD

Exam Type: Abdomen, Cardiac Transthoracic Echocardiogram, Thoracic and Renal

Abdomen Exam Findings & Impression:

Indications: patient with hypotension

RUQ Findings: the RUQ was visualized and was positive for free fluid

LUQ Findings: the LUQ was visualized and was positive for free fluid

Pelvis Findings: the retrovesicular space was visualized and was positive for free fluid

Other Findings: Ascites present

Cardiac Transthoracic Echocardiogram Exam Findings & Impression:

Indications: patient with hypotension

Views: apical four, parasternal long, parasternal short and subxiphoid

Pericardial Effusion: the pericardial space was visualized and was positive for a pericardial effusion

LV Function: the heart was visualized with depressed LV function

RV Size: the heart was visualized with a normal R ventricle size

IVC: the IVC was visualized and was plethoric

Overall Impression: positive



Billing

CPT Code	CPT Description	RVU 2024
76705-26	Ultrasound, abdominal, real time with image documentation; limited (e.g., single organ, quadrant, follow-up)	0.59
93008-26	Echocardiography, transthoracic, real-time with image documentation (2D), includes M-mode recording, when performed, follow-up or limited study	0.53
76604-26	Ultrasound, chest (includes mediastinum), real time with image documentation	0.59
76775-26	Ultrasound, retroperitoneal (e.g., renal, aorta, nodes), real time with image documentation; limited	0.58
93971-26	Duplex scan of extremity veins, including responses to compression and other maneuvers; unilateral or limited study	0.45
76937-26	Ultrasound guidance for vascular access requiring ultrasound evaluation of potential access sites, concurrent real time ultrasound visualization of vascular needle entry, with permanent recording and reporting (List separately in addition to code for primary procedure)	0.30
76942-26	Ultrasonic guidance for needle placement (e.g., biopsy, aspiration, injection, localization device), imaging supervision and interpretation	0.67



Limitations and Challenges



Adequate training and competency in POCUS



Operator Dependency



Image quality variability



Regulatory considerations



POCUS – what we do not want

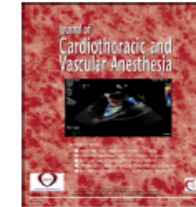
Journal of Cardiothoracic and Vascular Anesthesia 34 (2020) 2865–2866



Contents lists available at [ScienceDirect](#)

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com



Editorial

Point-of-Care Ultrasound—The Wild West of
Medicine



A global recognition of the limitations of POCUS, when performed by anyone less than a fully trained sonographer, is critical for the safe development of this field, especially as its practice expands not only across specialties but also into resource-limited settings.



Future Directions



Hand-held devices and AI enhanced interpretation



Integration into daily practice across various specialties



Expansion beyond POCUS Basics: Doppler utilization



Integration into telemedicine and remote settings



Research and development

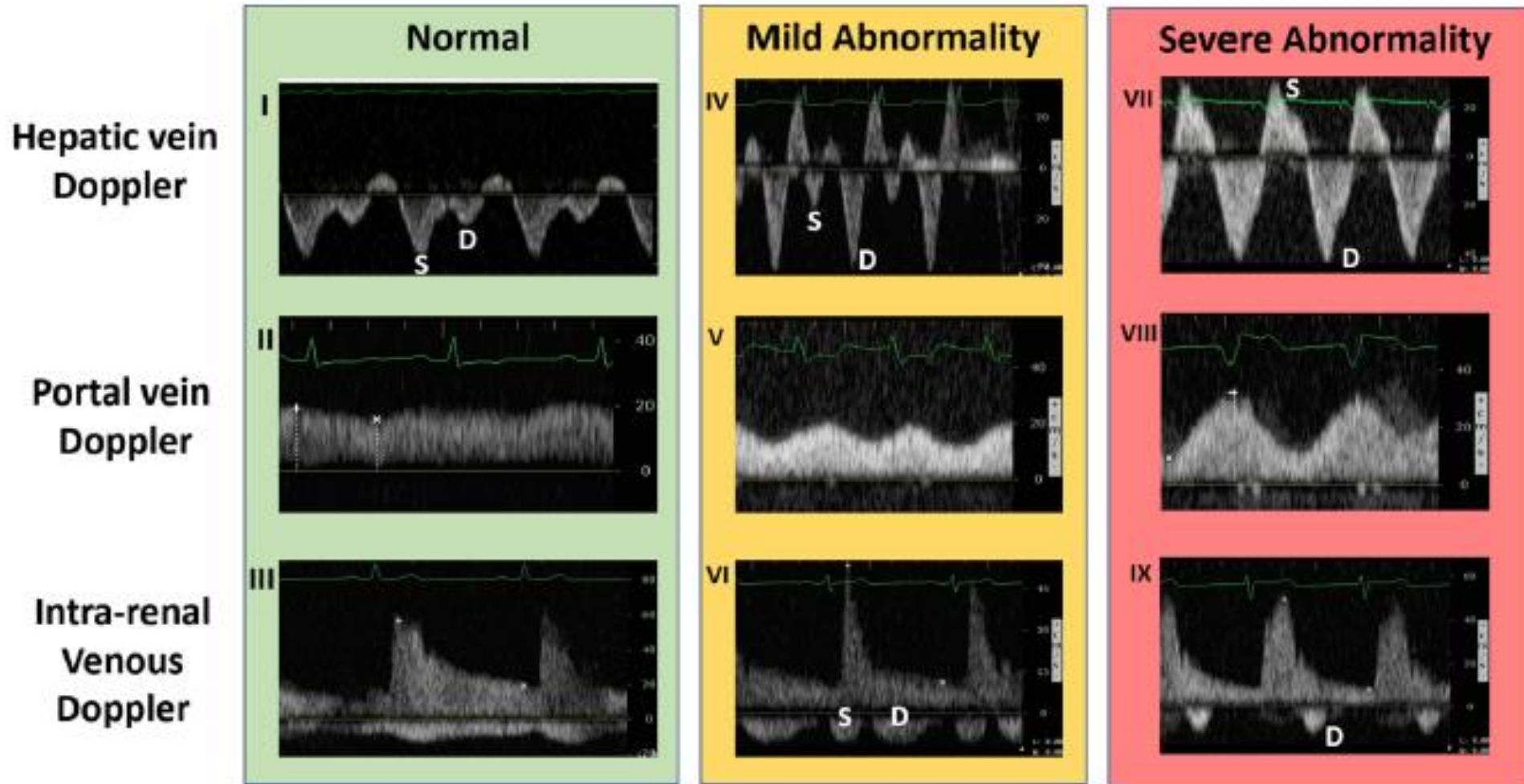


Future Directions – hand-held devices

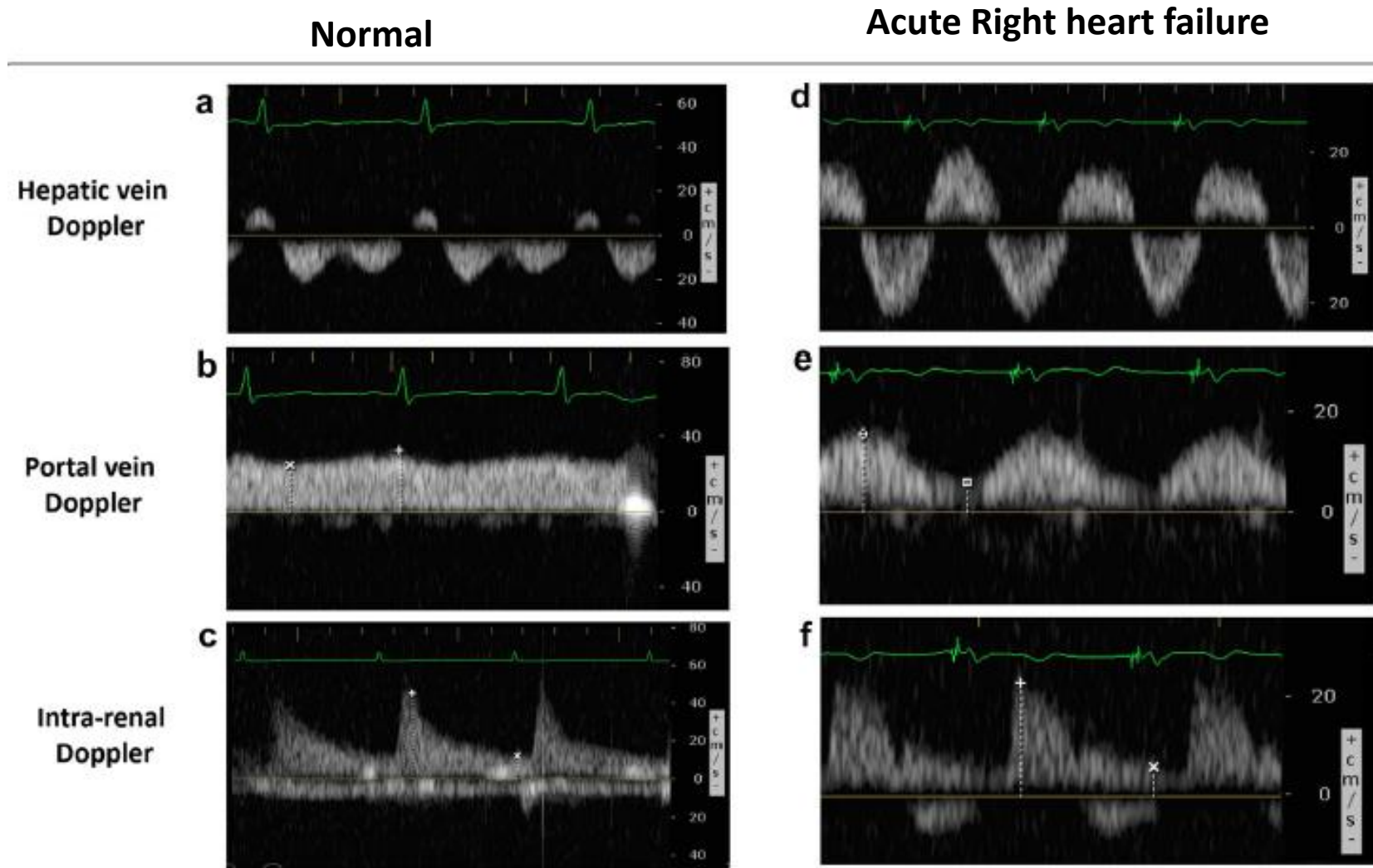


Vexus – venous ultrasound with Doppler

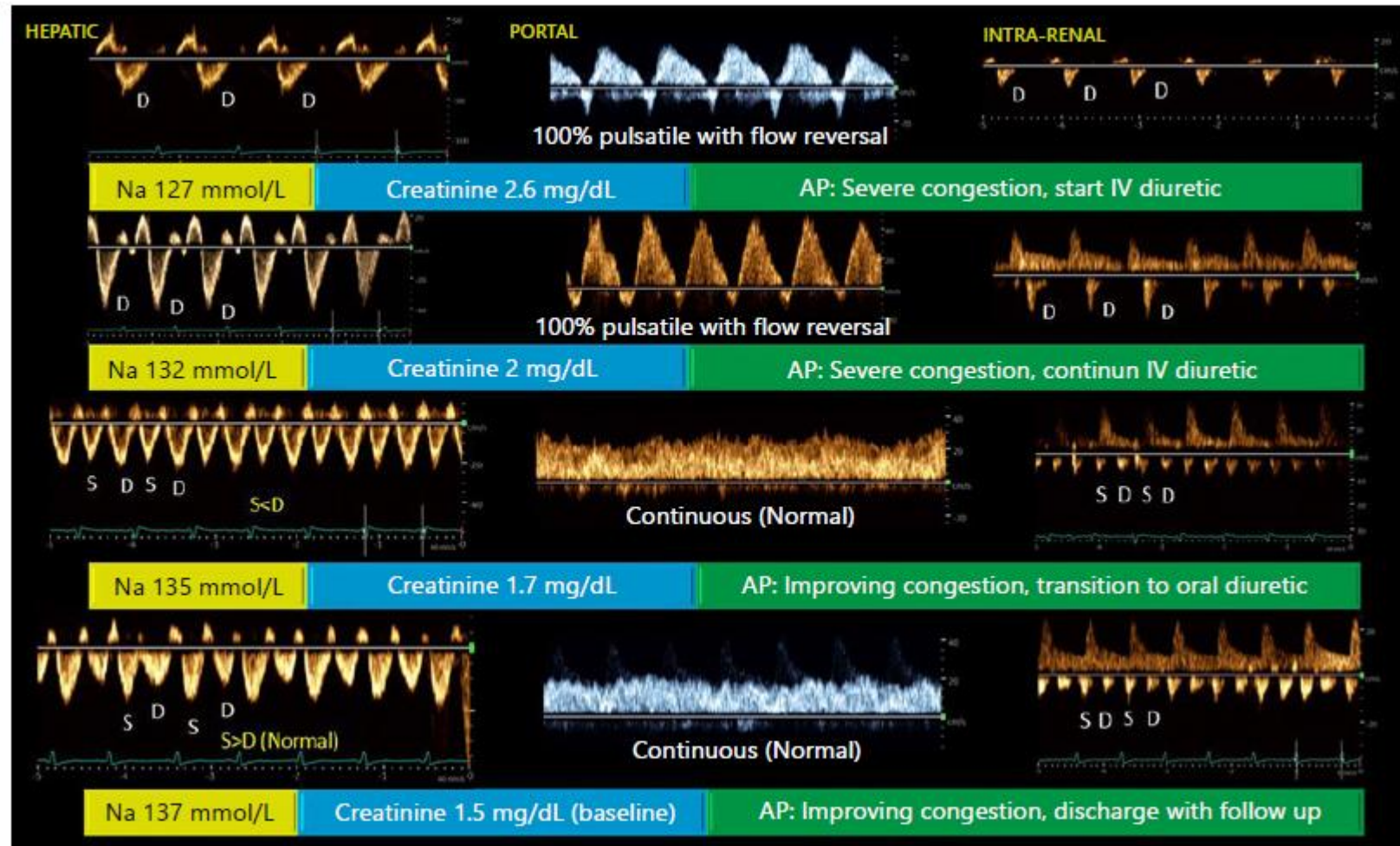
Venous congestion



Vexus - Heart failure



Vexus – Hyponatremia



POCUS for redefining AKI in liver disease

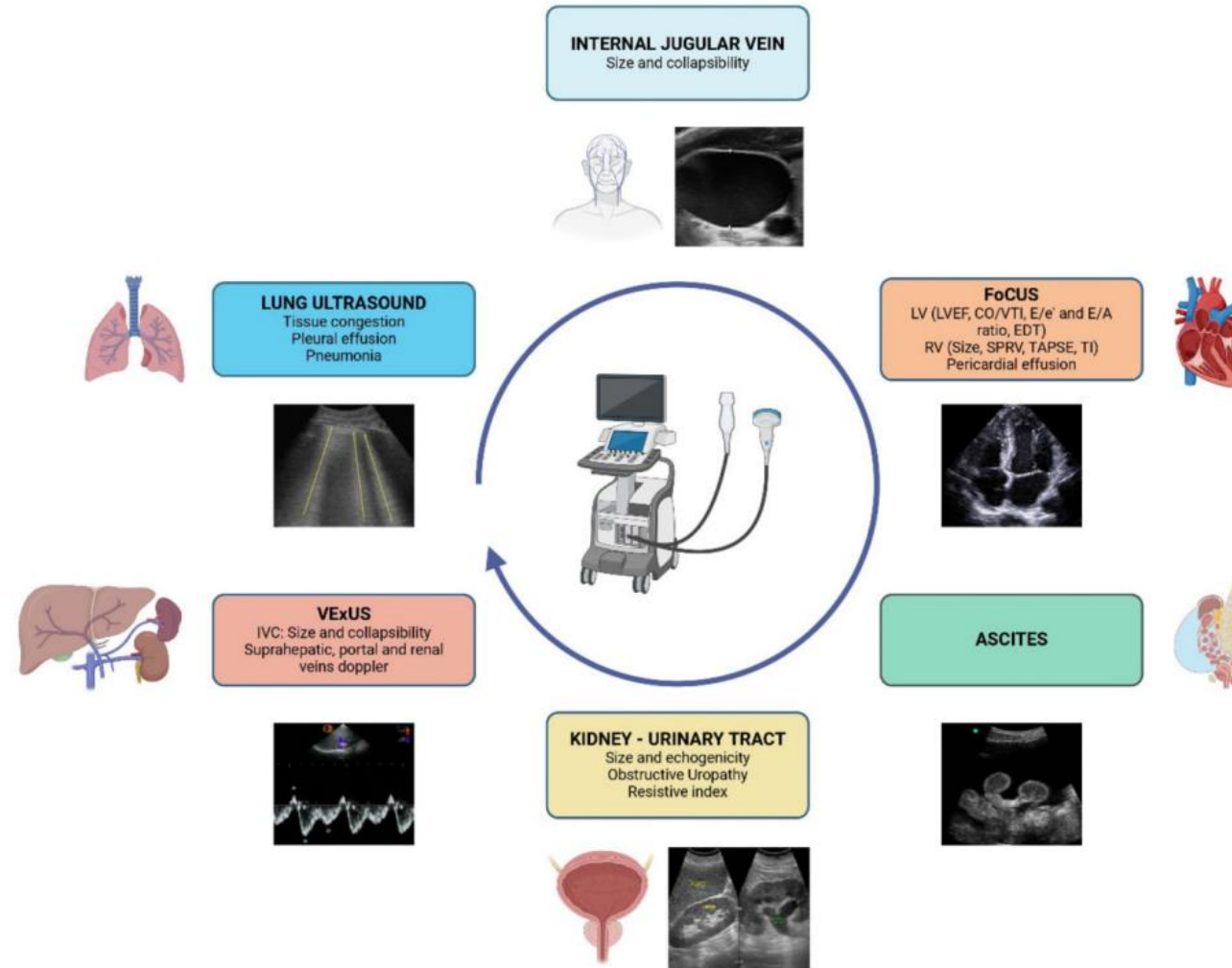
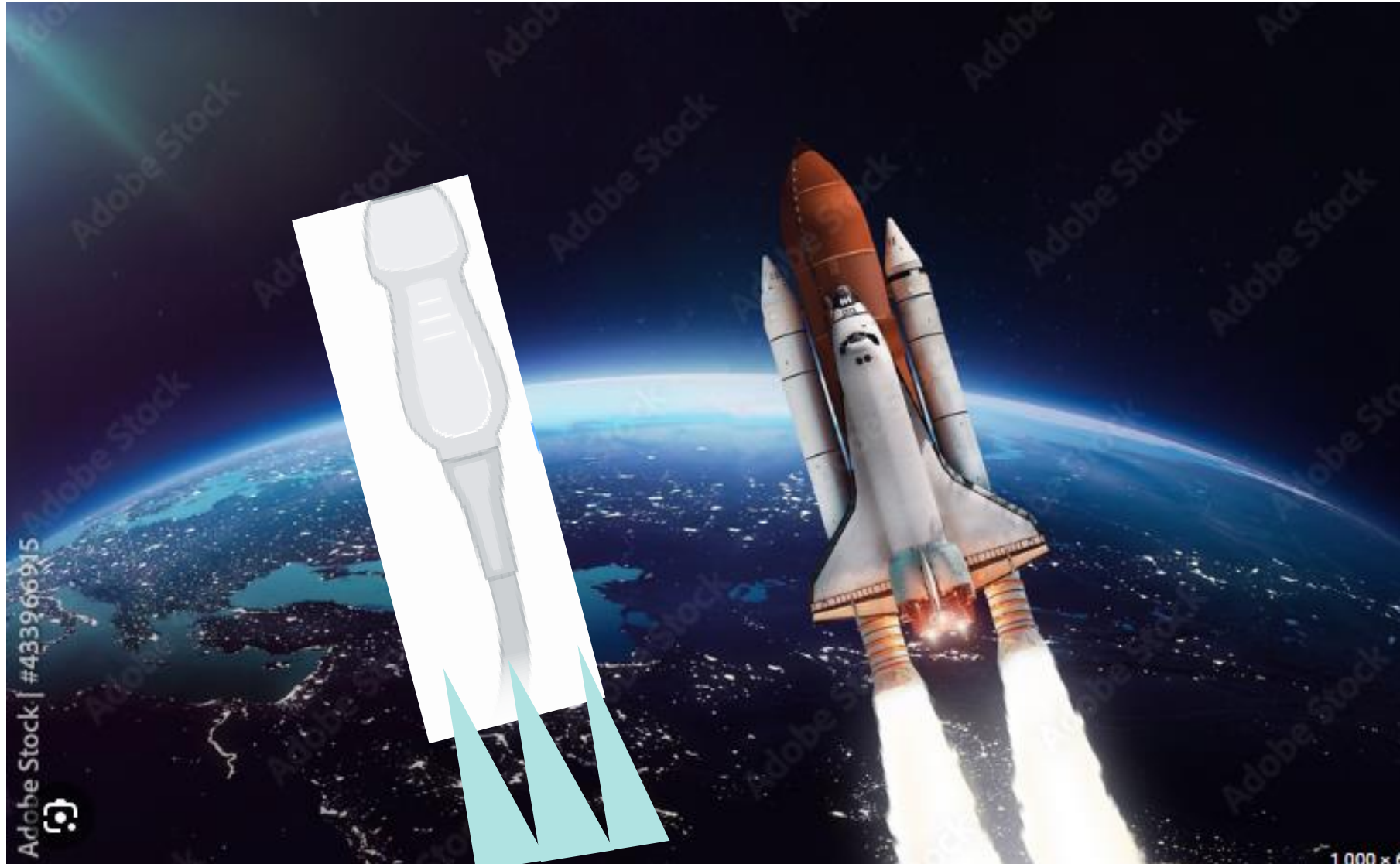


Figure 2: AKI and cirrhosis: multiorgan ultrasound assessment. LVEF: left ventricular ejection fraction; CO: cardiac output; EDT: E wave deceleration time; RV: right ventricle; SPRV: systolic pressure of the RV; TAPSE: tricuspid annular plane systolic excursion; TI: tricuspid insufficiency. Created with BioRender.com.

Point-of-Care Ultrasound for Pulmonary Concerns in Remote Spaceflight Triage Environments

Benjamin D. Johansen; Rebecca S. Blue; Tarah L. Castleberry; Erik L. Antonsen; James M. Vanderploeg



MOC Reflective Statement

Point of Care Ultrasound is an extremely valuable tool for the practicing clinician

The advantages of POCUS have been studied and documented in many different scenarios in medicine

Multi-organ ultrasound allows for integration of information for complex diseases like respiratory failure, shock and acute kidney injury

A standardized training with didactic lectures but more importantly sufficient supervised hands-on training is important to acquire competency

Adequate documentation, image storage, Q and A and continued education are necessary to ensure the highest quality and safety of its use



References

1. Diaz Gomez et al. Point of Care Ultrasonography – a Review. NEJM 2021
2. Soni N et al Point of Care Ultrasound for Hospitalists: A Position Statement of the Society of Hospital Medicine. J Hospital Medicine 2019
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