POCUS [POINT- OF- CARE ULTRASONOGRAPHY] IN NEPHROLOGY

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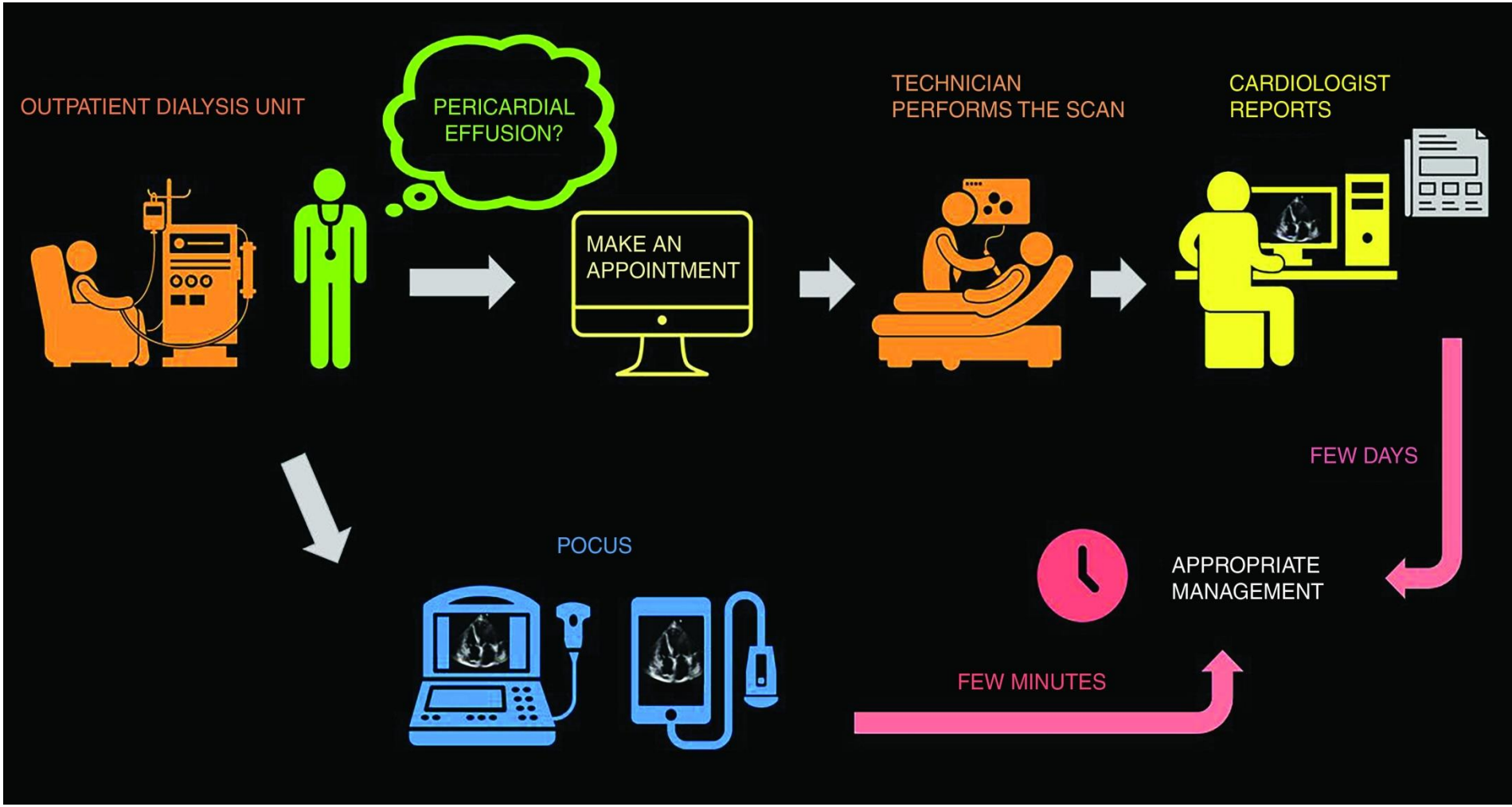
ACADEMIC CORDINATOR -ECNG

INTRODUCTION

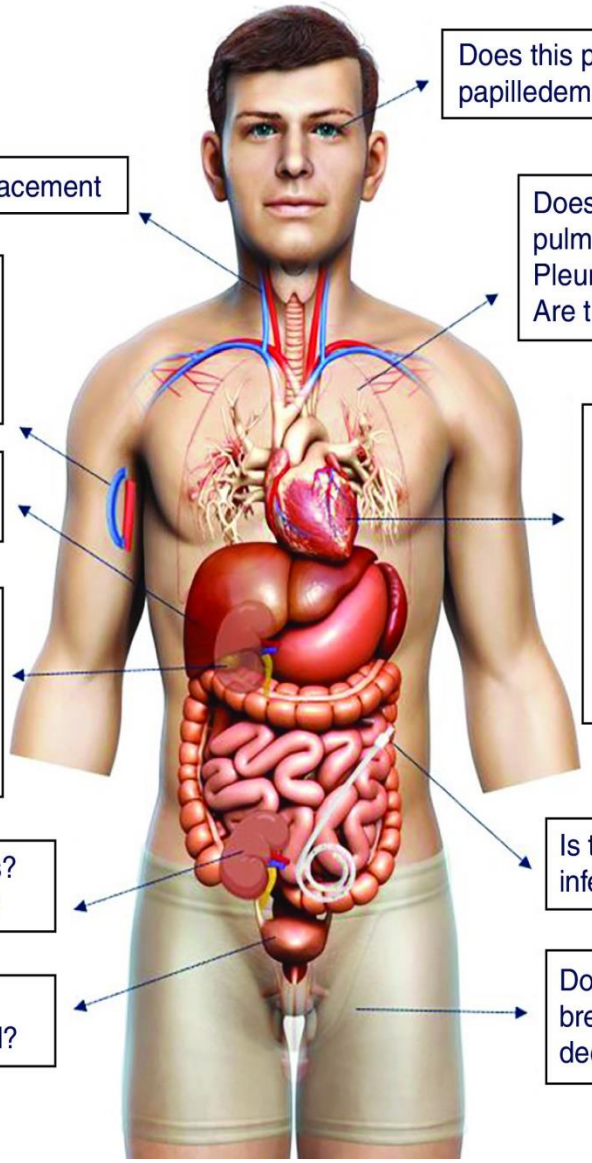
- Point-of-care ultrasonography (POCUS) consists of limited ultrasound examinations performed by the clinician at the patient's bedside to answer focused questions to confirm a suspected diagnosis, narrow the differential, or guide a procedure.

- Adjunct to physical examination , to arrive at the diagnosis early and help management.

- PHYSICAL EXAMINATION IS IMPORTANT AND IRREPLACABLE.



Expedited patient care with point-of-care ultrasonography (POCUS). This infographic illustrates how POCUS can provide answers to focused clinical questions (pericardial effusion in this case) within minutes as opposed to consultative imaging.



Does this patient with hypertensive urgency have papilledema?

Guide dialysis catheter placement

Does this patient with shortness of breath have pulmonary edema?
Pleural effusion?
Are there any lesions suggestive of COVID-19?

Is there a thrombus in the arteriovenous fistula?
How big is the pseudoaneurysm?
Is there a stenosis of the access?*
Guide cannulation

Does this patient with heart failure have congestive hepatic/portal vein flow?*

Does this dialysis patient with unexplained hypotension have pericardial effusion?
How is LV systolic function?
Does my patient with hypertension have LVH?
Does the IVC suggest elevated right atrial pressure?
Are LV filling pressures elevated?*
Is the stroke volume reduced?*
What is the RV systolic pressure?*

Does this patient with AKI have hydronephrosis?
Are the kidney cycts growing?
How is the stone burden compared to last year?
What is the resistive index/how is venous flow?*
Guide renal biopsy

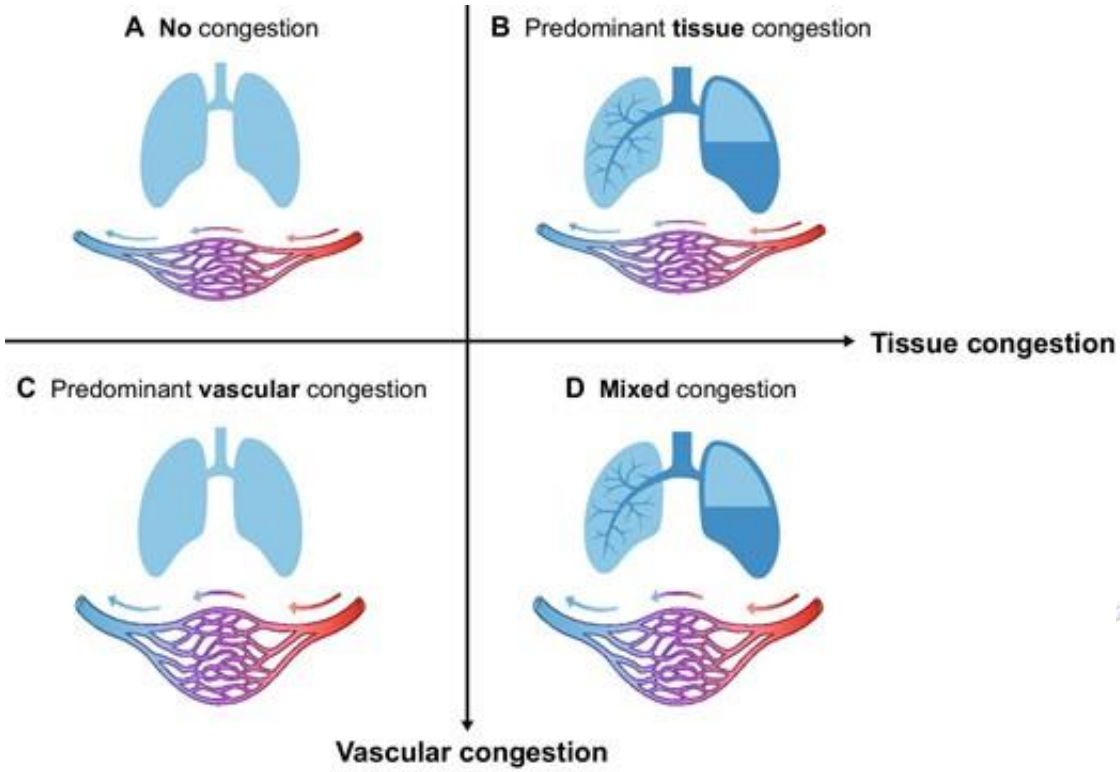
Any peri-nephric collections?
Guide renal allograft biopsy

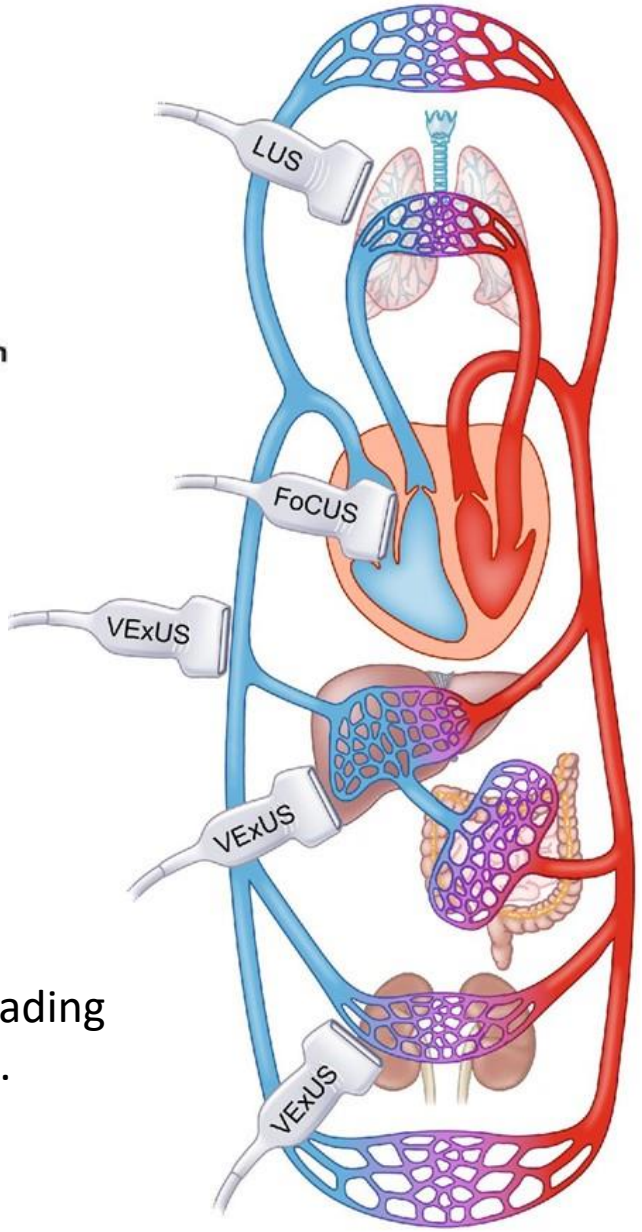
Is there a paritoneal dialysis catheter tunnel infection/abscess?

Is this patient retaining urine?
Is the Foley catheter obstructed?

Does this patient with shortness of breath but no pulmonary edema have a deep vein thrombosis?

Organ-specific focused questions that can be answered by bedside ultrasonography



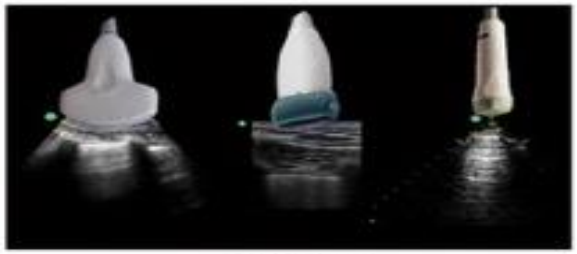


PoCUS strategies to assess congestion**: LUS (**Lung Ultrasound), **VExUS** (venous excess ultrasound grading system) and **FoCUS** (Focused Cardiac Ultrasound).

PNEUMOTHORAX

STEP 1. Patient position

STEP 2. Probe selection

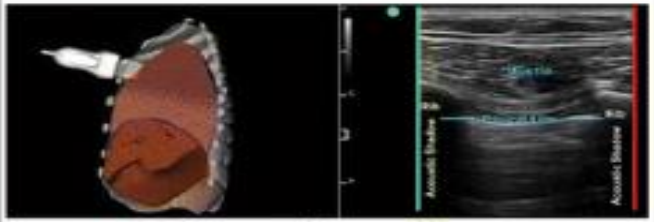


1st choice
High-frequency (13-6 MHz)

2nd choice
Low-frequency
curvilinear (5-2 MHz)
(unless whole-body US considered)

3rd choice
Low-frequency
phased array
(5-1 MHz)

STEP 3. Image acquisition



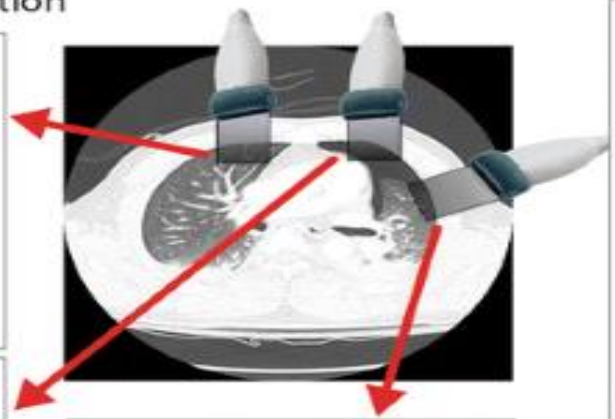
- Cephalo-caudal orientation
- Identify:
  a) superior and inferior ribs
  b) pleural line
- Start medially and then slide laterally/posteriorly

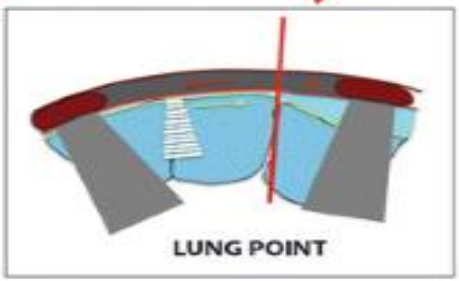
http://pie.med.utoronto.ca/POCUS

STEP 4. Image Interpretation

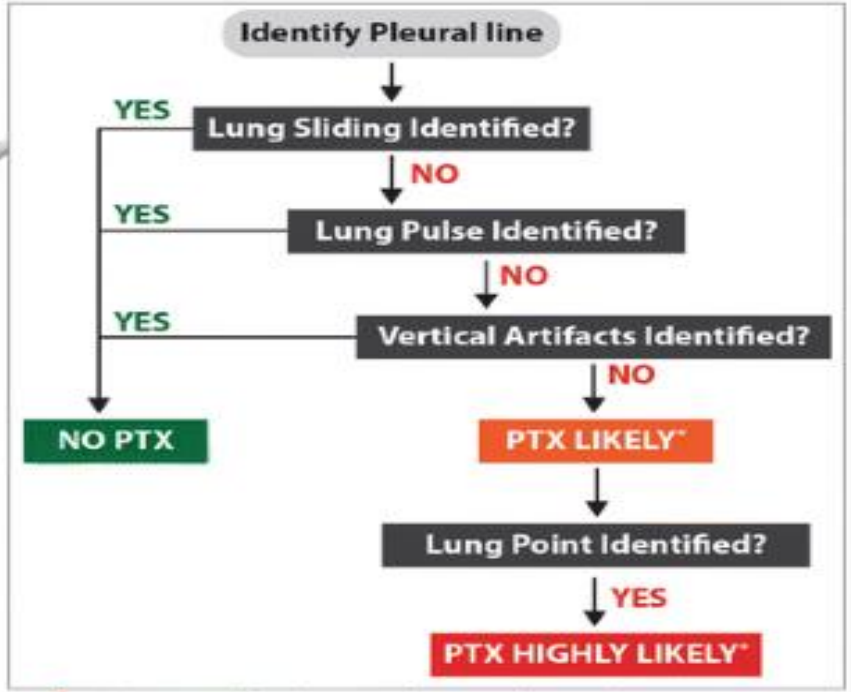
YES lung sliding
and/or
YES lung pulse
and/or
YES vertical artifacts

NO lung sliding
and
NO lung pulse
and
NO vertical artifacts





LUNG POINT



* Beware of findings and/or conditions that may cause false positive or false negative results (see Table)

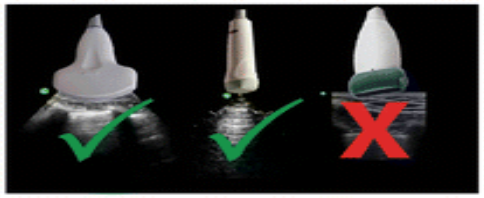
PLEURAL EFFUSION

STEP 1. Patient position

1st choice
Semi-sitting position maximizes effect of gravity and sensitivity of scan

2nd choice
Supine position

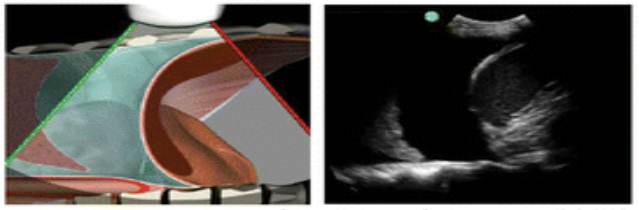
STEP 2. Probe selection



YES
- Low-frequency curvilinear (5-2 MHz)
- Low-frequency phased array (5-1 MHz)

NO
High-frequency linear

STEP 3. Image acquisition

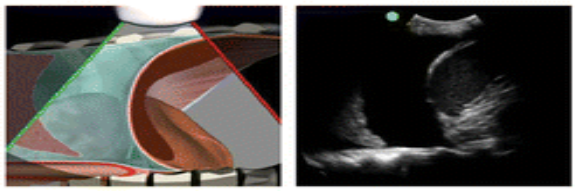


http://pie.med.utoronto.ca/POCUS

- Probe at the mid-axillary line in a cephalo-caudal orientation with slight counterclockwise rotation
- Beam directed posteriorly towards the vertebral column
- Identify lung artifacts, diaphragm, liver/spleen and vertebral column
- Visualization of the spine is essential

STEP 4. Image Interpretation

PLEURAL EFFUSION

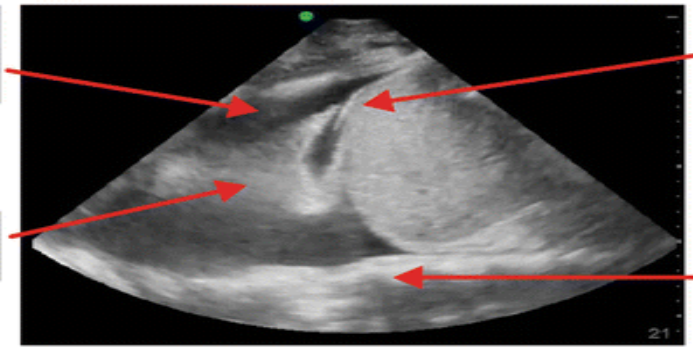


NO CURTAIN SIGN & POSITIVE SPINE SIGN

NO PLEURAL EFFUSION

CURTAIN SIGN NEGATIVE SPINE SIGN

1. Anechoic region above the diaphragm between the visceral and parietal pleura.



2. Absent curtain sign
Lung artifacts and diaphragm do not descend with inspiration and the abdominal organs remain visible throughout

4. Lung consolidation/collapse within effusion

3. Positive spine sign
The spine is visualized above as well as below the diaphragm because the fluid conducts the ultrasound beam

Beware of findings and/or conditions that may cause false positive or false negative results (e.g. free fluid below the diaphragm) - see Table

INTERSTITIAL SYNDROME

STEP 1. Patient Position and Protocols

8-zone protocol

Four areas per side:
- *anterior zones (upper and lower):* parasternal and anterior axillary lines
- *lateral zones (upper and lower):* anterior and posterior axillary lines

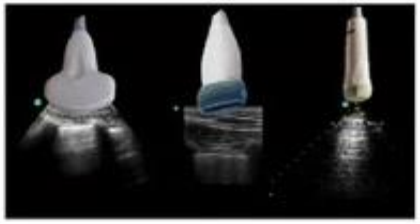
6-zone protocol

Three areas per side:
- *Anterior Zone 1:* 2nd intercostal space on the mid-clavicular line
- *Anterior Zone 2:* 4th intercostal space on the anterior axillary line
- *Lateral Zone:* 5th intercostal space on the mid-axillary line

28-zone protocol

- **Sixteen areas right** hemithorax (2nd, 3rd, 4th, 5th intercostal space)
- **Twelve areas left** hemithorax (2nd, 3rd, 4th intercostal space)

STEP 2. Probe selection

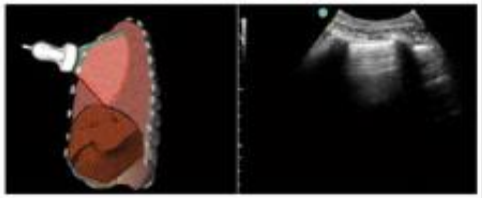


1st choice
Lower-frequency curvilinear (5-2 MHz)

2nd choice
Lower-frequency phased array (5-1 MHz)

3rd choice
High-frequency (13-6 MHz)

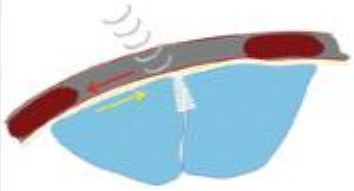
STEP 3. Image acquisition

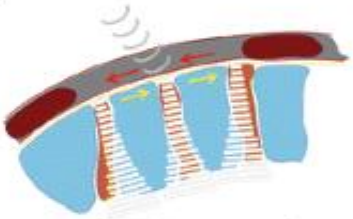


http://pie.med.utoronto.ca/POCUS

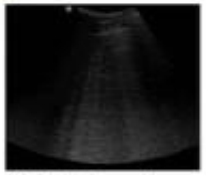
- Cephalo-caudal orientation
- Identify:
  a) superior and inferior ribs
  b) pleural line
- Adjust gain to maximize contrast and visualization of pleural line and B-lines (if present)
- Start medially and slide laterally/posteriorly according to chosen protocol

STEP 4. Image Interpretation





Normal Lung
Lung sliding
Lung pulse
Short vertical artifacts



Interstitial Syndrome (Increased lung density)
- Increased lung weight (water, cells, blood, pus, protein, connective tissue, lipids)
- Lung deflation

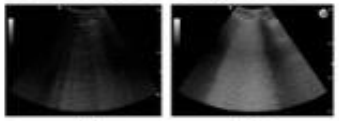
B-lines
- Discrete laser-like vertical hyperechoic reverberation artifacts
- Arise from the pleural line
- Extend to the bottom of the screen without fading
- Move synchronously with lung sliding

Interstitial Syndrome:
≥ 3 B-lines/intercostal space

Interstitial Syndrome

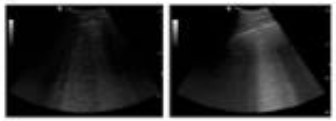
Diffuse | **Focal**

± associated findings:
- **Changes in lung sliding and pulse**
- **Gravity-dependent or –independent pattern**
- **B lines "density"**

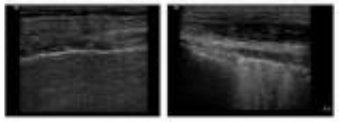


B1 B2

- **B lines distribution**



- **Pleural line abnormalities**



- **Subpleural abnormalities**

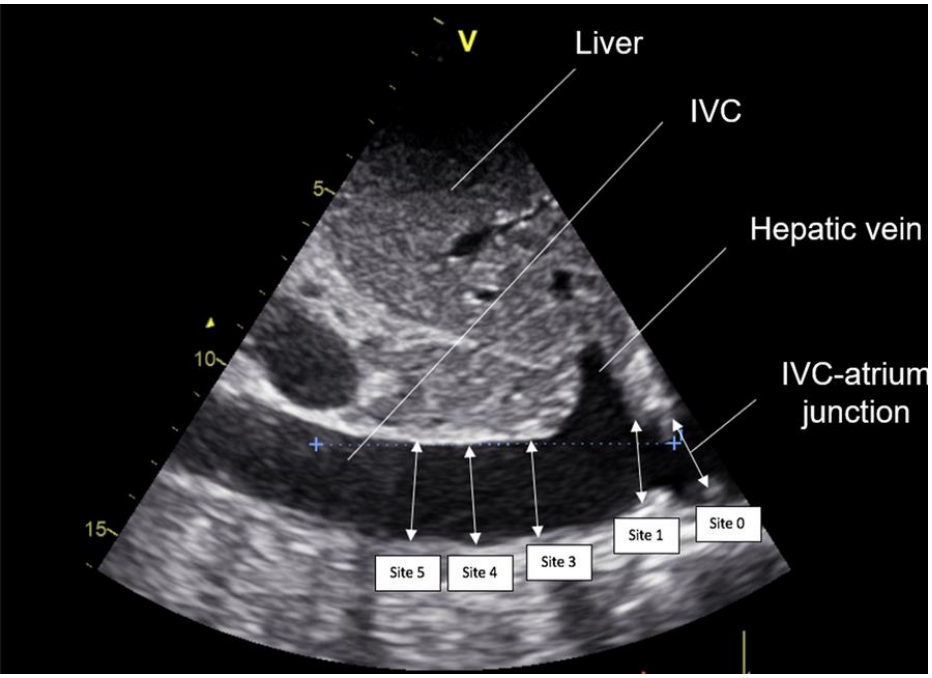
Short vertical artifacts (formerly called Z lines) and **vertical artifacts originating above the pleural line** (formerly called E lines - seen in the context of subcutaneous emphysema) should not be confused with B lines

IVC DIAMETER

IVC assessment in the POCUS setting can assist with the following:-

- Evaluating volume status in hypovolemic shock patients.
- Guiding fluid resuscitation.
- Assessing fluid responsiveness.
- Monitoring patients with heart failure.

- LIMITATIONS:-
- Body habitus and increased intra-abdominal pressure.
- Respiratory effort and mechanical ventilation.
- The right heart function can impact IVC appearance independent of volume status.



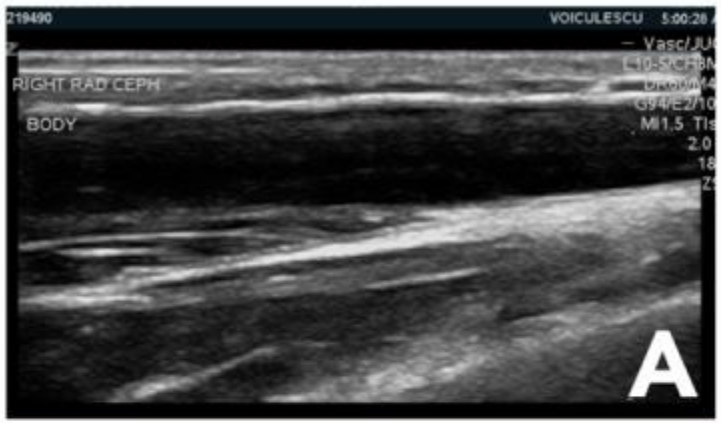
Bi-dimensional ultrasound recording of the inferior vena cava (IVC) generated using the sub-costal, long-axis view. Measurement of IVC diameters were carried out at five sites: at the IVC–right atrium junction (site 0), then at 1 (site 1), 3 (site 3), 4 (site 4) and 5 cm (site 5) caudal to the IVC–atrial junction

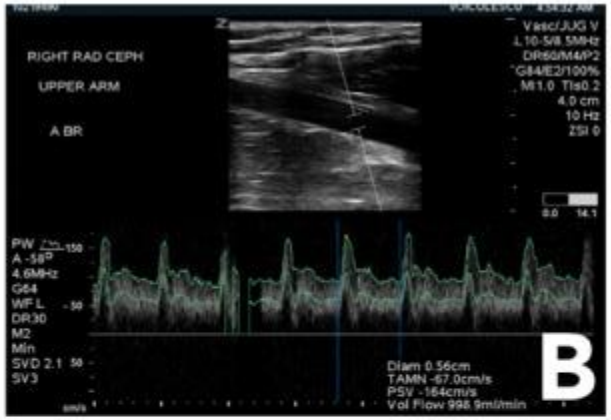
IVC Diameter	IVC Variability	Estimated RA Pressure (mm Hg)
<1.5 cm	>50%	0-5
>1.5 cm	>50%	6-10
>1.5 cm	<50%	11-15
>2 cm	None	>15

Abbreviations: IVC, inferior vena cava; POCUS, point-of-care ultrasound; RA, right atrial.

IVC DIAMETER TO ASSESS VOLUME STATUS

AVF ASSESSMENT USING POCUS





B-mode is used to identify the access and other surrounding structures such as blood vessels or fluid collections.

Color Doppler is used to assist and confirm findings on the B-mode and to monitor the patency of the access.

Doppler mode is used to measure blood flow.

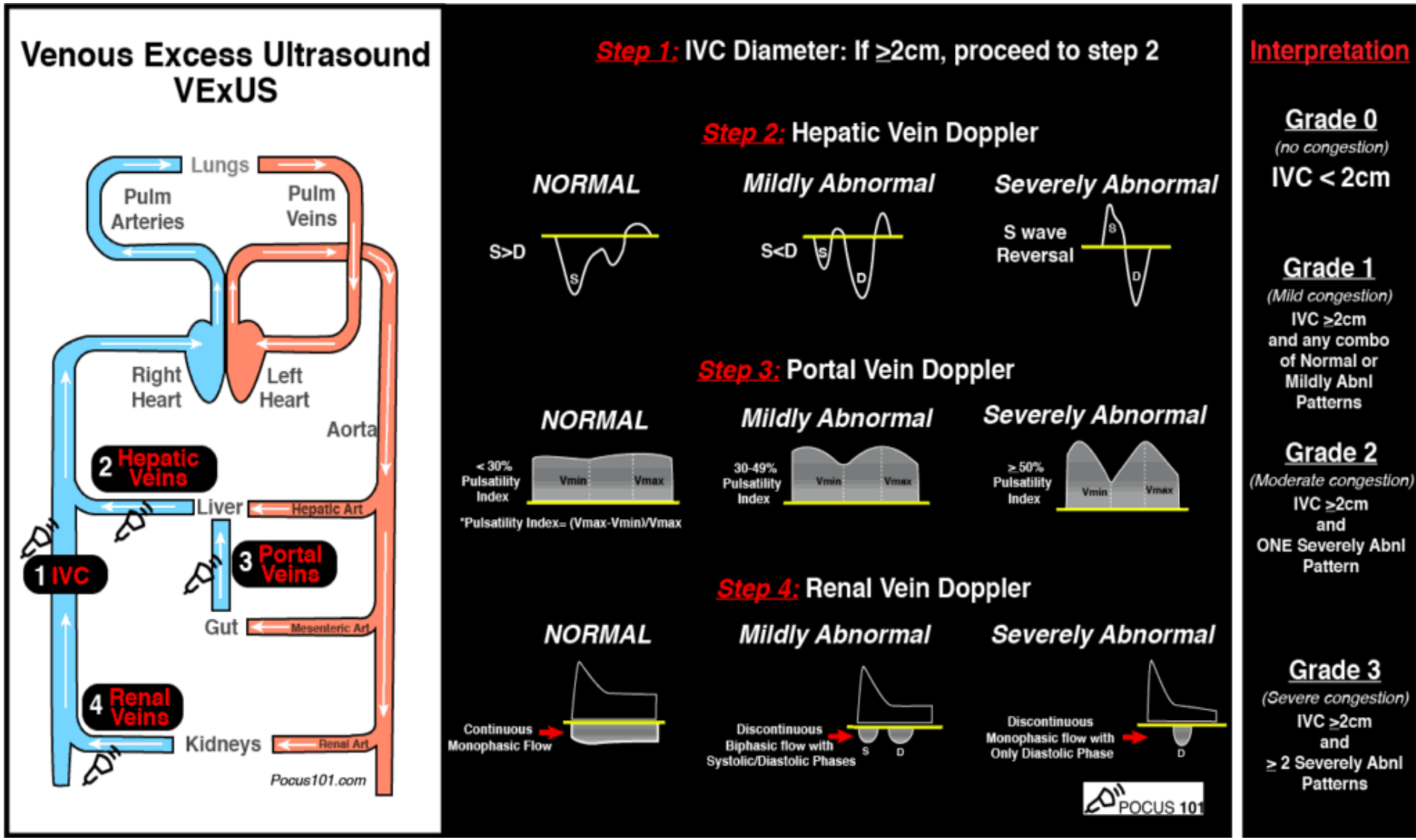
Ultrasound modes used for vascular access examination.

A) B-mode (brightness);

B) B) D-mode (Doppler);

C) C) C-mode (color)

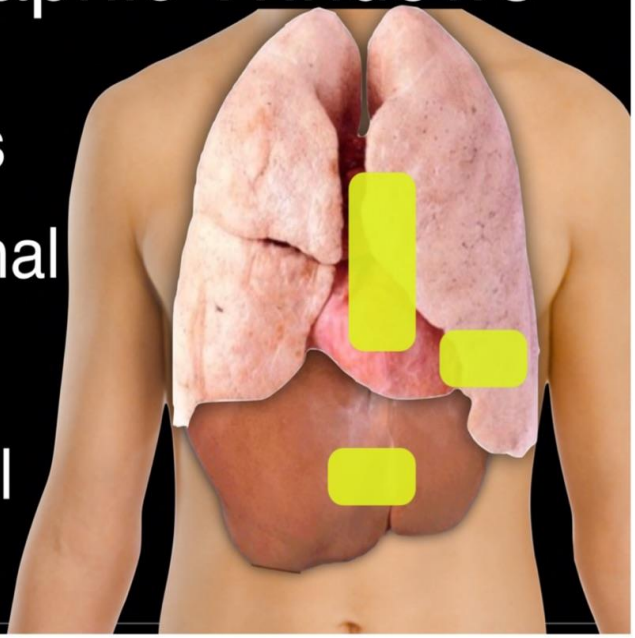
VExUS Ultrasound Score – Fluid Overload and Venous Congestion Assessment



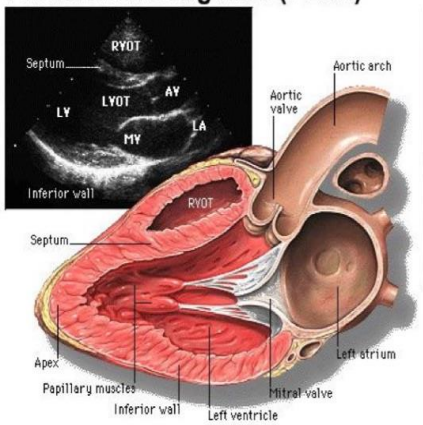
Pocus- Cardiac

Sonographic Windows

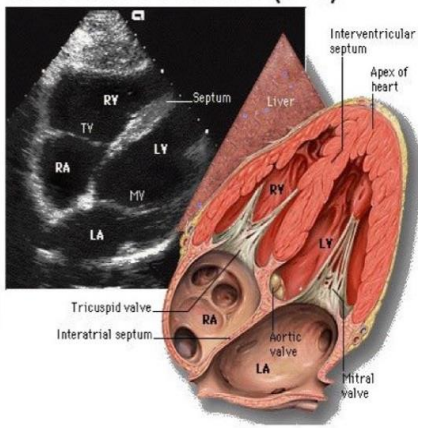
- 3 Windows
  - Parasternal
  - Apical
  - Subcostal



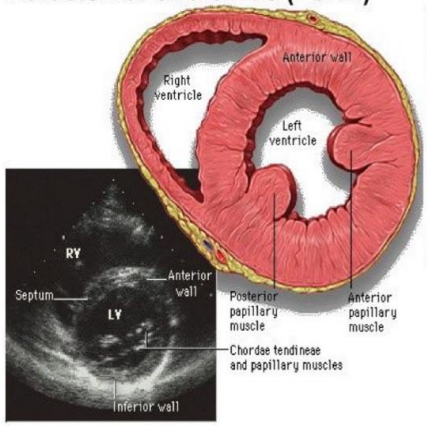
Parasternal Long Axis (PLAX)



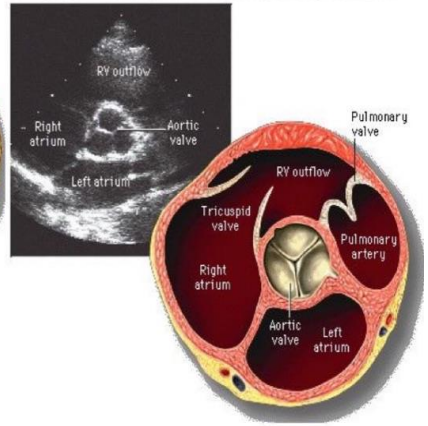
Subcostal 4 Chamber (S4C)



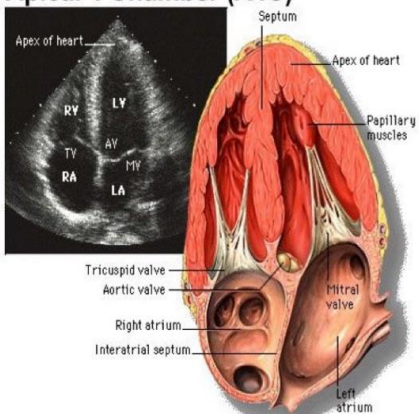
Parasternal Short Axis (PSAX)



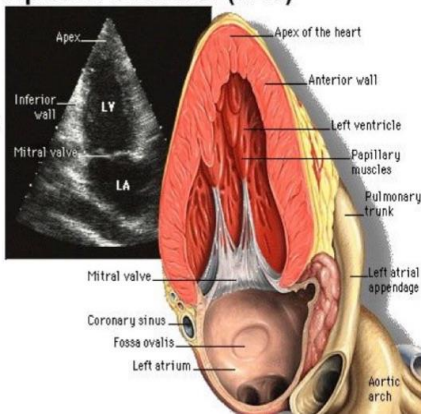
PSAX - Level of the Aortic Valve



Apical 4 Chamber (A4C)



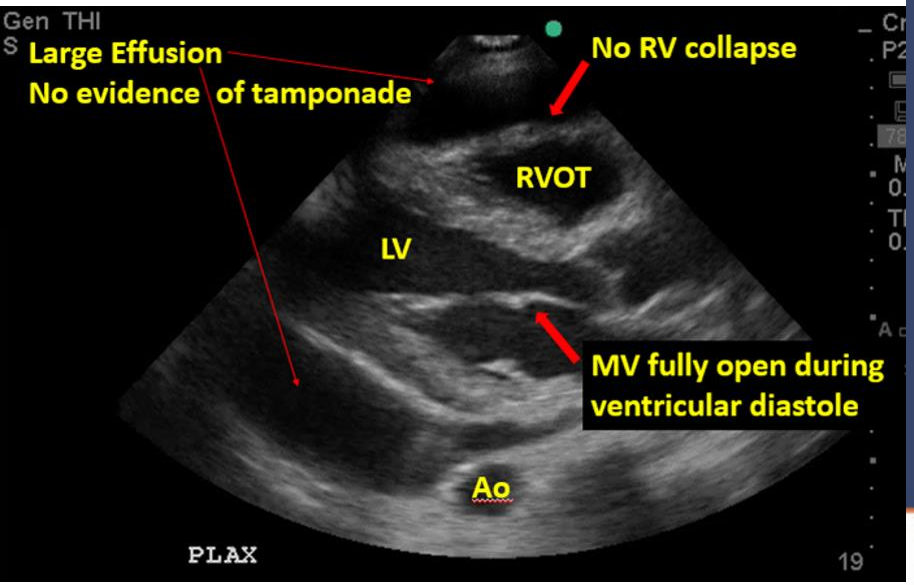
Apical 2 Chamber (A2C)



FoCUS

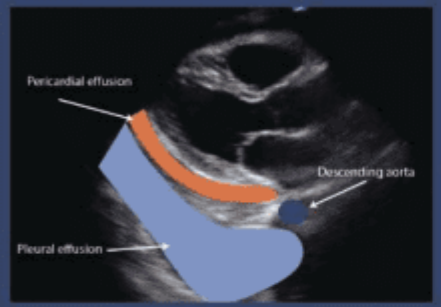
(Focused Cardiac Ultrasound)

PERICARDIAL EFFUSION



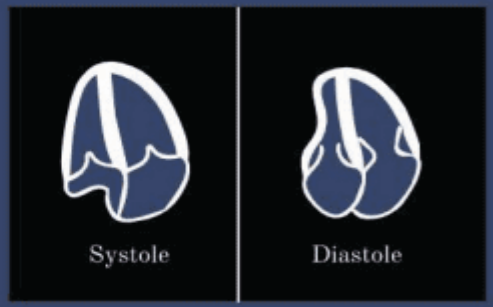
PERICARDIAL EFFUSION

Pleural vs Pericardial?



In Plax View: Is fluid above or below descending aorta?

Right Sided Collapse?



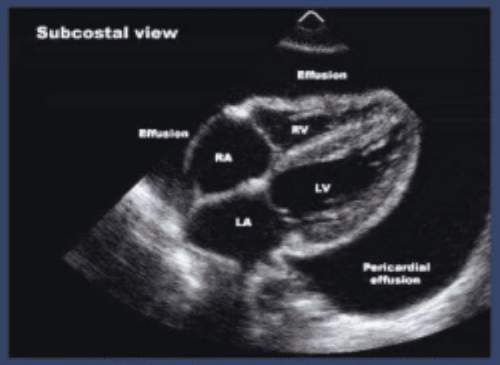
RA Collapse- Valves are closed
RV Collaspe- Valves are open

Classification?

Onset	Acute Subacute Chronic (>3 months)
Size	Mild < 10 mm Moderate 10-20 mm Large > 20 mm
Distribution	Circumferential Loculated
Composition	Transudate Exudate

NL Fluid is 30-50ml of thin clear straw colored fluid.

Approaching Tamponade?



Large Effusions- take time and pericardium accomadates
Moderate Effusions- take days or hours, pericardium hasn't adapted

POCUS™ Point-of-Care Ultrasound Certification Academy

The Point-of-Care Ultrasound (POCUS) Certification Academy™ exists to provide physicians and advanced care providers the opportunity to collaborate in the shared mission of improving global health and setting the standards of excellence in POCUS.

TAKE HOME MESSAGES

1. Improved Diagnostics and Faster Time to Treatment:

- POCUS allows clinicians to rapidly assess patients at the bedside, leading to quicker diagnoses and faster initiation of appropriate treatment.
- POCUS can identify abnormalities that augment consultation with local experts.

2. Enhanced Cost-Effectiveness:

- POCUS can reduce the need for more expensive imaging modalities and supplemental exams, leading to cost savings.
- It can also lead to shorter hospital stays and reduced healthcare expenditures.
- POCUS is a cost-effective approach that directly and indirectly saves healthcare expenses.

TAKE HOME MESSAGES

3. Safe and Versatile:

- POCUS uses non-ionizing radiation, making it a safe imaging modality that can be repeated without posing risks to patients.
- It can be used for monitoring disease progression or recovering injuries, as well as guiding procedures.
- POCUS is not confined to a single organ, allowing clinicians to rapidly assess multiple organ systems.

4. Improved Patient Satisfaction and Therapeutic Relationships:

- POCUS can improve patient satisfaction with their hospital providers and care overall.
- POCUS can provide reassurance to patients by interpreting images and explaining findings.

TAKE HOME MESSAGES

5. Enhanced Clinical Skills and Training:

- POCUS training can significantly improve diagnostic accuracy and confidence among healthcare professionals.

- It offers a unique opportunity to develop and research.

- POCUS can be used in various healthcare settings, including emergency departments, ICUs, and primary care.