HOCUS POCUS: Introduction to Point of Care Ultrasound

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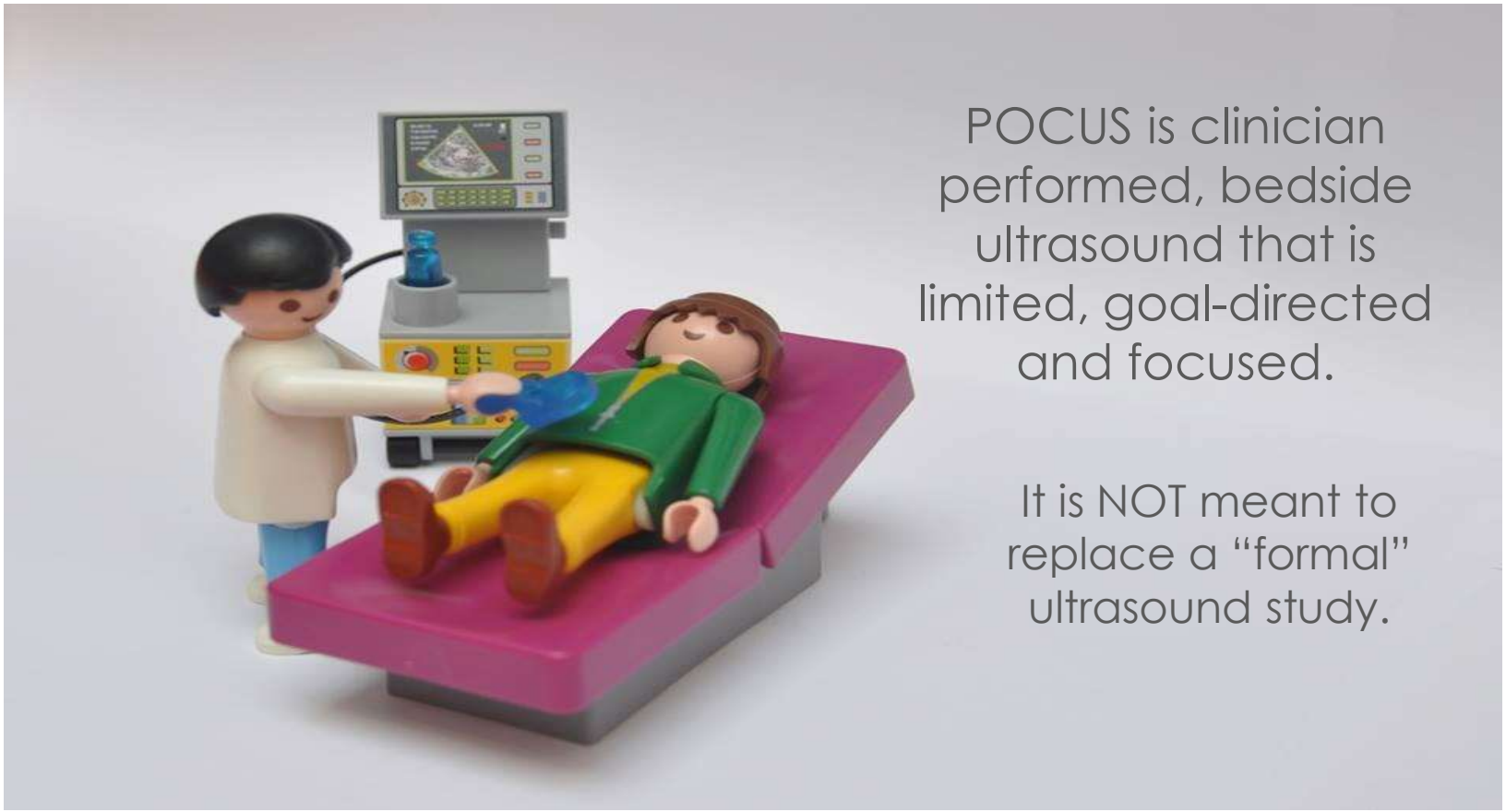
Disclosures

No relevant relationships with ineligible companies to disclose within the past 24 months

Objectives

- Explain the indications for the use of bedside, point-of-care ultrasound (POCUS).
- Describe the basics of ultrasound technology, and "knobology".
- Be able to perform basic cardiac, lung, and eFAST ultrasound exams.

Point-Of-Care Ultrasound (POCUS)



POCUS is clinician performed, bedside ultrasound that is limited, goal-directed and focused.

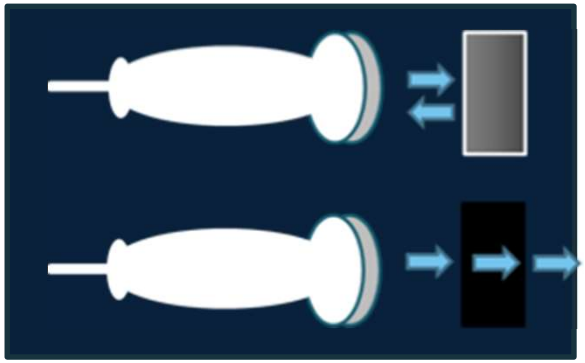
It is NOT meant to replace a "formal" ultrasound study.

Why should I learn ultrasound?

- It will make you a **better clinician**
- It will improve your procedural skills
- You can be reimbursed for this!

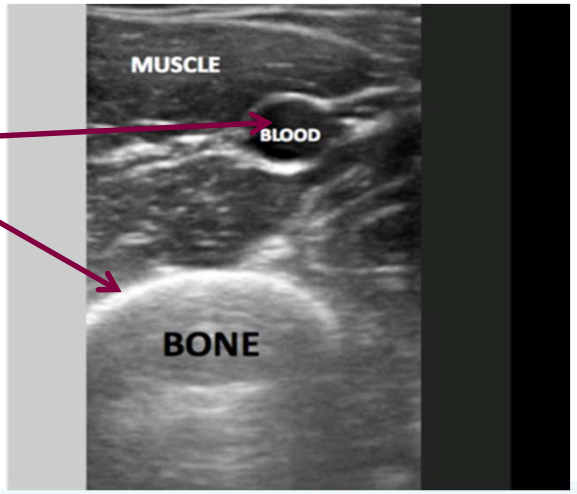
Basics of Ultrasound

Principle of Ultrasound:
sound waves are emitted from the probe and reflect on objects depending on impedance.



- Returned hyperechoic signals appear white
- Anechoic appears black (eg. fluid)

- Frequency ∝ resolution



Basic "Knobology"

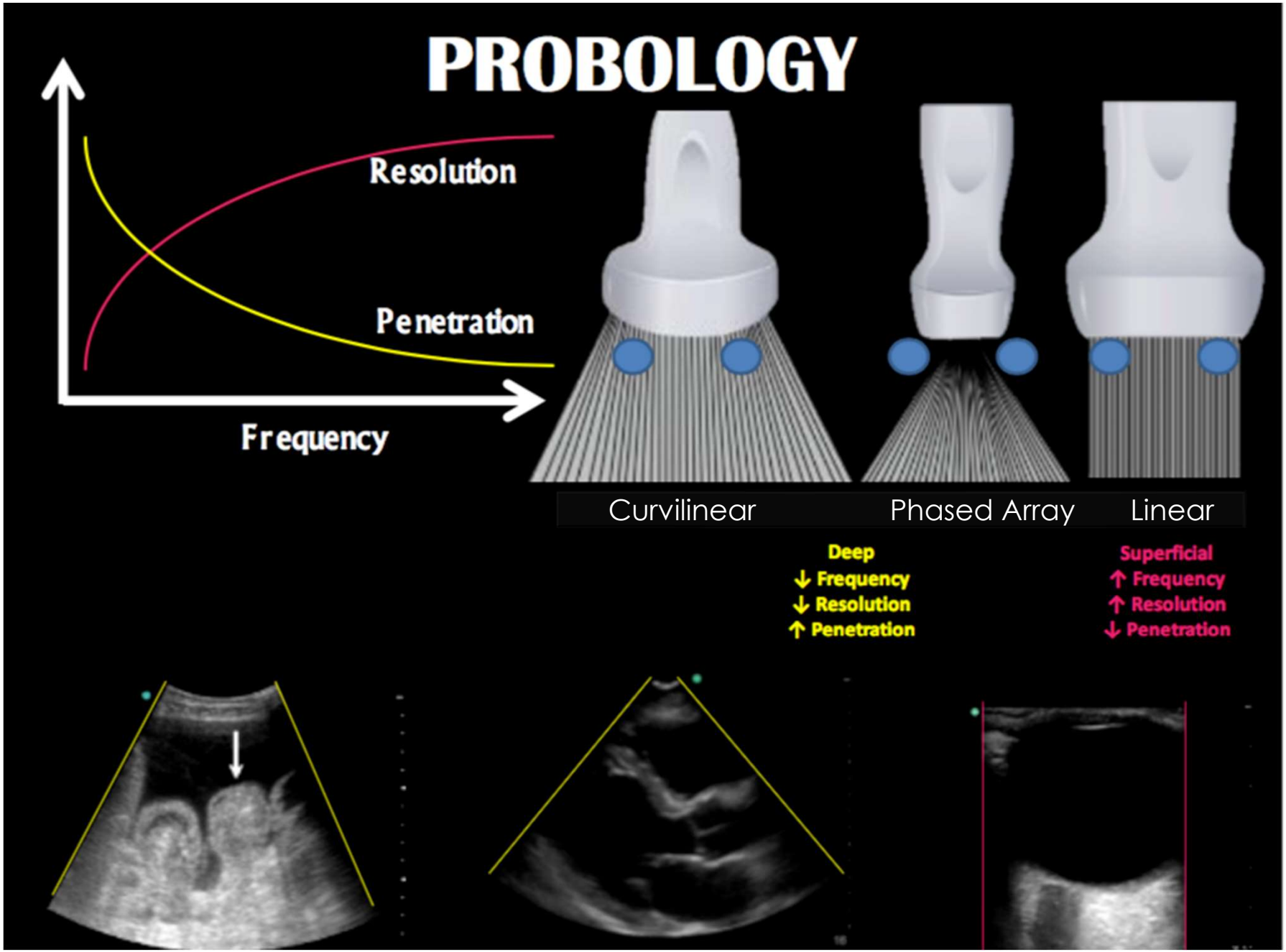
1. Power button
2. Exam type
3. Depth
4. Gain

Transducers

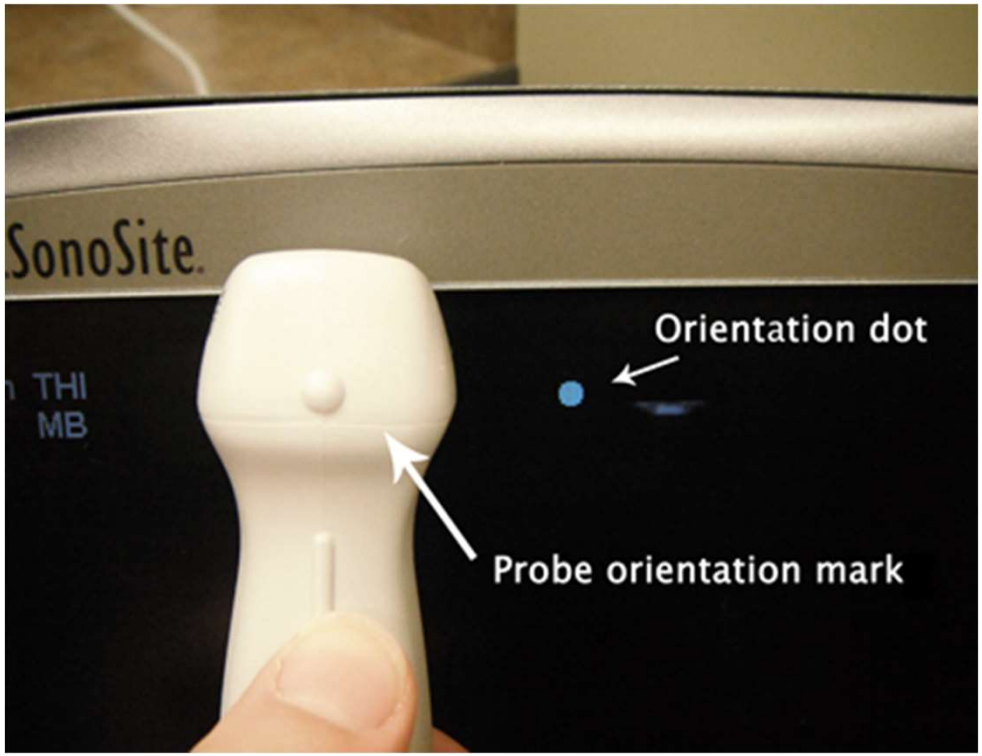
Linear
(high frequency)
“Vascular”

Phased Array
(low frequency)
“Cardiac”

Curvilinear
(low frequency)
“Abdominal”


PROBOLOGY
Resolution
Penetration
Frequency
Curvilinear
Phased Array
Linear
Deep
↓ Frequency
↓ Resolution
↑ Penetration
Superficial
↑ Frequency
↑ Resolution
↓ Penetration

Indicator!



UNDERSTANDING THE IMAGE

There are a variety of scanning modes used in point of care ultrasound. Here we will discuss **B-** or **brightness mode**, **M-mode** or **motion mode** and **D-** or **doppler mode**.

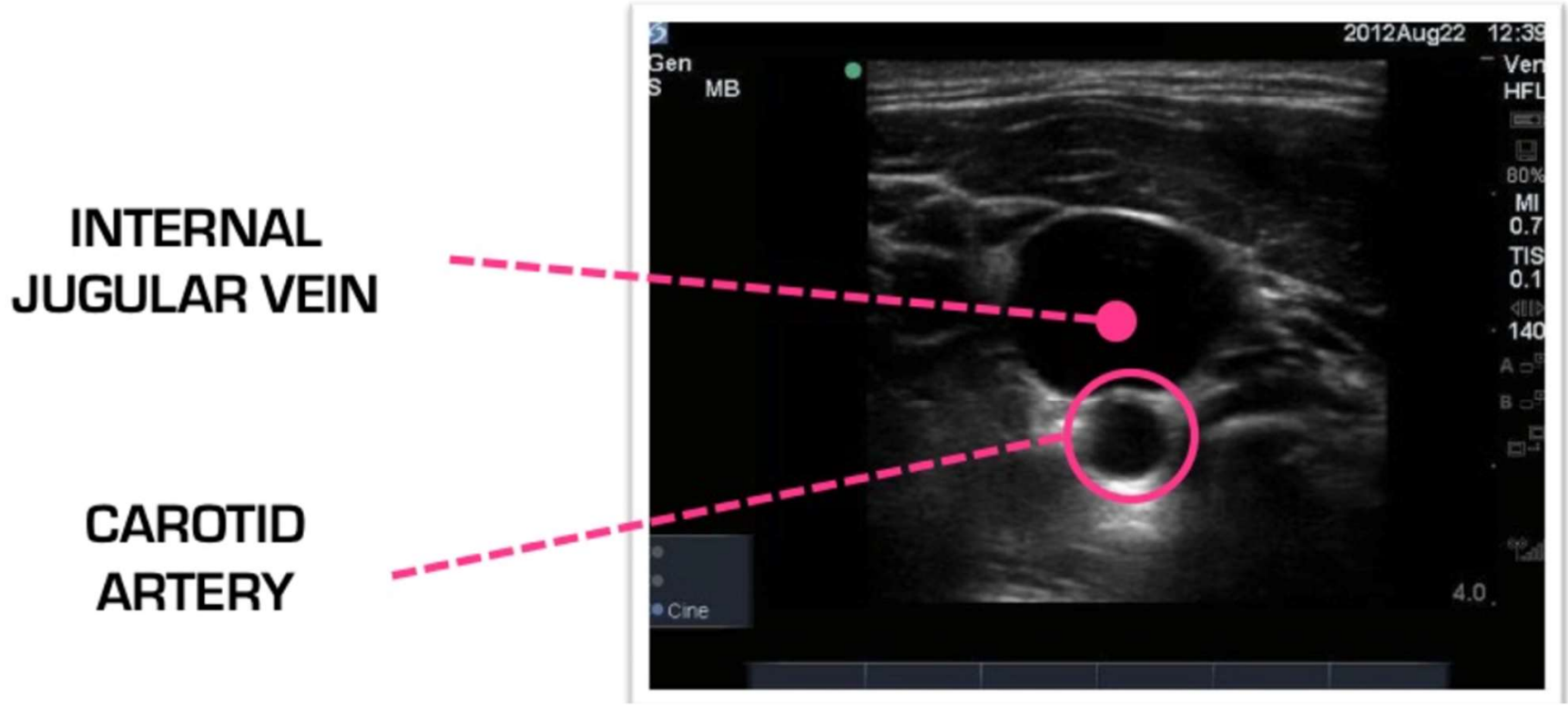
B-MODE

M-MODE

DOPPLER

UNDERSTANDING THE IMAGE

B-mode (also called **2D mode**) converts echo waveforms into a **256 shade** grayscale image. The shade of gray depends on the amplitude of the returning echo.



UNDERSTANDING THE IMAGE

M-mode plots the motion of a structure of interest. The probe's **image plane** is plotted on a vertical axis and **time** is plotted on a horizontal axis.

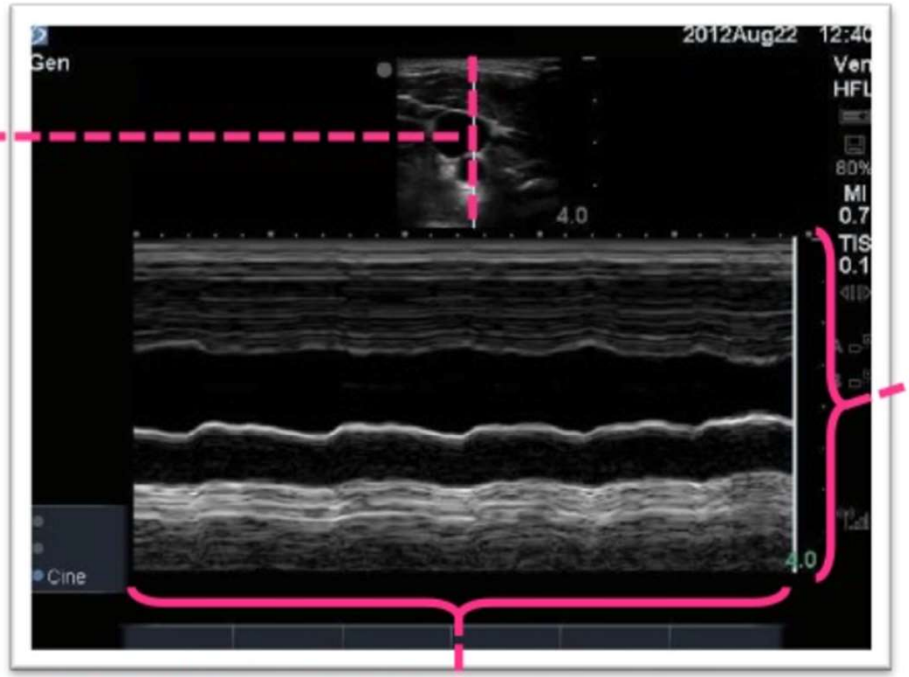


IMAGE PLANE REPRESENTED ON 2D IMAGE

IMAGE PLANE

TIME

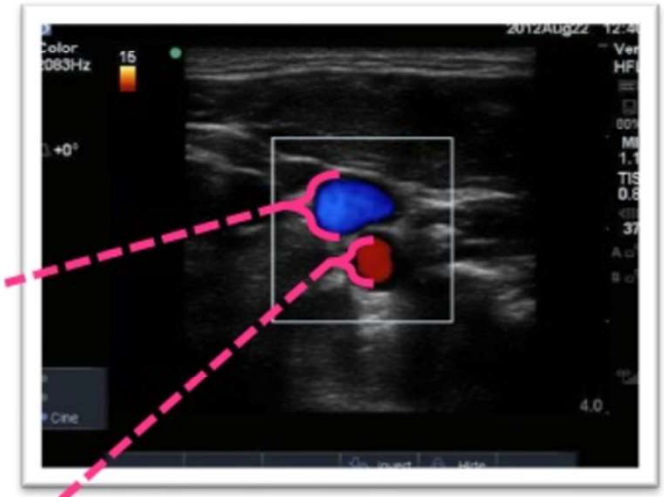
UNDERSTANDING THE IMAGE

Doppler mode can determine movement of reflected ultrasound waves toward or away from the probe. This can be represented by colour changes or graphical peaks.

Doppler flow- "BART" -Blue Away, Red Towards

BLUE REPRESENTS MOTION **AWAY** FROM TRANSDUCER

RED REPRESENTS MOTION **TOWARDS** TRANSDUCER



COLOUR DOPPLER

SPECTRAL DOPPLER

Advantages of POCUS

- Repeatable as clinical status changes
- Portable
- Non-invasive
- Non-ionizing radiation
- Low cost
- Easy to learn

Disadvantages of POCUS

- Air/Gas
- Body Habitus
- Experience / operator dependent
  - This is **NOT** a formal echo or ultrasound evaluation

Indications for POCUS

- Hypotension
- Trauma
- Respiratory Distress
- Assessment of fluid status

Indications for Ultrasound

- Foreign body
- Cardiac Arrest
- Appendicitis
- Fractures
- Retinal Detach
- DVT
- Tamponade
- Gallstones
- Hemoperitoneum
- Testicular torsion
- Hemothorax
- Abscess
- Urinary retention
- Ovarian cyst
- Tendon rupture
- AAA
- Arthrocentesis
- Ectopic Pregnancy
- Any type of shock
- Sepsis
- Pneumothorax
- CHF
- Optic nerve
- Vascular access
- Paracentesis
- Pyloric stenosis
- Nerve blocks
- Resuscitation
- Intubation
- Epididymitis
- Hydronephrosis
- Baker's Cyst
- IUP
- Bowel Obstruction
- Hernia
- Ascites
- Cellulitis
- Joint effusion
- Thyroid

Our Focus

- **Cardiac Ultrasound**
  - IVC/Fluid Assessment
- **FAST (Focused Assessment Sonography in Trauma)**
- **Lung**
- "Miscellaneous" (vascular, eye, etc.)

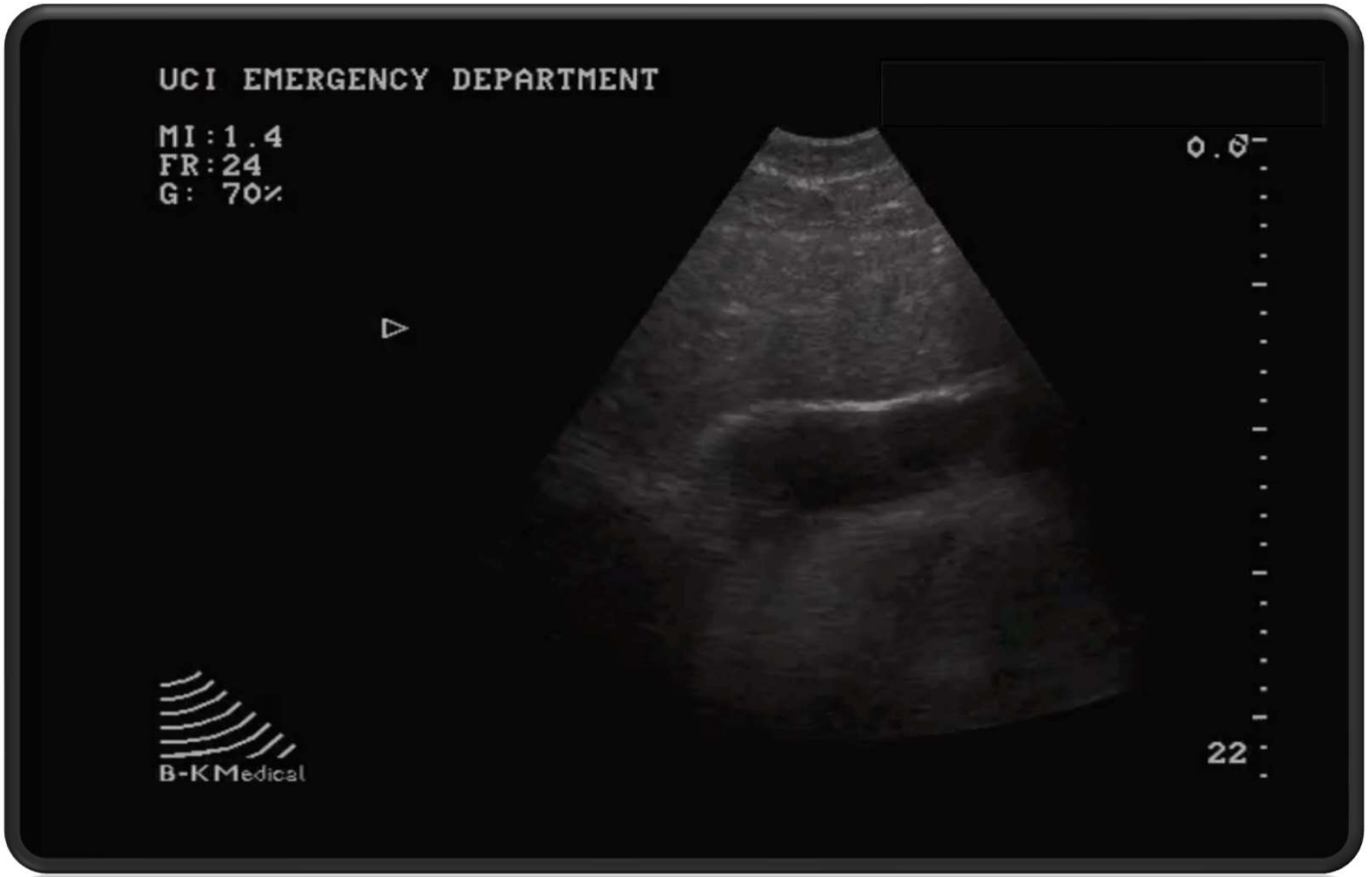
Sonographic Assessment of Medical Emergencies

1. Use a **structured** approach
2. Limited and focused exam
3. Repeat as necessary!

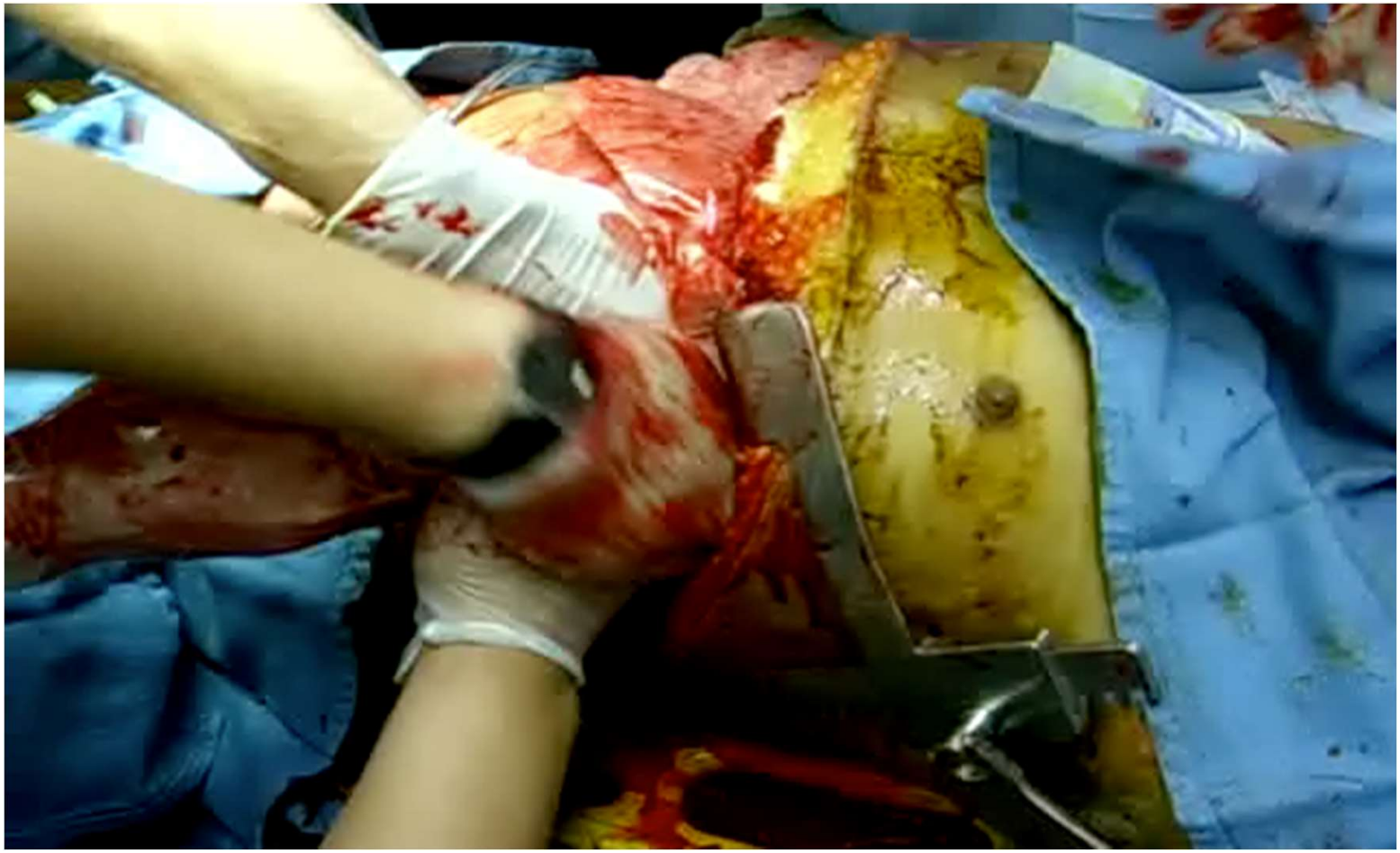
Case #1

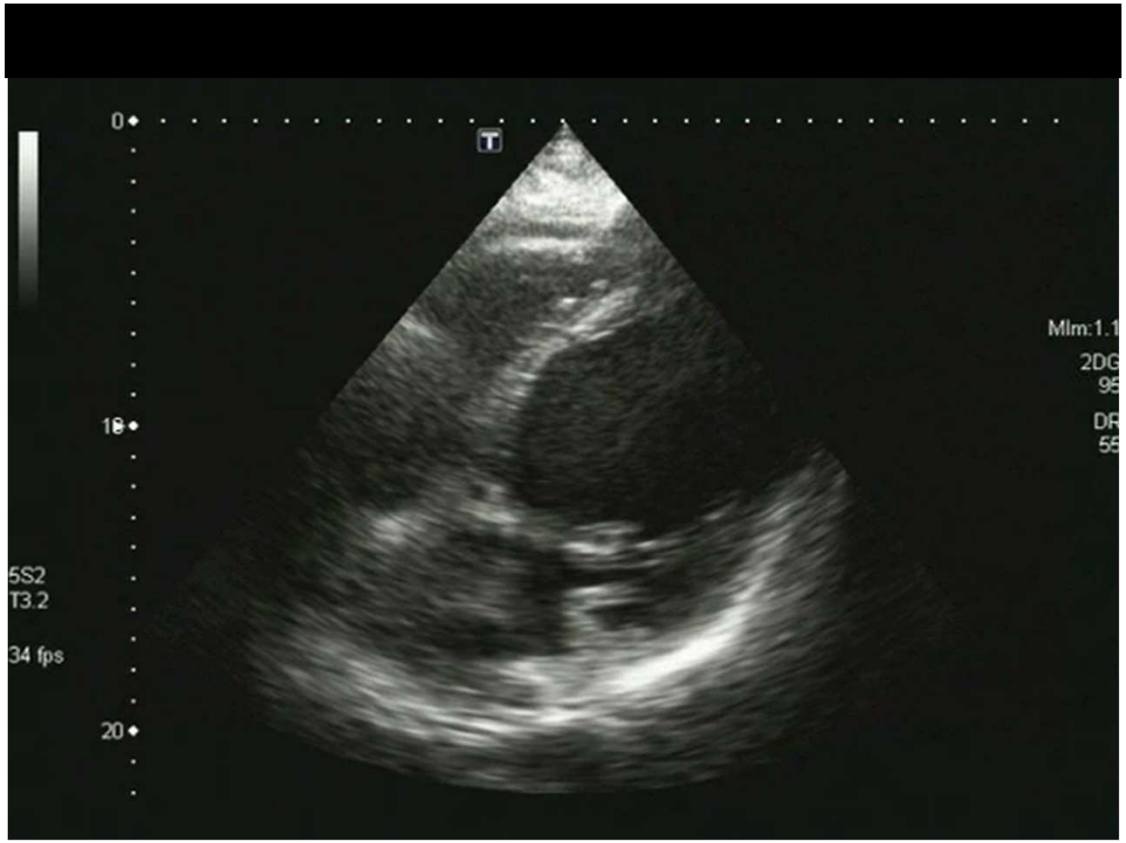
- 38 yo male was involved in a car accident.
- No seatbelt.
- Had a pulse in the ambulance, now has no pulse.

Case #1



Case #1





Cardiac Ultrasound

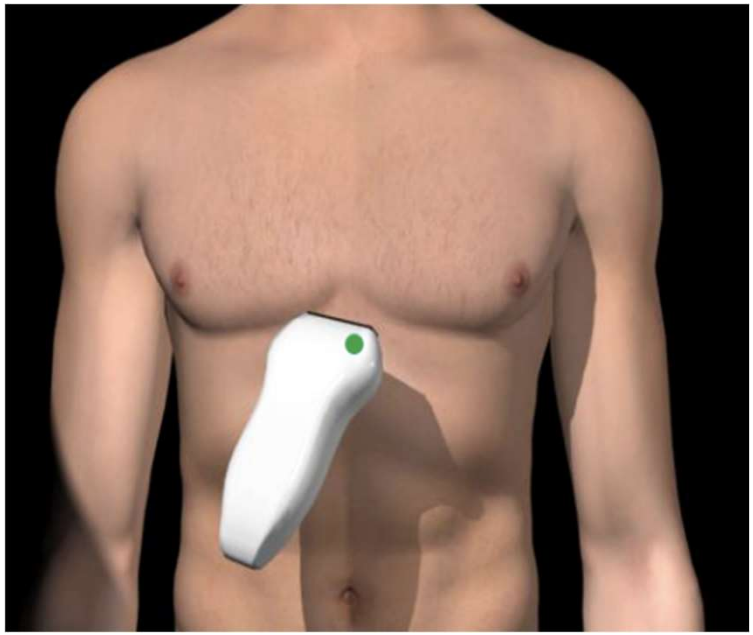
Goals of Cardiac Ultrasound

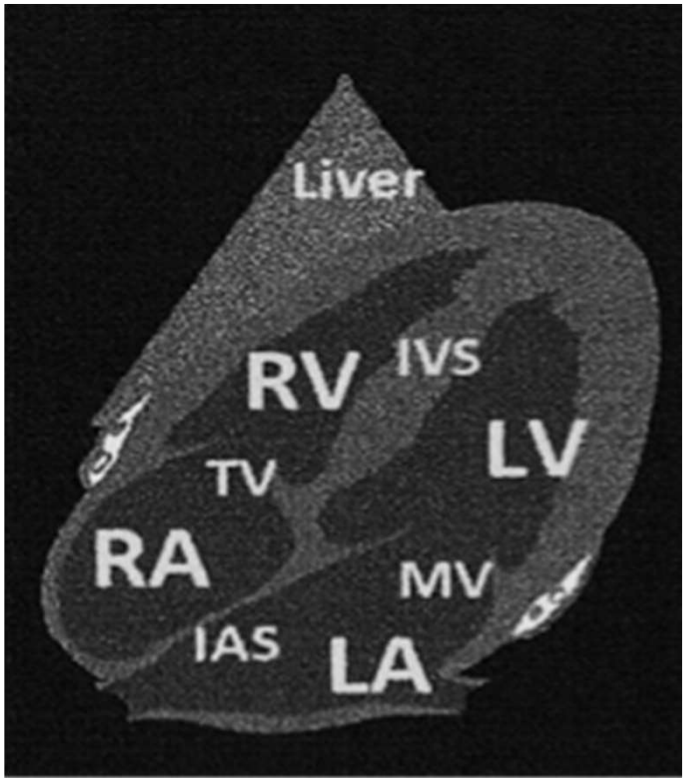
- **Is the heart strong or weak?**
  - LV and RV size/systolic function
- **Is there fluid around the heart?**
  - Pericardial effusion/cardiac tamponade
- **What is the fluid status of the patient?**

Four Views of the Heart

- Subxiphoid/subcostal
- Parasternal Long
- Parasternal Short
- Apical (Four Chamber)

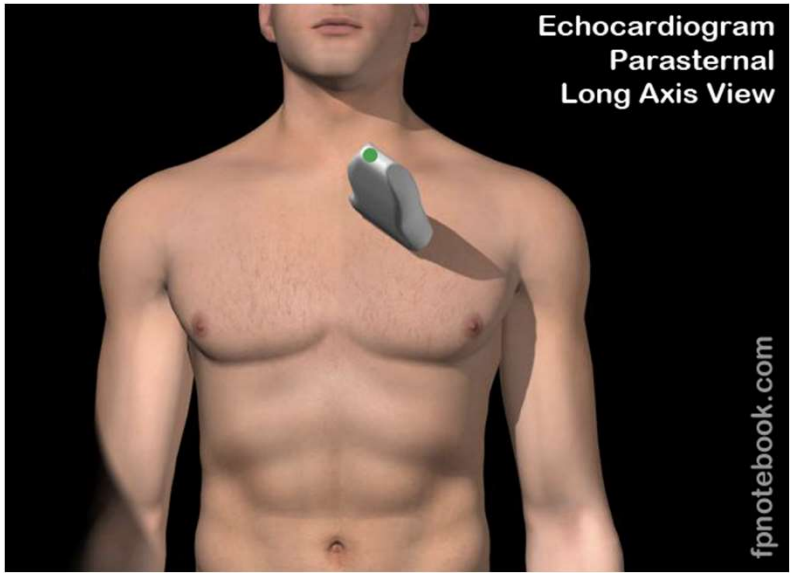
Subxiphoid View

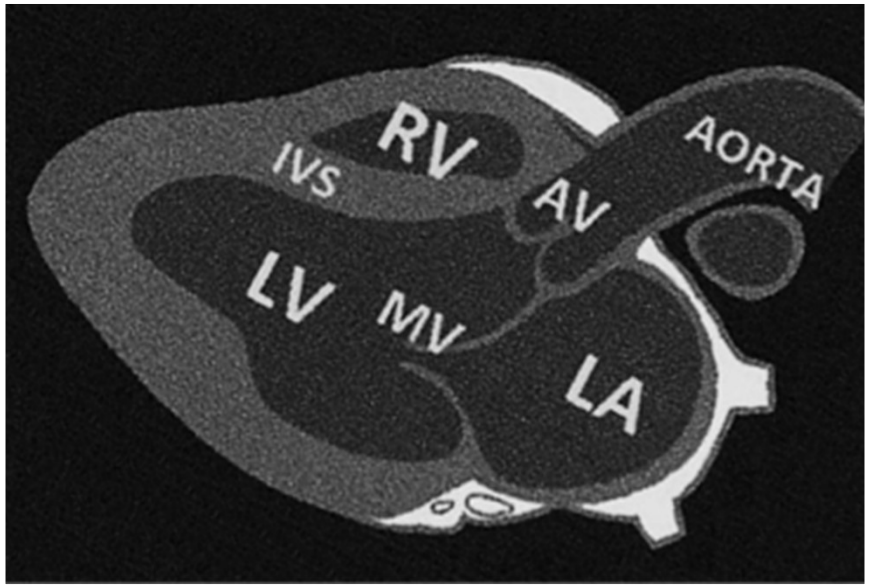


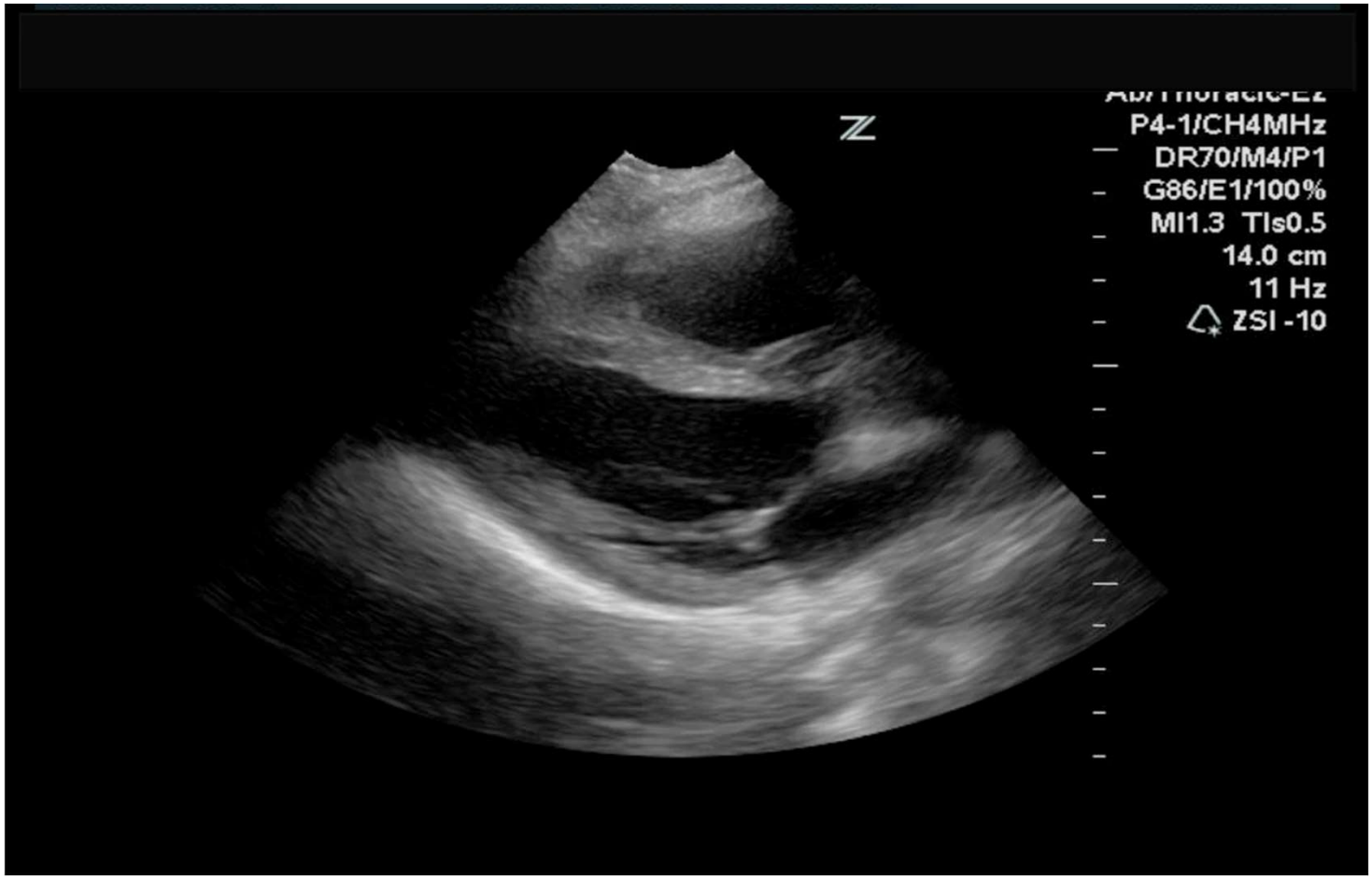


Subxiphoid View

Parasternal Long View

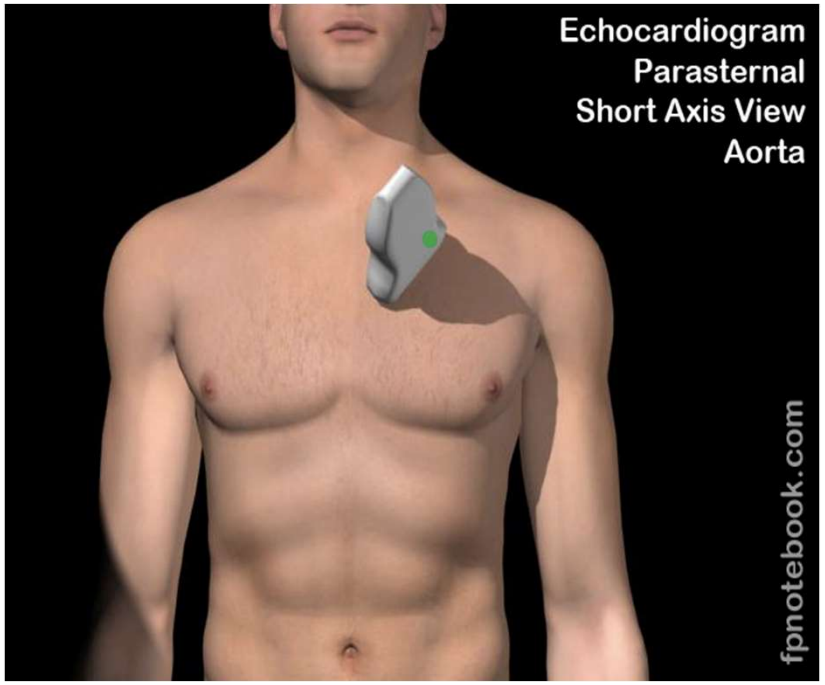


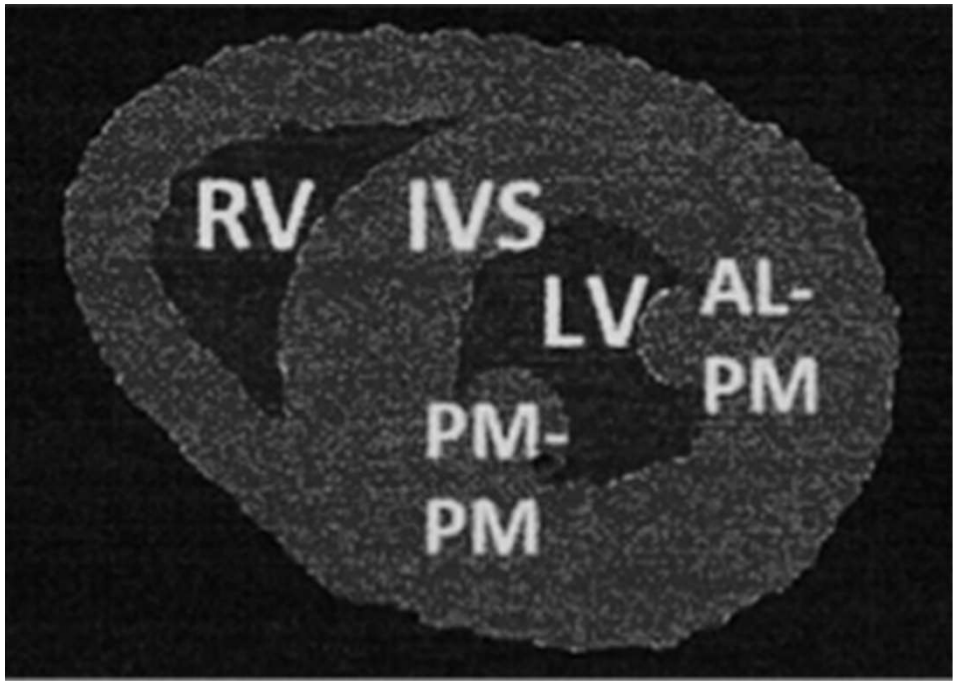


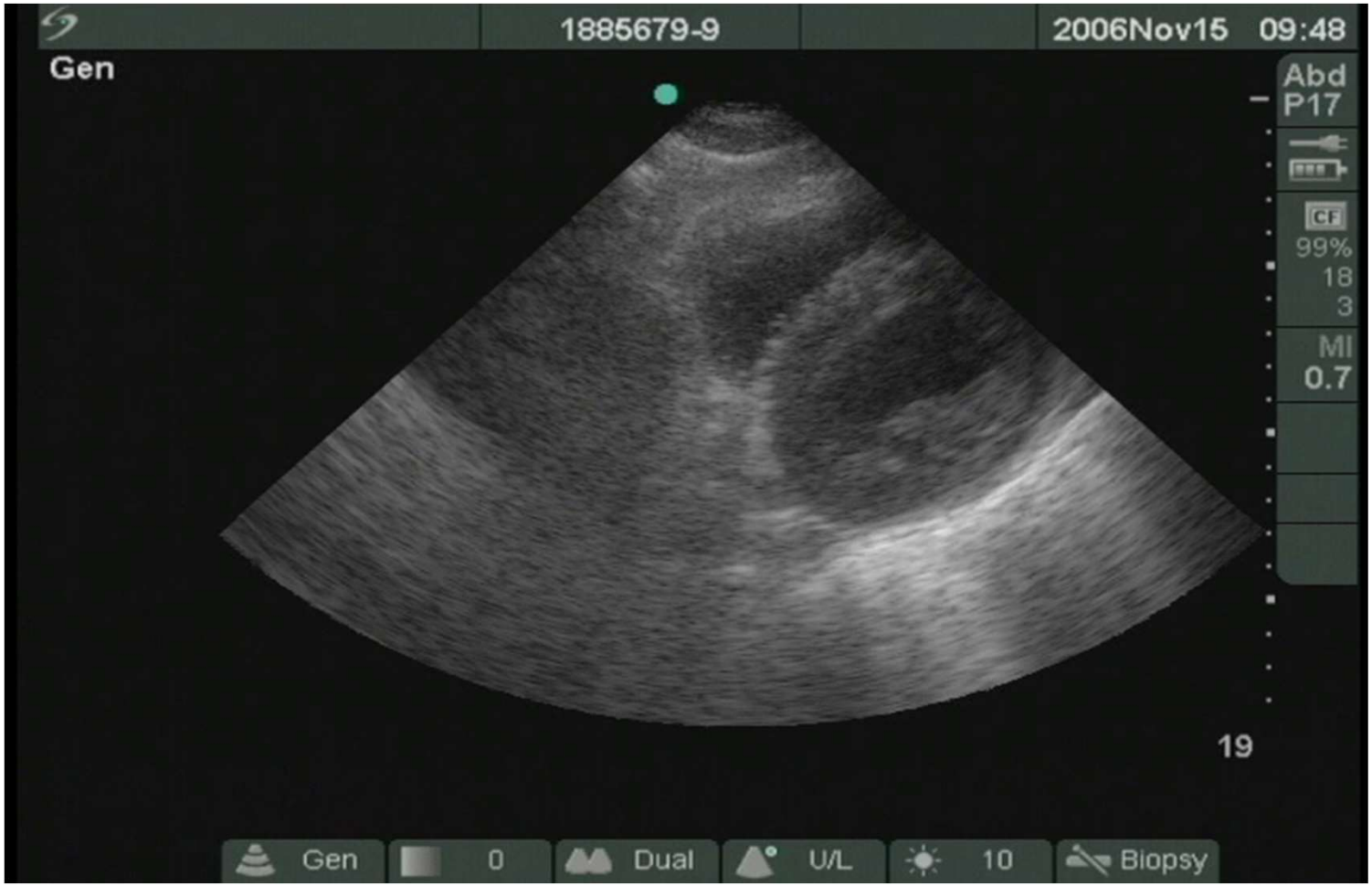


Parasternal Long View

Parasternal Short View

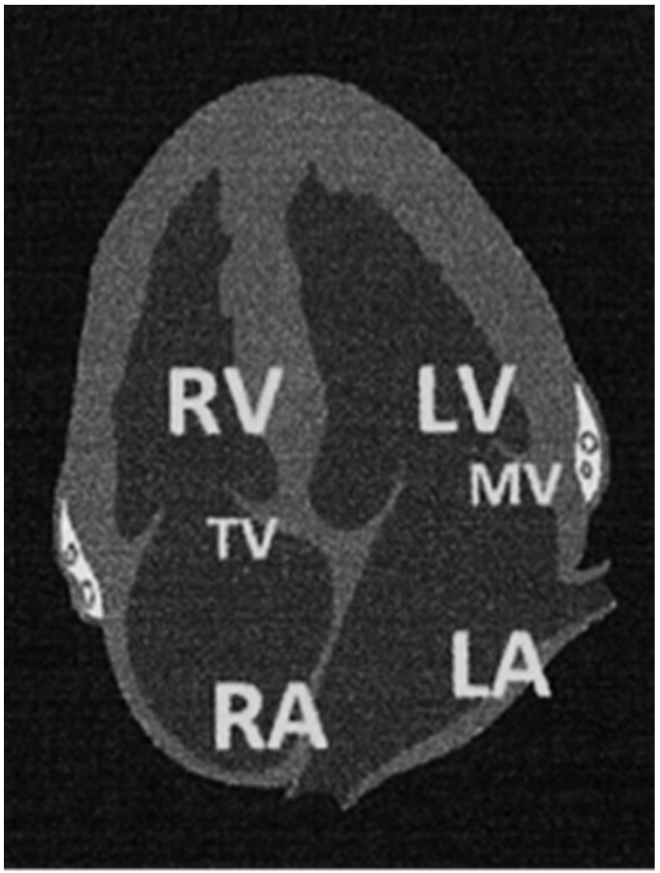


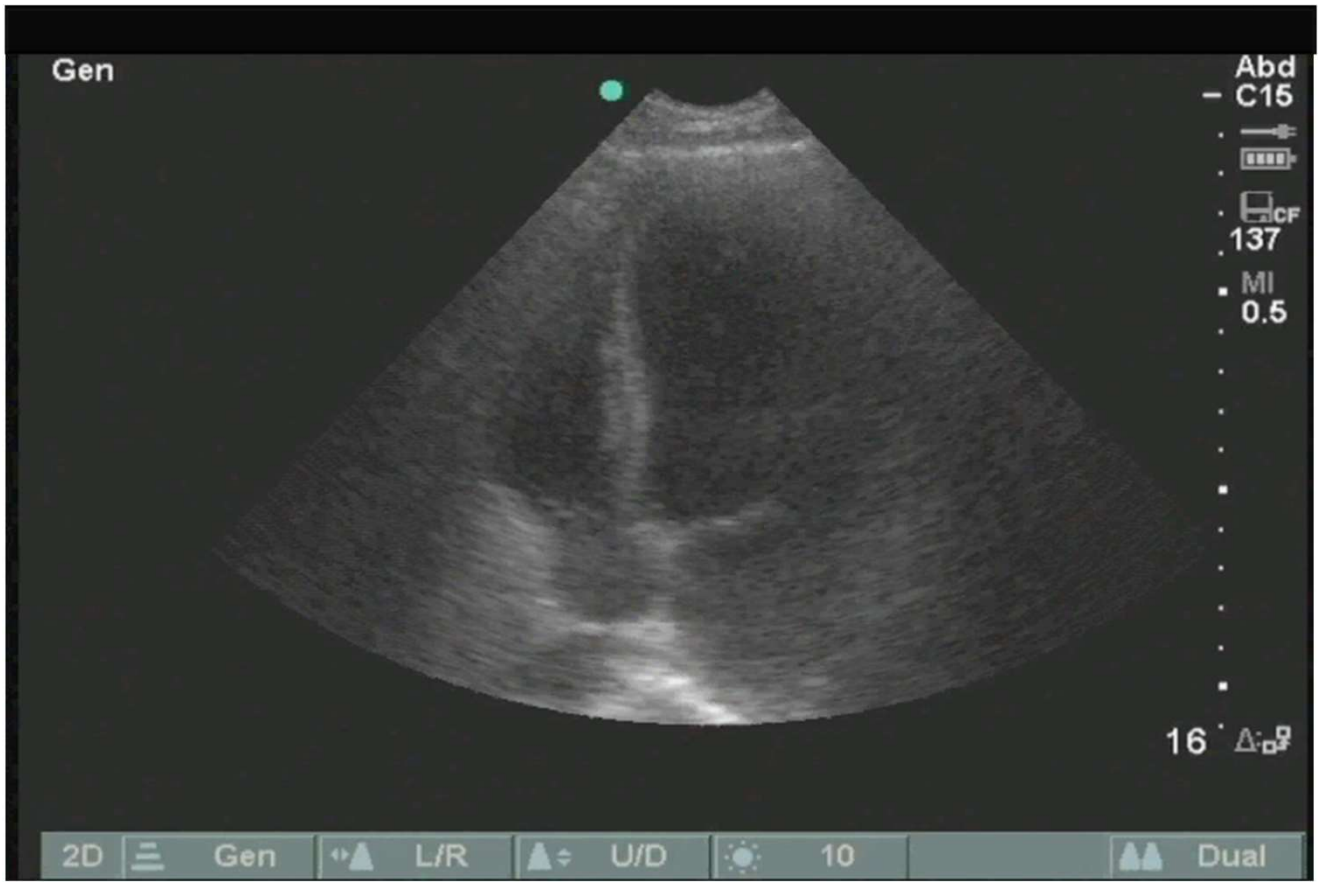




Parasternal Short View

Apical (Four Chamber) View

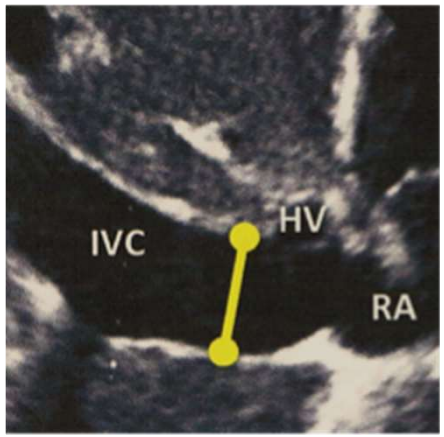




Apical (Four Chamber) View

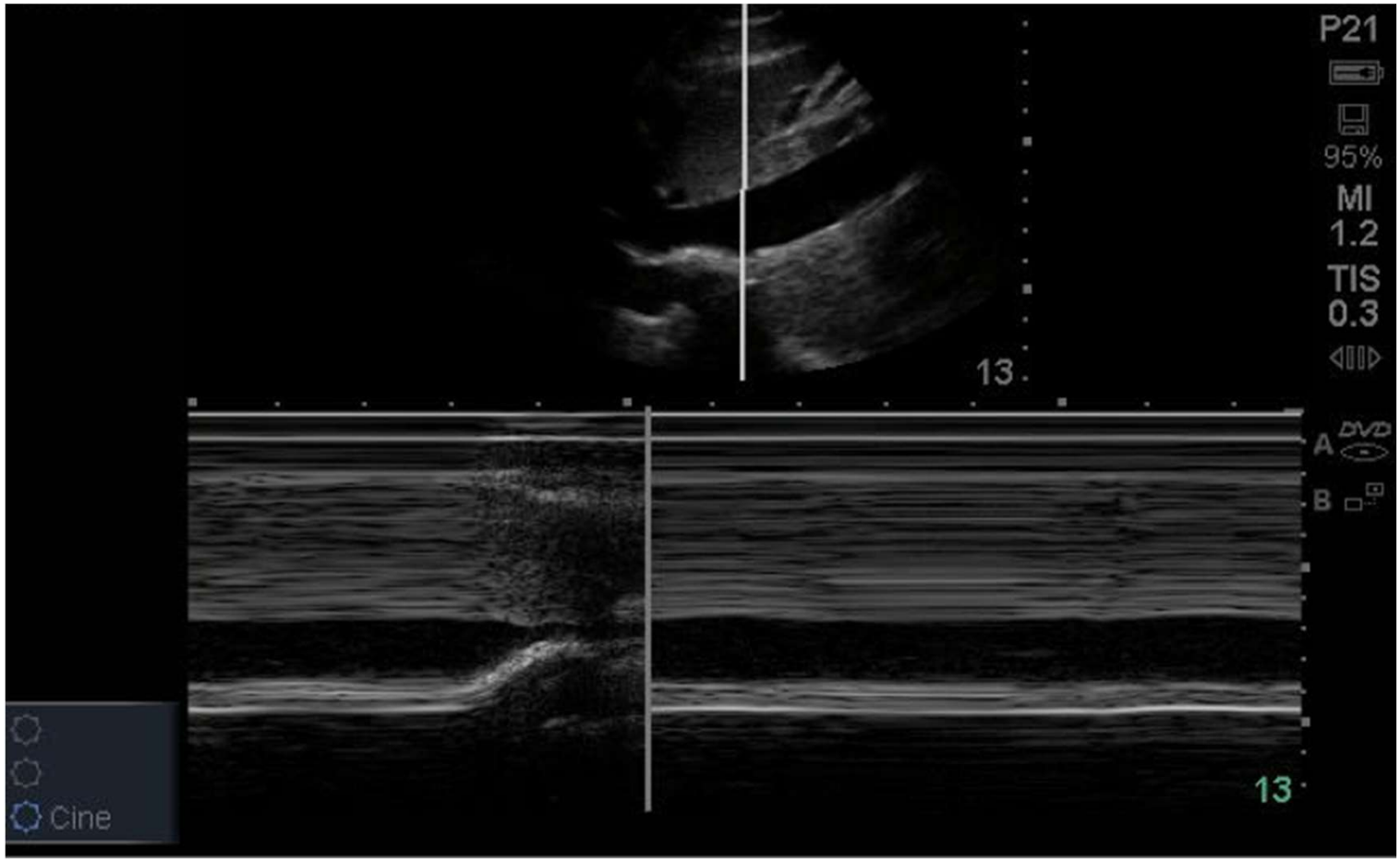
Evaluation of the IVC

Static Parameter for estimating $P_{RA} \approx CVP \approx$ fluid status of patient



IVC Diameter (cm)	Collapse	RA Pressure (mmHg)	CVP	Fluid Status
<2	>50%	<10	0-10	"Dry"
>2	<50%	>10	10-20	"Full"

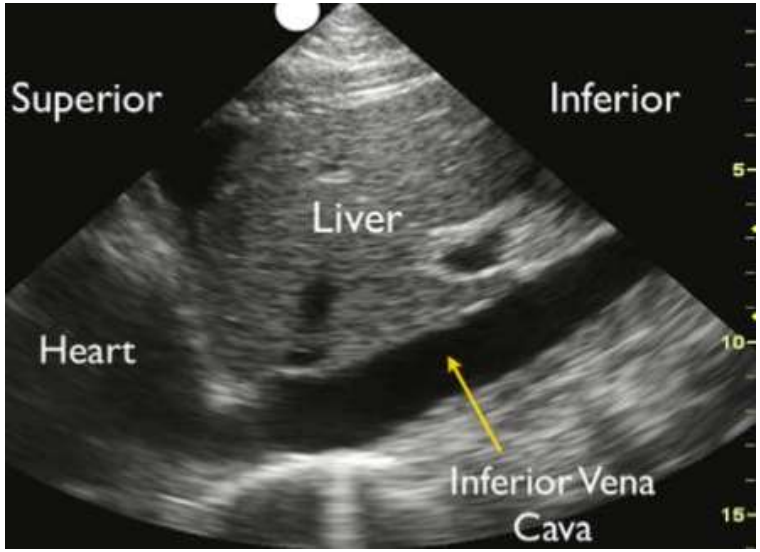
The “M Mode” can be used to measure IVC as well

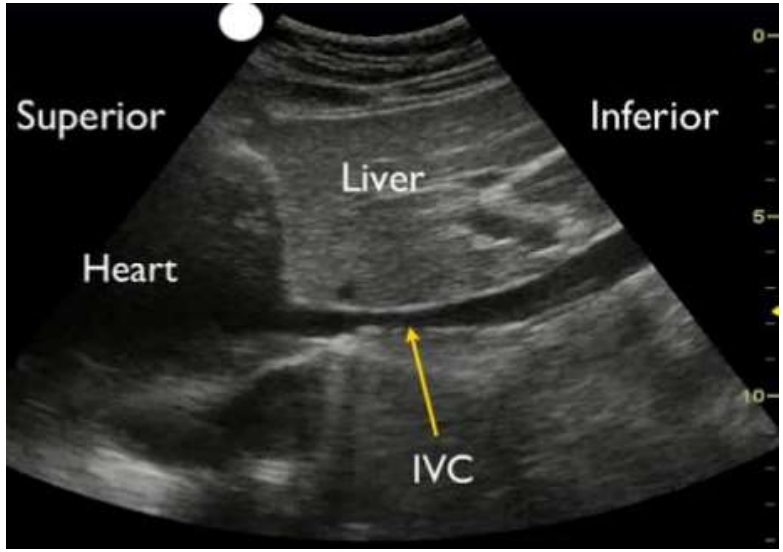


Anything that increases the RA pressure can dilate the IVC → LV failure, RV failure, Pulmonary HTN, TR, Hypervolemia

Evaluation of the IVC

Sensitivity: 63% Specificity: 73%





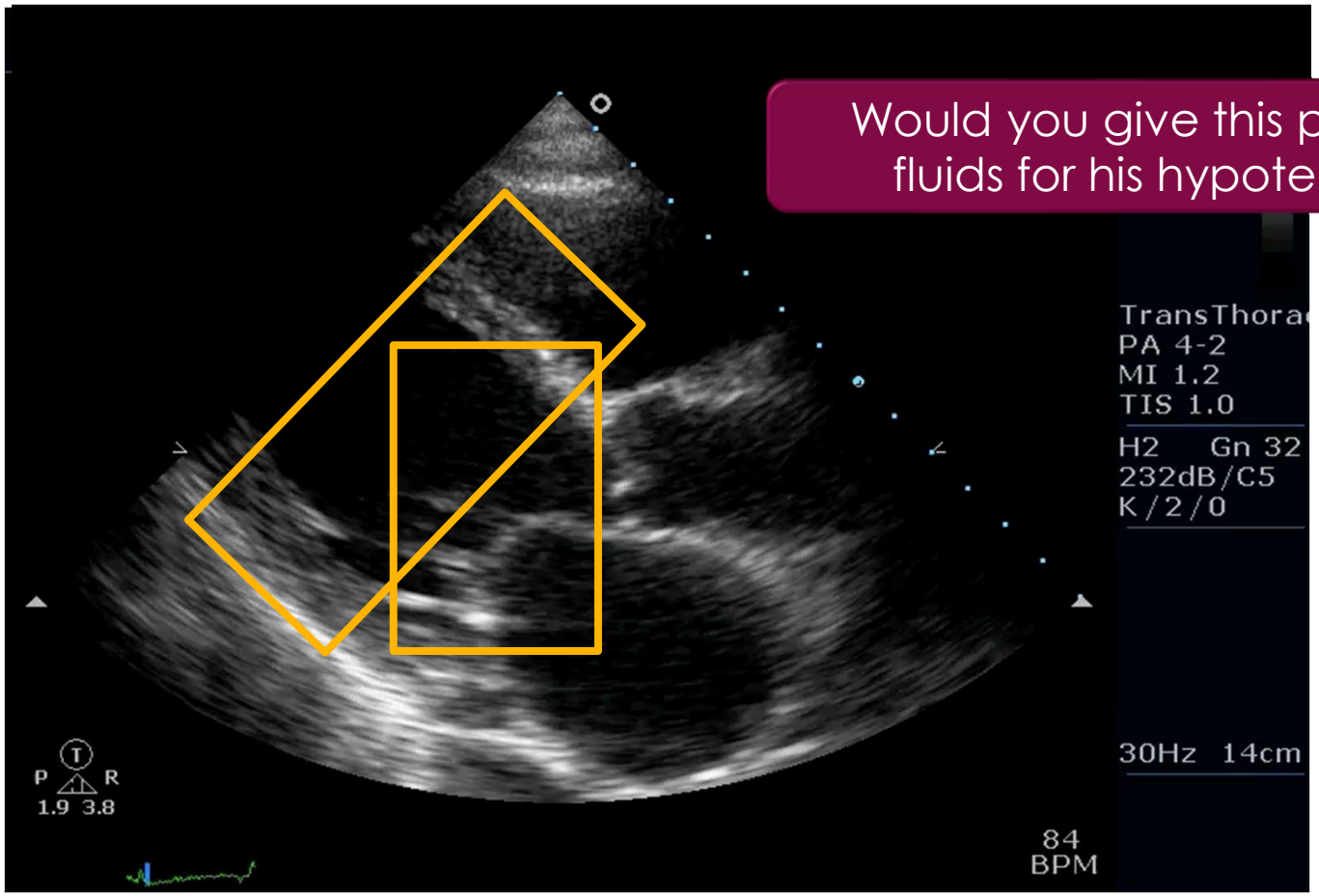
"A small IVC is moderately predictive of fluid responsiveness, however a dilated IVC cannot rule out fluid responsiveness."

Case #2

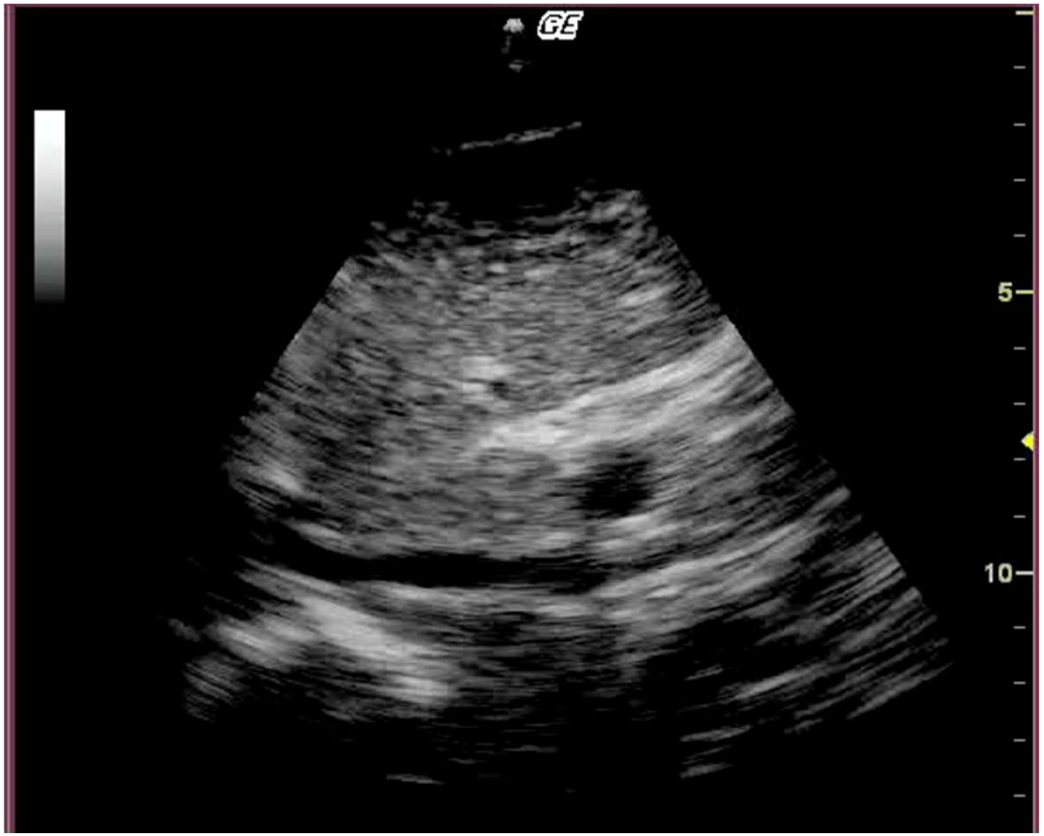
- 82 year old male presents to the ED with weakness
- BP: 84/70 HR: 104 RR: 24 Temp: 36.2 ^{O}C
- O2 sats 78% on RA, 91% on High Flow Oxygen.

Case #2

Case #2


Would you give this patient IV fluids for his hypotension??
TransThora
PA 4-2
MI 1.2
TIS 1.0
H2 Gn 32
232dB/C5
K/2/0
30Hz 14cm
P R
1.9 3.8
84
BPM

Case #2



Patient's BP: 86/68

Case #2

- After the ultrasound, patient was given a fluid bolus.

- After 500cc of fluid:
  - BP: 100/70 HR: 98 RR:20 Temp: 38.2°C
  - Pneumonia treatment was initiated.

Focused Assessment Sonography in Trauma (FAST)

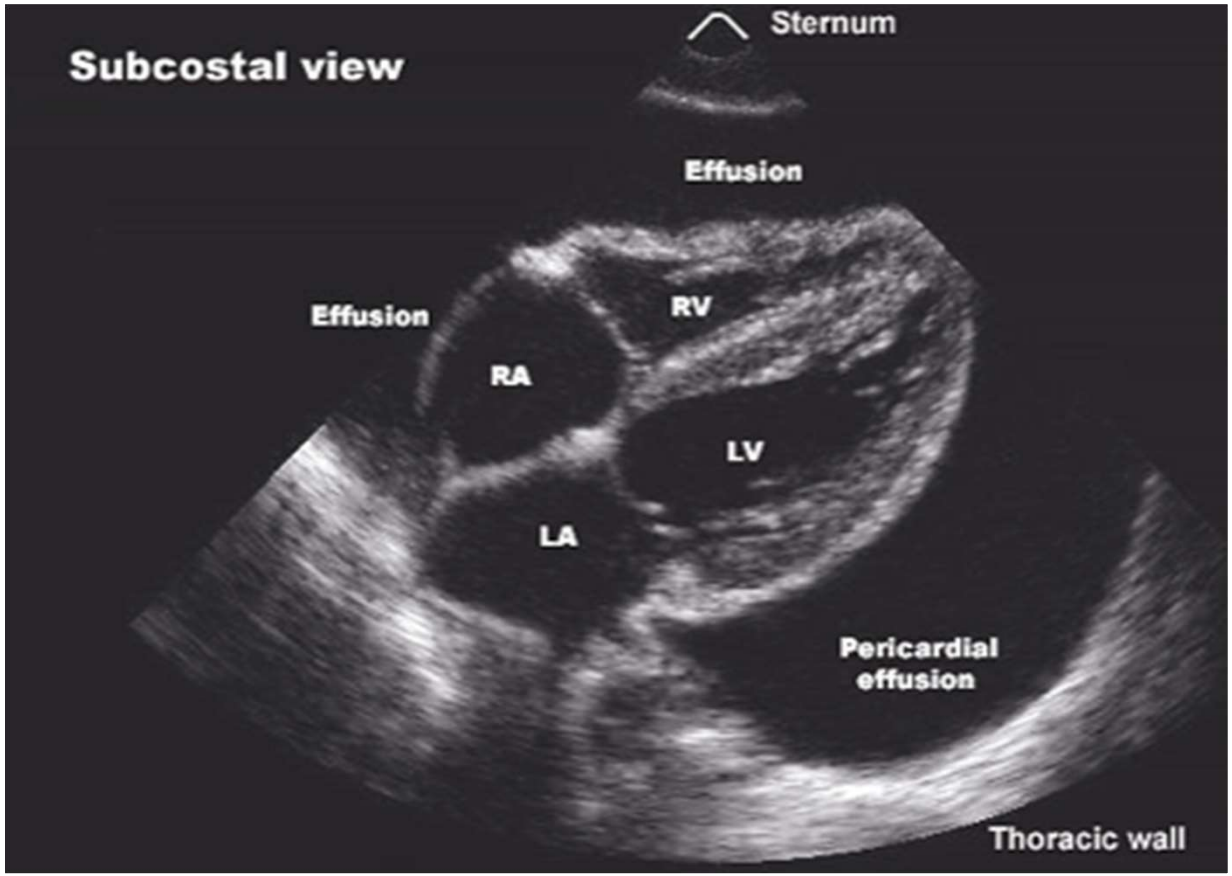
- Quick and can be repeated
- Look for free intraperitoneal fluid

A negative FAST exam does **NOT** rule out throacoabdominal injury, free fluid or a pneumothorax!! It is just used for **screening**!!

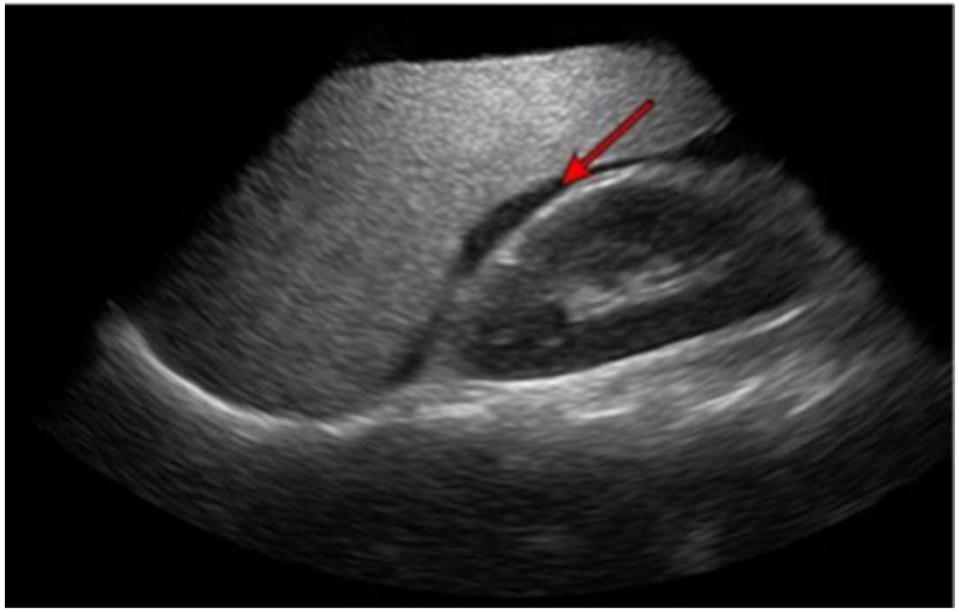
FAST

- Image Acquisition
  - Low frequency probe, usually the curvilinear probe.
  - Four views:
    - Pericardial
    - Hepatorenal
    - Splenorenal
    - Rectovesicular

FAST – Pericardial

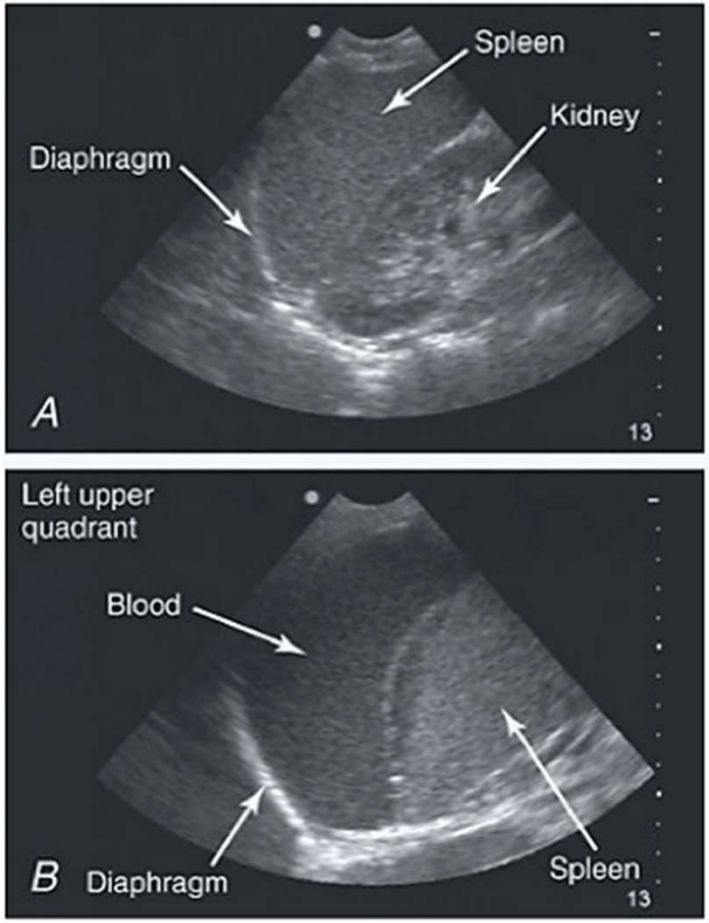


FAST – Hepatorenal

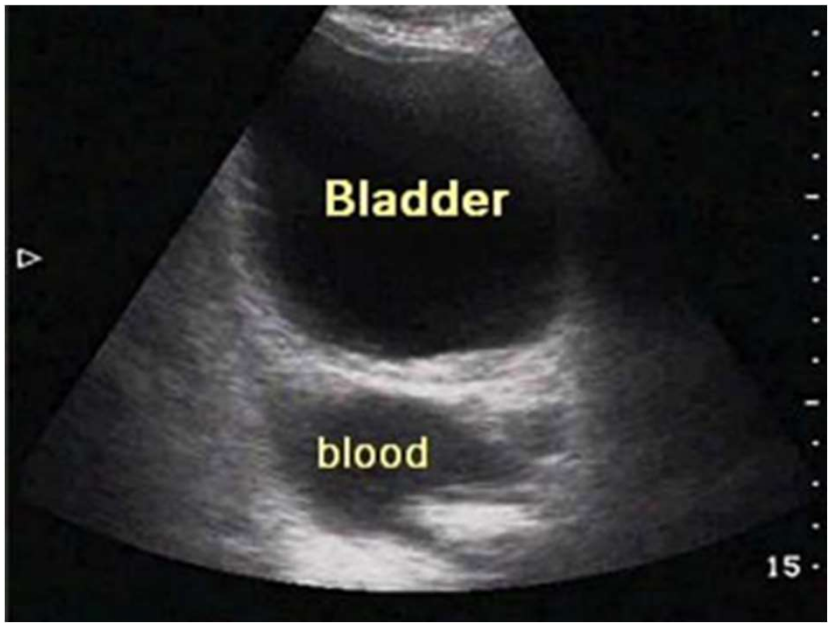


Morison's pouch

FAST – Splenorenal



FAST – Rectovesicular



Lung Ultrasound

- Can assess for:
  - Pulmonary edema
  - Consolidation/pneumonia
  - Pleural effusions
  - Pneumothorax

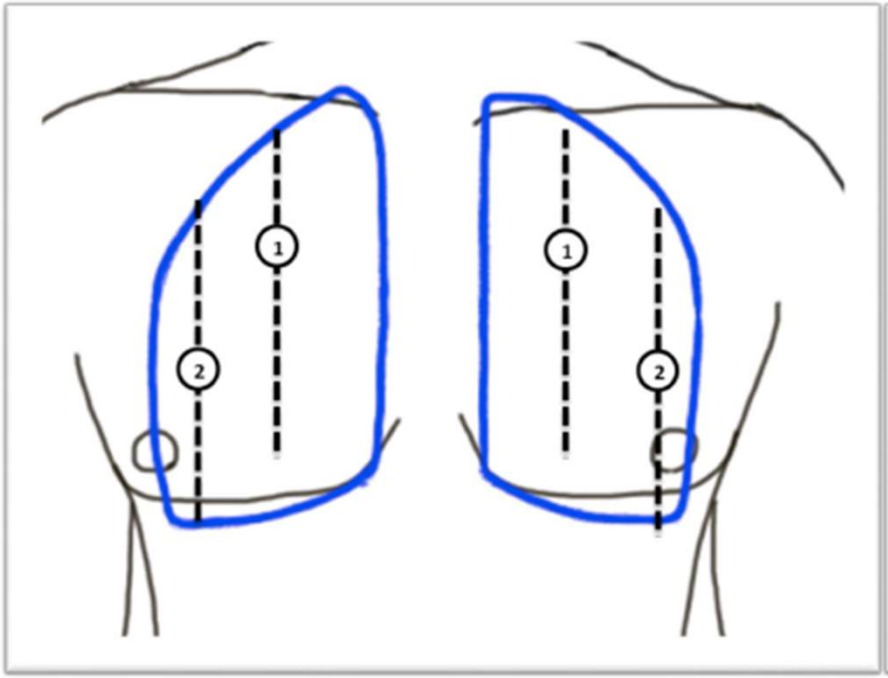
	CXR (sensitivity)	US (sensitivity)
Pulmonary edema	56.9%	85-92%
Pneumonia	38-64%	85-96%
Pneumothorax	39-50%	78-90%

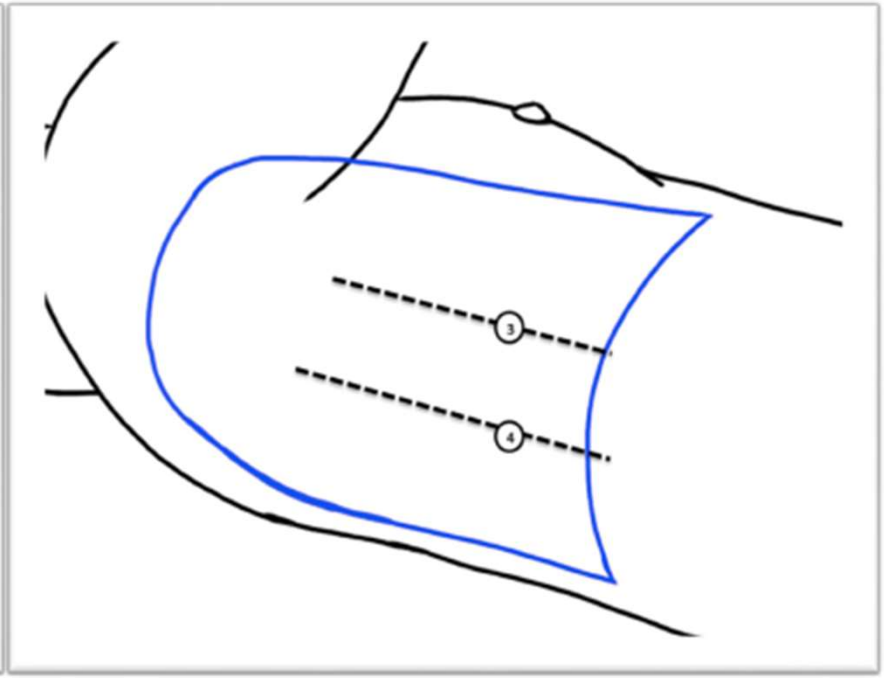
In a study, lung ultrasound provided the correct diagnosis in **90.5% cases of acute respiratory failure.

Chest. 2008 Jul;134(1):117-25. doi: 10.1378/chest.07-2800.

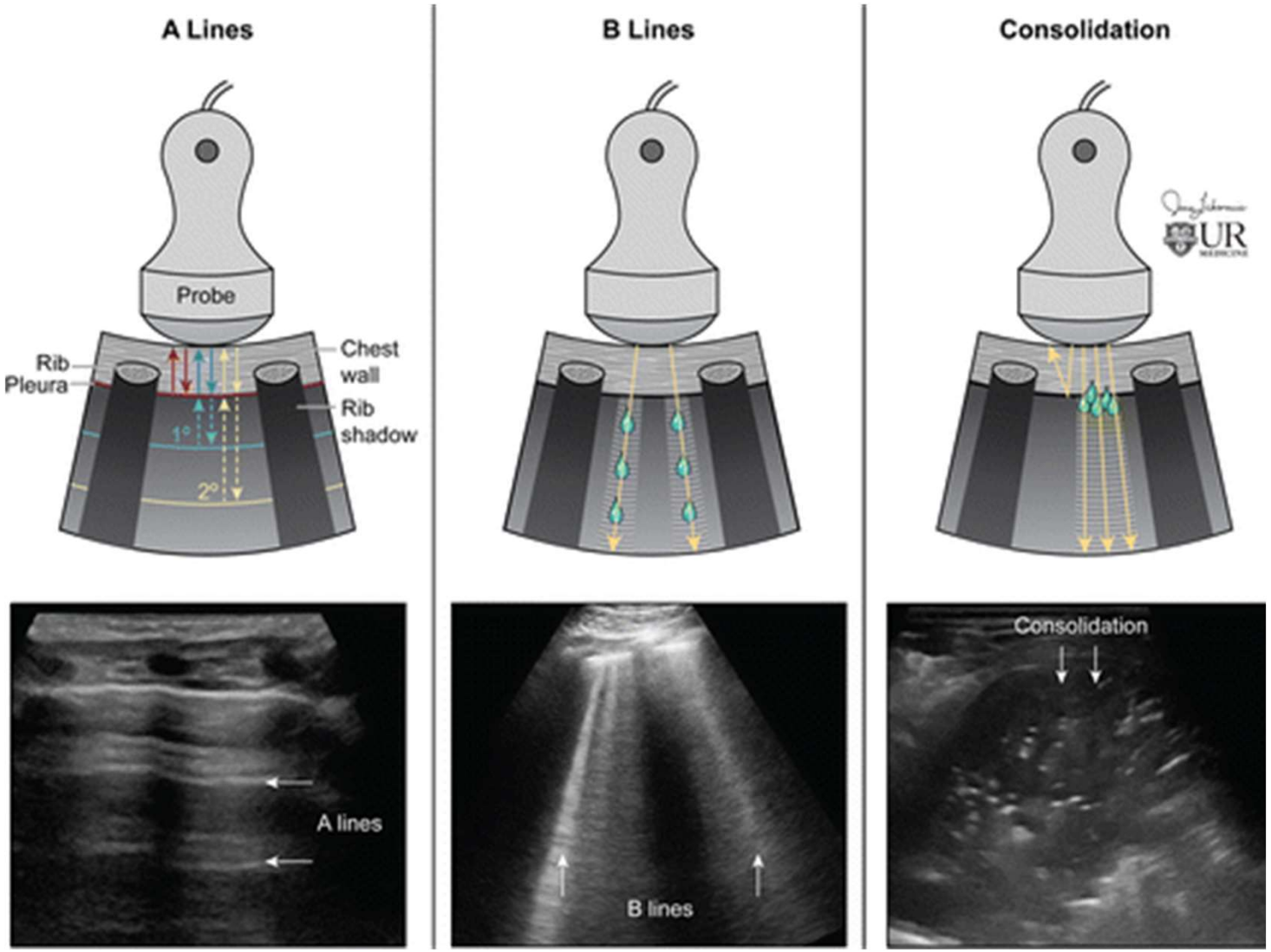
BLUE Protocol

BLUE (Bedside Lung Ultrasound in Emergency) Protocol Exam Points:





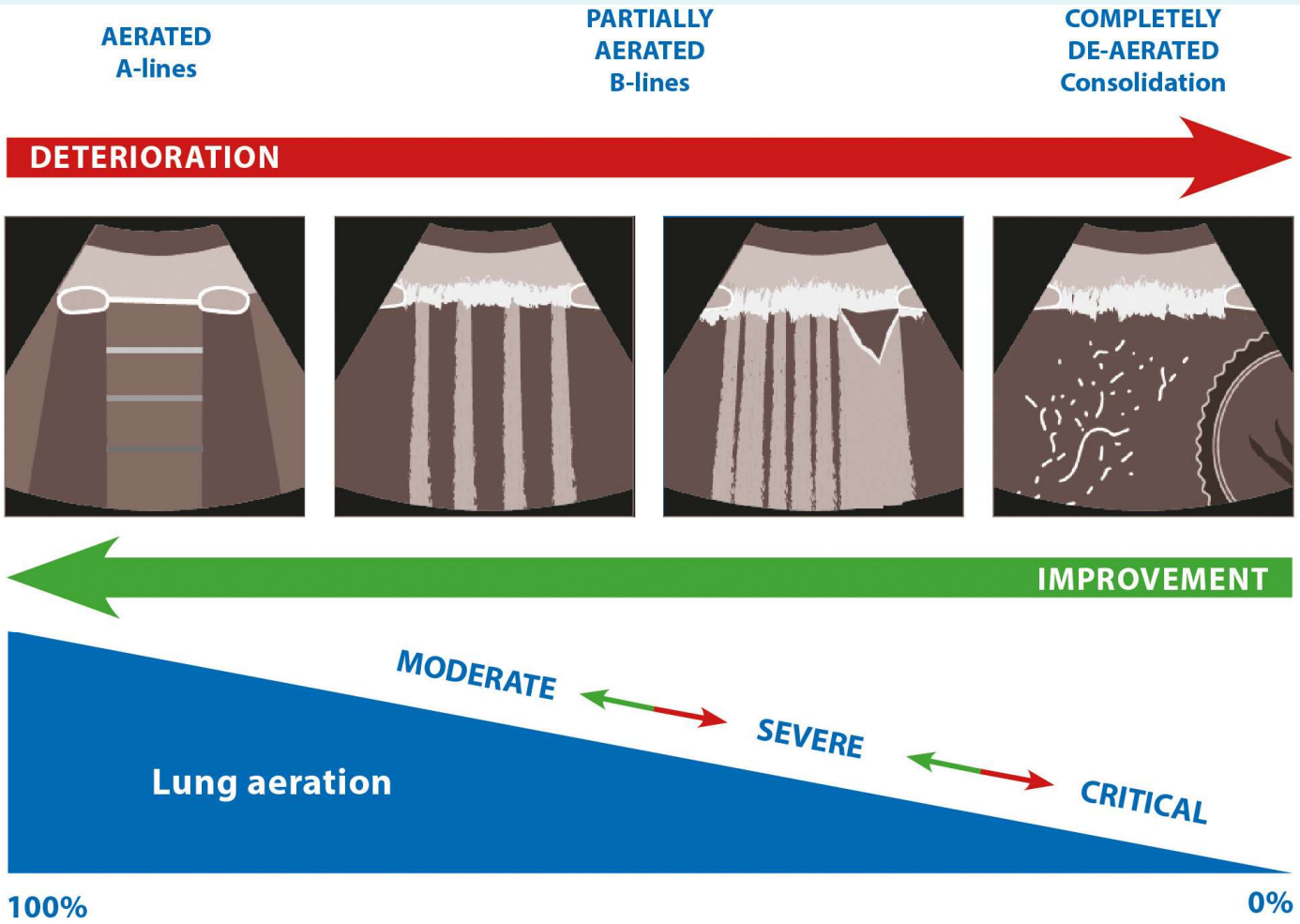
1. 2nd intercostal space, mid-clavicular line
2. 5th IC space, anterior axillary line
3. Level of diaphragm, axillary line
4. Level of diaphragm, posterior axillary line



"**A line**" artifact is seen in air filled lungs (reverberation artifact in **normal** lungs)

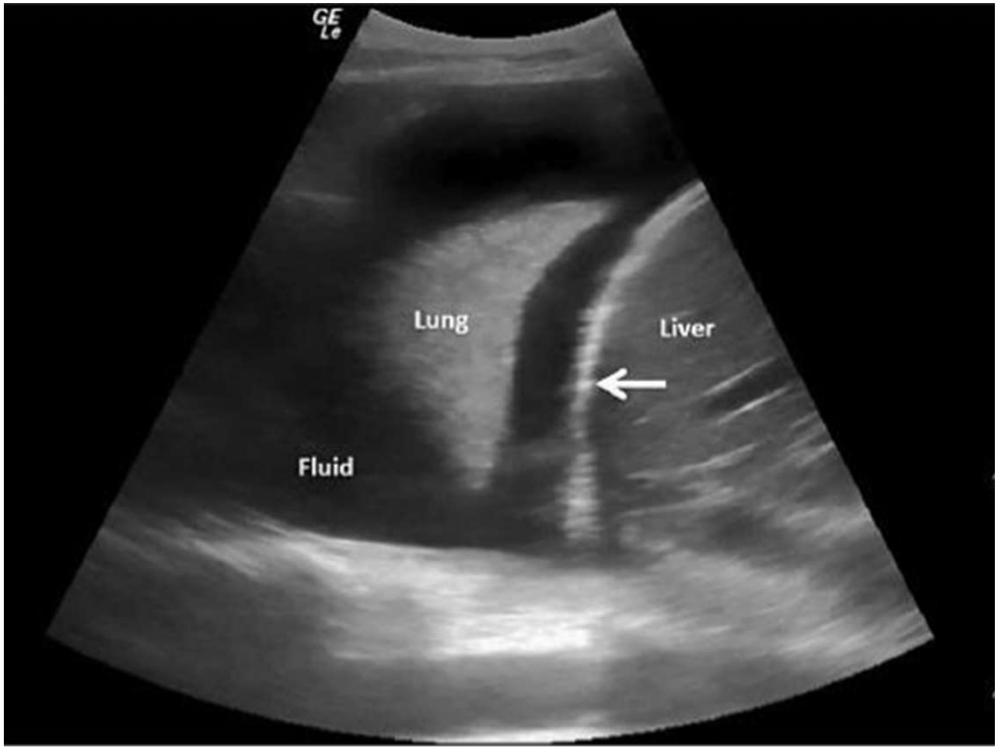
"**B Lines**" = abnormal findings with increased lung density (2/2 edema, pus, hemorrhage, etc)

Lung Ultrasound: The Essentials.Radiology: Cardiothoracic Imaging 2021 3:2https://doi.org/10.1148/ryct.2021200564



Anaesthesia, 75: 1096-1104. https://doi.org/10.1111/anae.15082

Lung Ultrasound



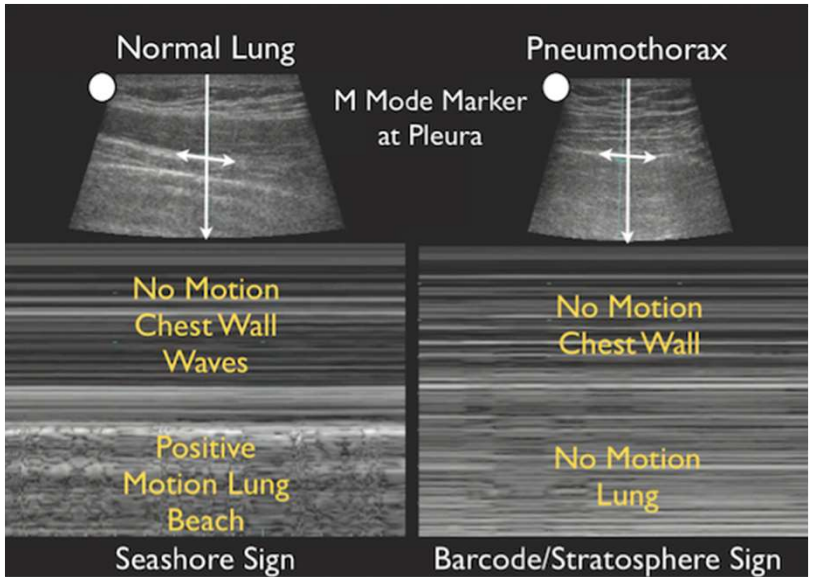
Pleural Effusion

Lung Ultrasound

"B Lines" = Pulmonary Edema

Pneumothorax

- Midclavicular, longitudinal
- Find the pleura between two ribs
  - Lung sliding = normal (rules out pneumothorax)
  - No sliding = Pneumo
  - "Seashore" = Normal
  - Barcode = Pneumo



Ultrasound is actually more sensitive than CXR for finding a pneumothorax!

Normal Lung Sliding

Which side demonstrates a pneumothorax?

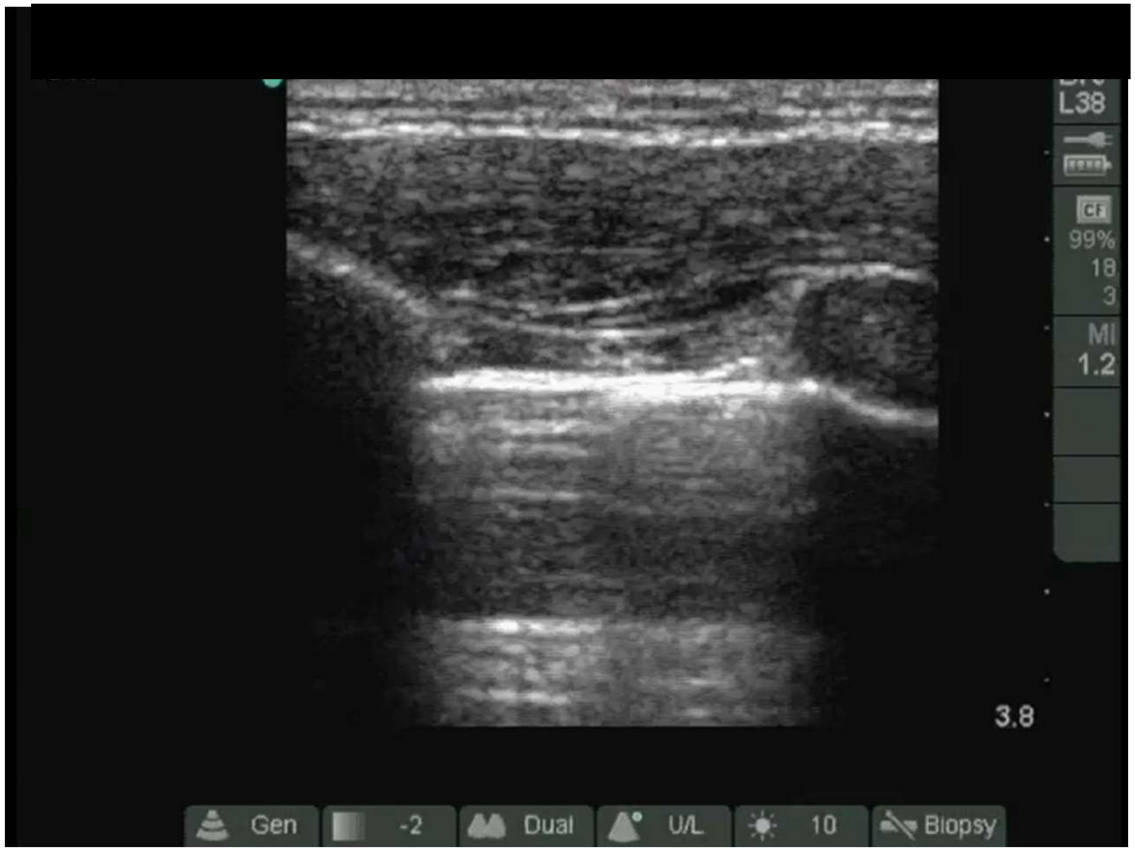
Case #3

22yo female with history of asthma, collapsed in her front yard.

- Her neighbor witnessed the event and called 911, saying "I think she must've had an asthma attack, she's turning blue!"
- **Tachycardic, hypotensive, and cyanotic** in field.
- Intubated. Has a weak, fast pulse.

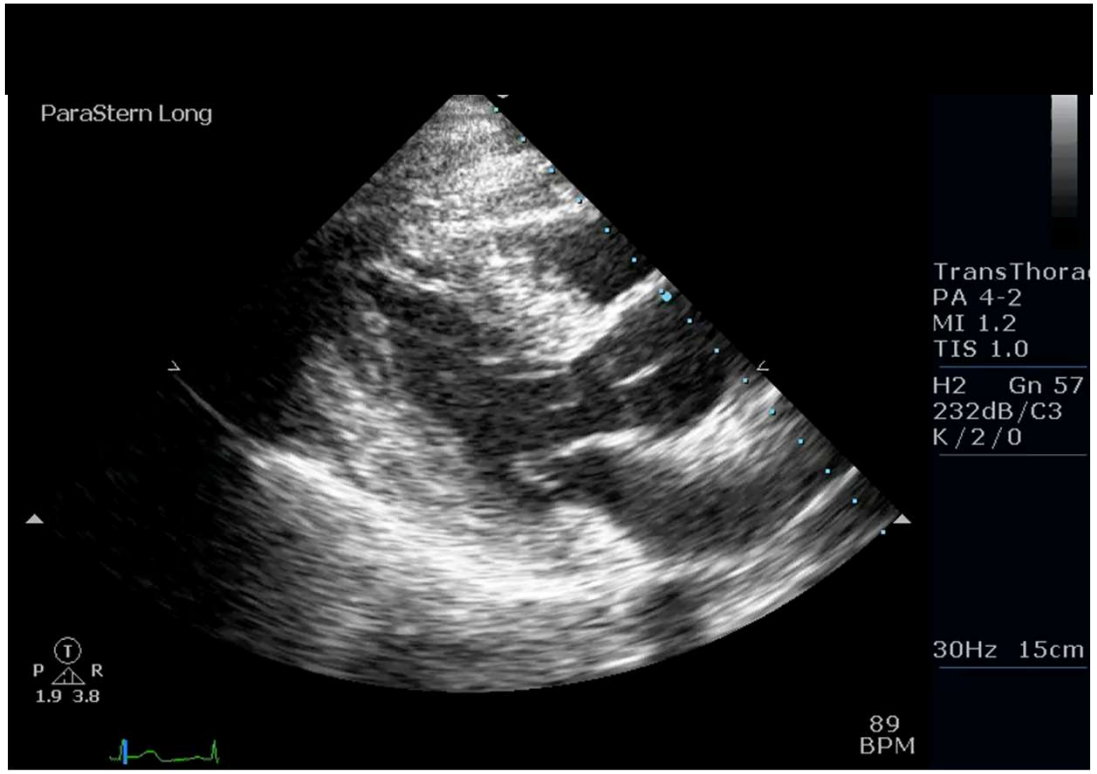
Case #3

Does she have a pneumothorax?? Pulmonary edema?



Case #3

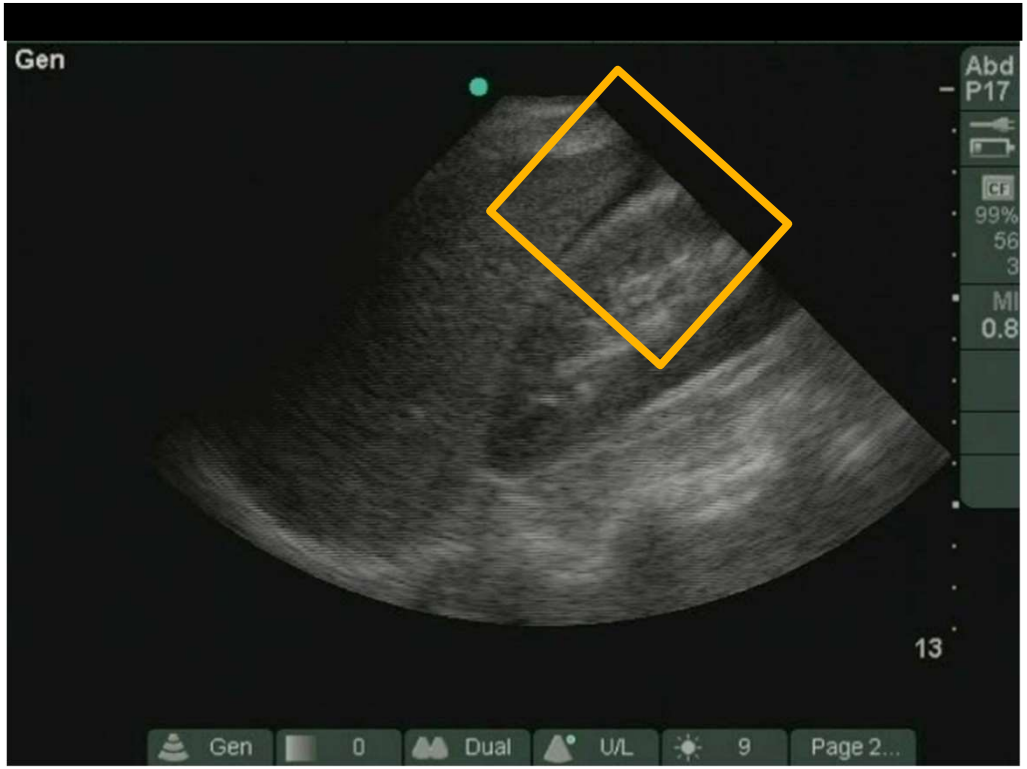
Is it her heart??



Case #3

Why is she hypotensive??

- Hepatorenal view
- Free fluid in Morison's Pouch
- Ruptured ectopic pregnancy



Case #3


14:29:52
2CV 5.0M
DVA: 100%
29Hz MI = 0.4
END VAG
GDT/PS
R12
G70
G03
5:ENDOVAG

Reminder!

If you have a patient with unexplained **hypotension**, consider:

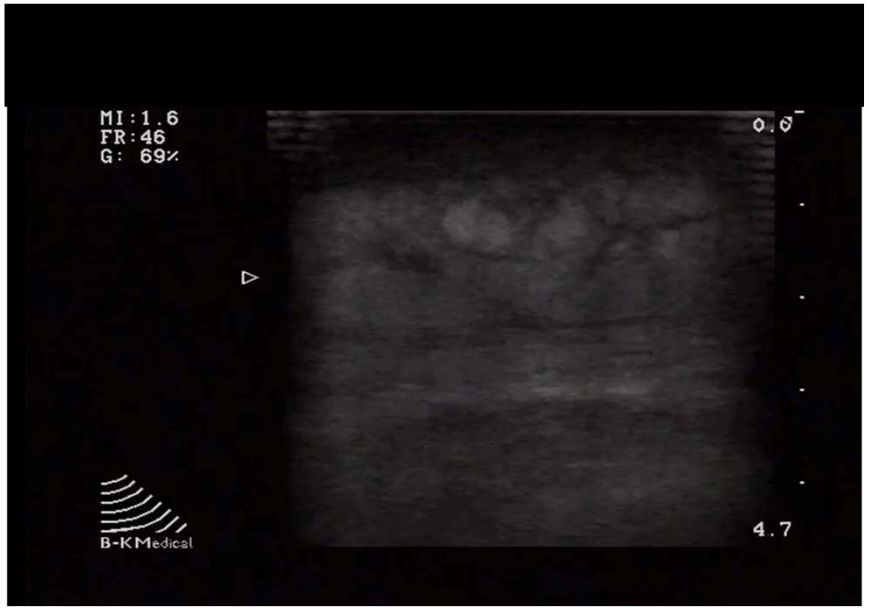
1. Is it the pump??
2. Is is the pipes?? (hypovolemia, bleeding)

How can I use this in the office?

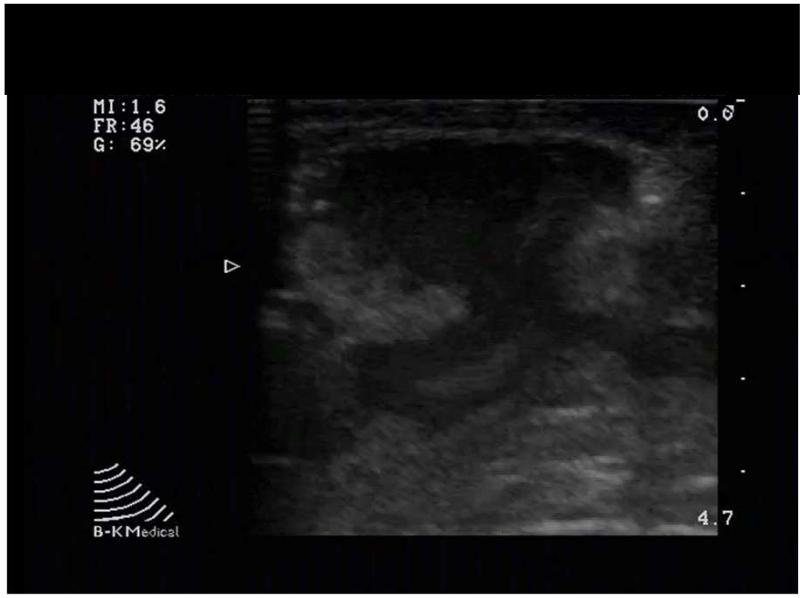
Should I do an I&D or apply heat and give antibiotics?

Cellulitis vs. Abscess?

Cellulitis

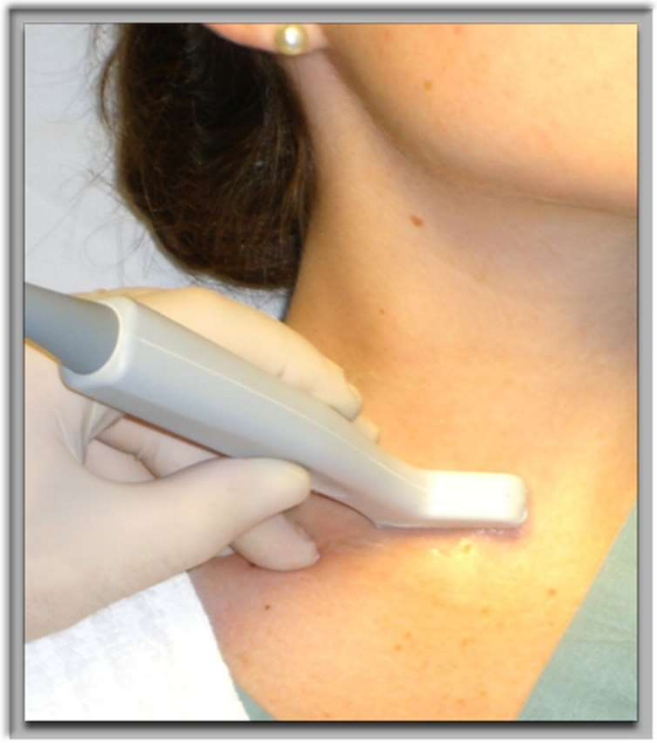


Abscess



42 yo female with nausea and RUQ pain

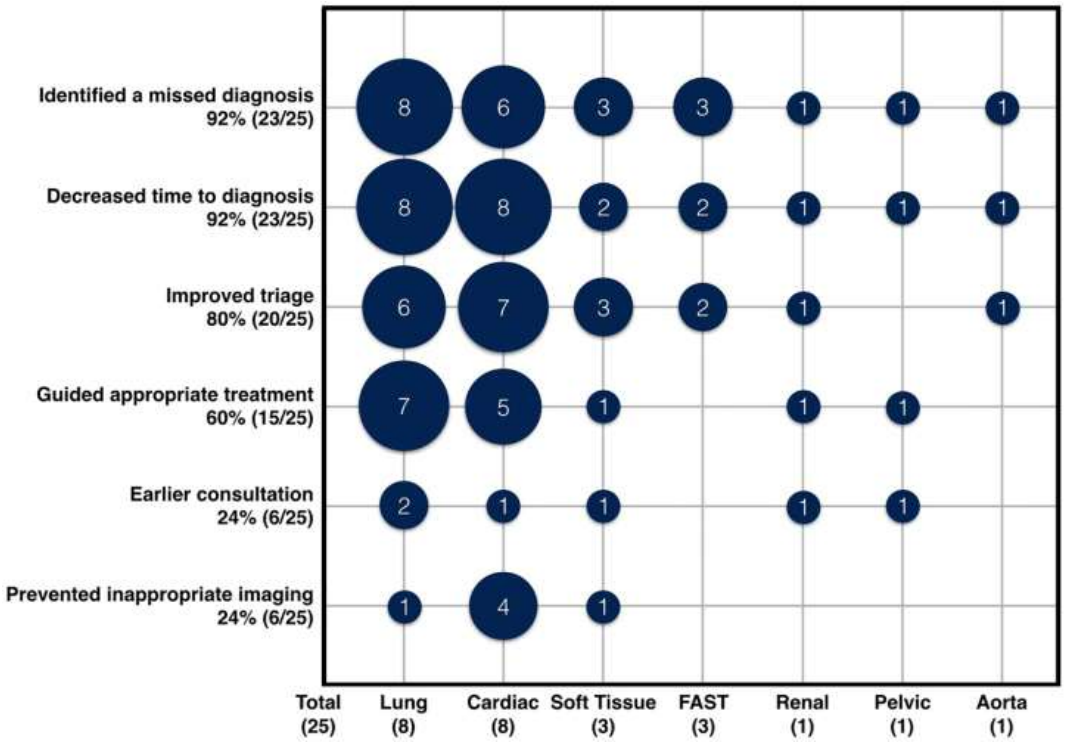
Central Line Placement



Why implement POCUS?

POCUS was felt to have the potential to reduce or prevent M&M in **45% of cases** in which it was not used.

Cardiac and lung POCUS were among the most useful applications, especially in patients with cardiopulmonary complaints and in those with abnormal vital signs.



West J Emerg Med. 2020 Oct 28;21(6):172-178. doi: 10.5811/westjem.2020.7.47486. PMID: 33207163; PMCID: PMC7673874.

POCUS in Cardiorespiratory Arrest (POCUS-CA)

In the hands of a trained clinician, allows for:

- Evaluation of the quality of compressions
- Rapid diagnosis of reversible causes of arrest with non-defibrillable rhythms (eg. Hypovolemia, PE, Tamponade, Pneumothorax, etc).
- Monitoring of response to treatment
- Prognostic information regarding the possibility of ROSC and survival

Ultrasound J **13**, 46 (2021). https://doi.org/10.1186/s13089-021-00248-0

Point of Care Ultrasound improves clinical outcomes in patients with acute onset dyspnea

A systematic review and meta-analysis including 8 randomized controlled trials and 6 observational studies (5393 patients)

Reduces **time to diagnosis**
(MD **-63 min**; 95% CI, -115 to -11 min)

Reduces **time to treatment**
(MD **-27 min**; 95% CI -43 to -11 min)

Decreases **length of stay** in the Intensive Care Unit
(MD **-1.27 days**; -1.94 to - 0.61 days)

Improve the **rate of appropriate treatment**
(OR **2.31**; 95% CI, 1.61-3.32)

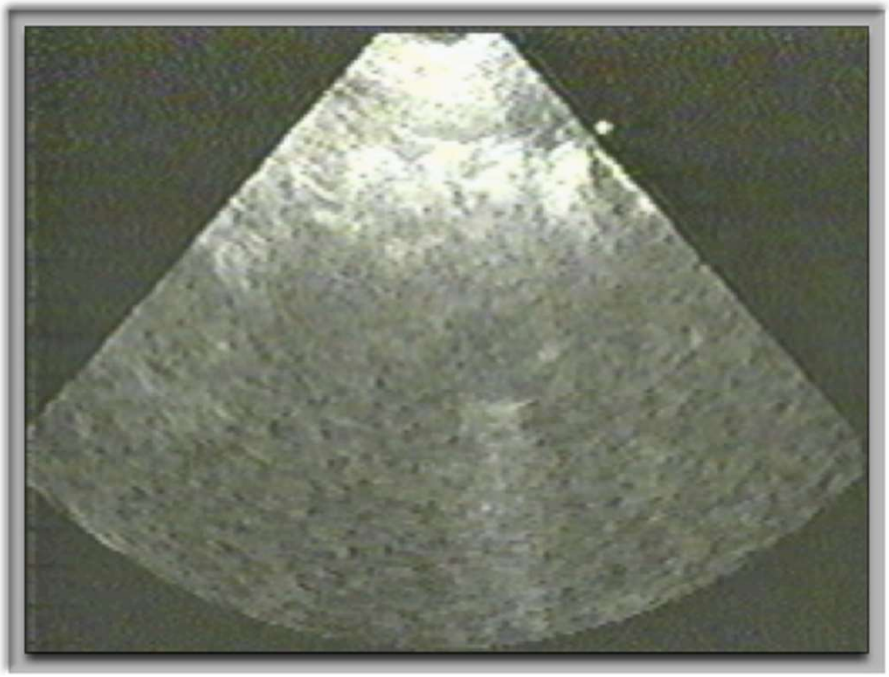
Intern Emerg Med **18**, 639–653 (2023). https://doi.org/10.1007/s11739-022-03126-2

How am I going to learn to ultrasound?!?

Keep it simple!

Typical Learning Curve

Step #1:
Snow storm



Typical Learning Curve

Step #2:
"I see gallstones!!"

Typical Learning Curve

Step #3:

"This is exciting! What else can I do with this?!"

Lessons for Practice

- PRACTICE ultrasound as much as possible!
- Don't interpret something you are not sure of.
- The more you scan, the better you will get! ☺

Questions??

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