HOCUS POCUS: Introduction to Point of Care Ultrasound

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Disclosures

- I have no relevant relationships with ineligible companies* to disclose within the past 24 months.

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Objectives

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

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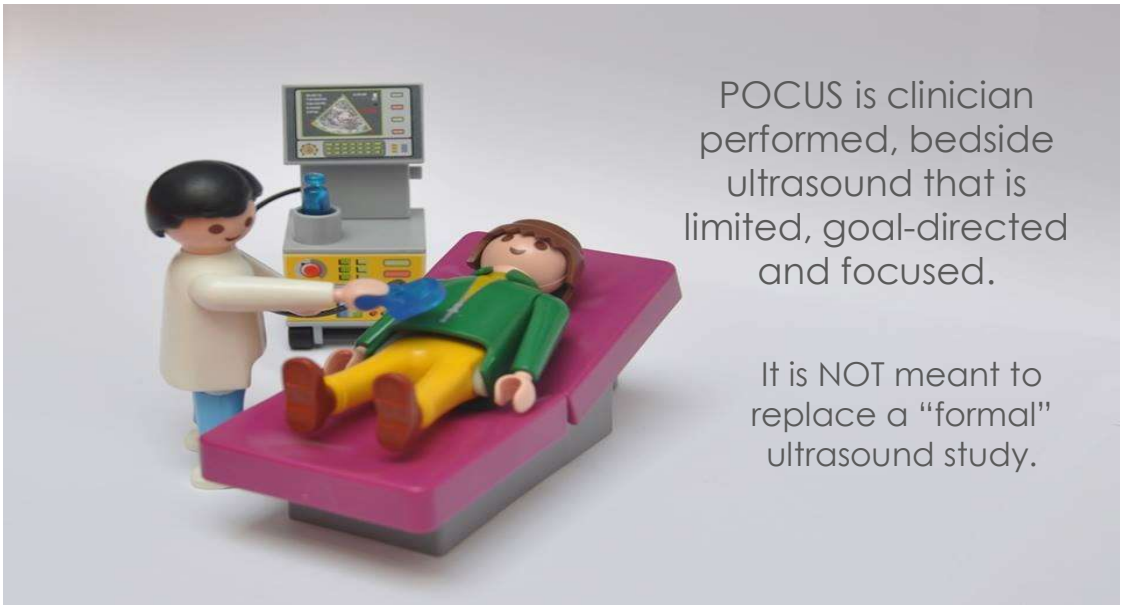
Point-Of-Care Ultrasound (POCUS)



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

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

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Why should I learn ultrasound?

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

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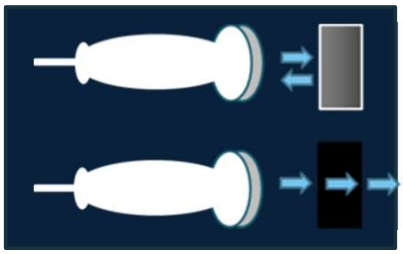
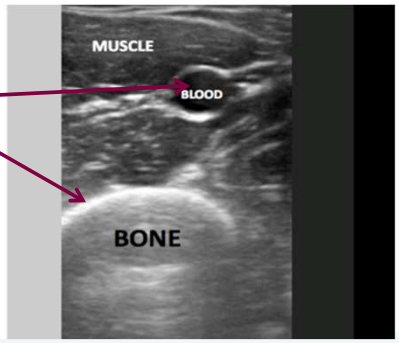
Basics of Ultrasound

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



- Returning hyperechoic signals appear white
- Anechoic appears black (eg. fluid)
- Frequency ∝ resolution



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Basic "Knobology"

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

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Transducers

Linear
(high frequency)
"Vascular"

Phased Array
(low frequency)
"Cardiac"

Curvilinear
(low frequency)
"Abdominal"

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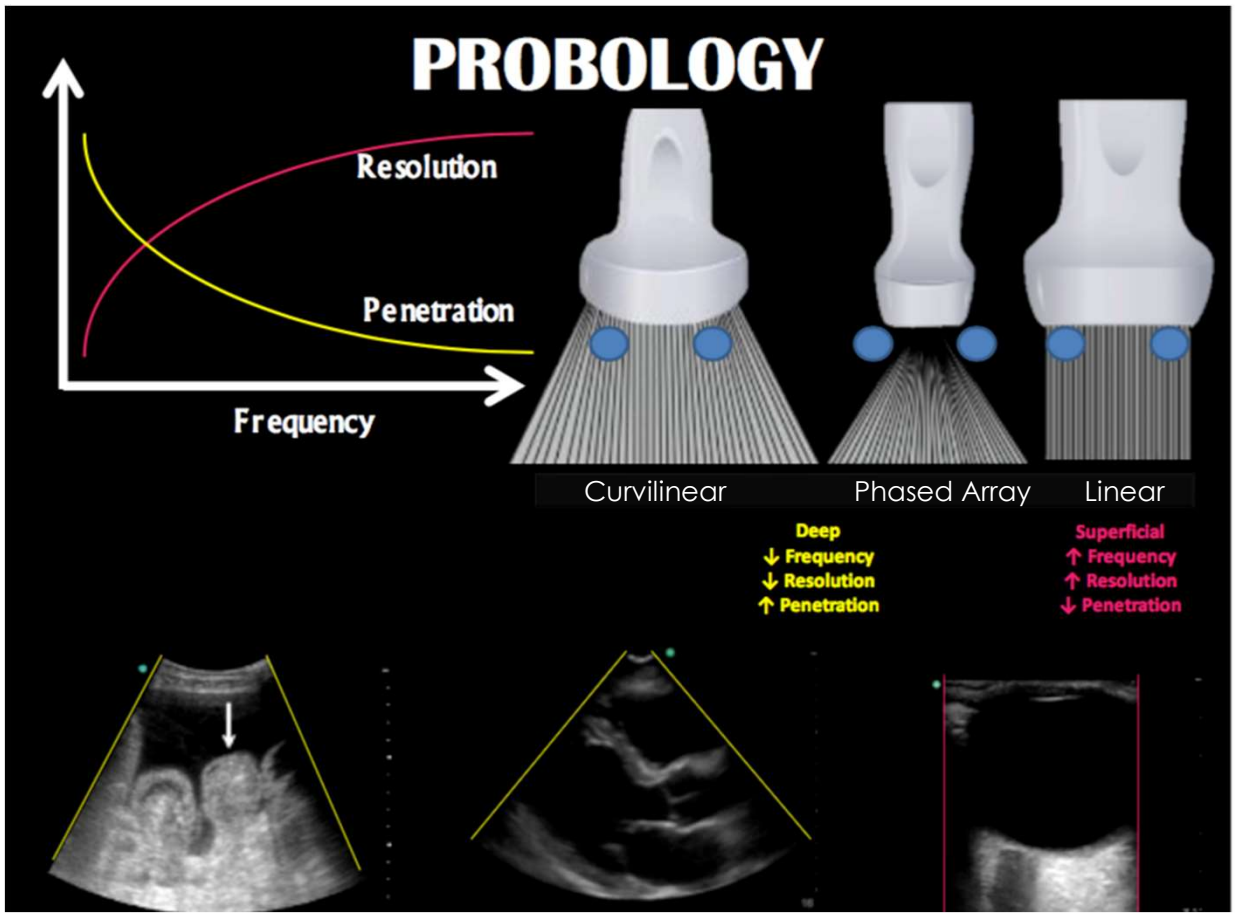
PROBOLOGY
Resolution
Penetration
Frequency
Curvilinear
Phased Array
Linear
Deep
↓ Frequency
↓ Resolution
↑ Penetration
Superficial
↑ Frequency
↑ Resolution
↓ Penetration

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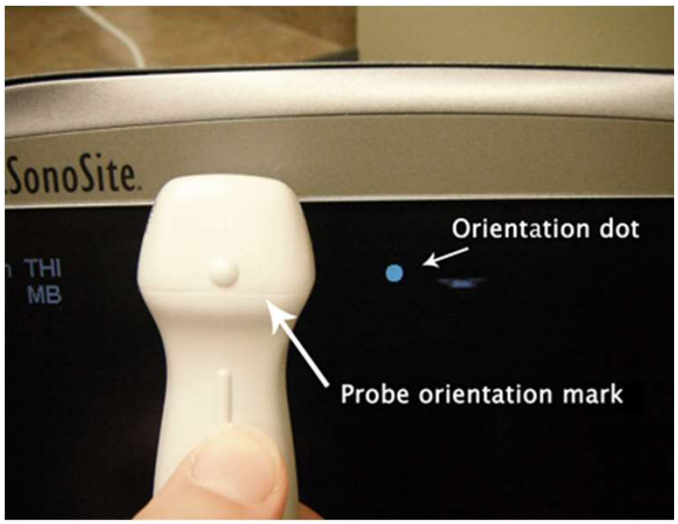
Indicator!



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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

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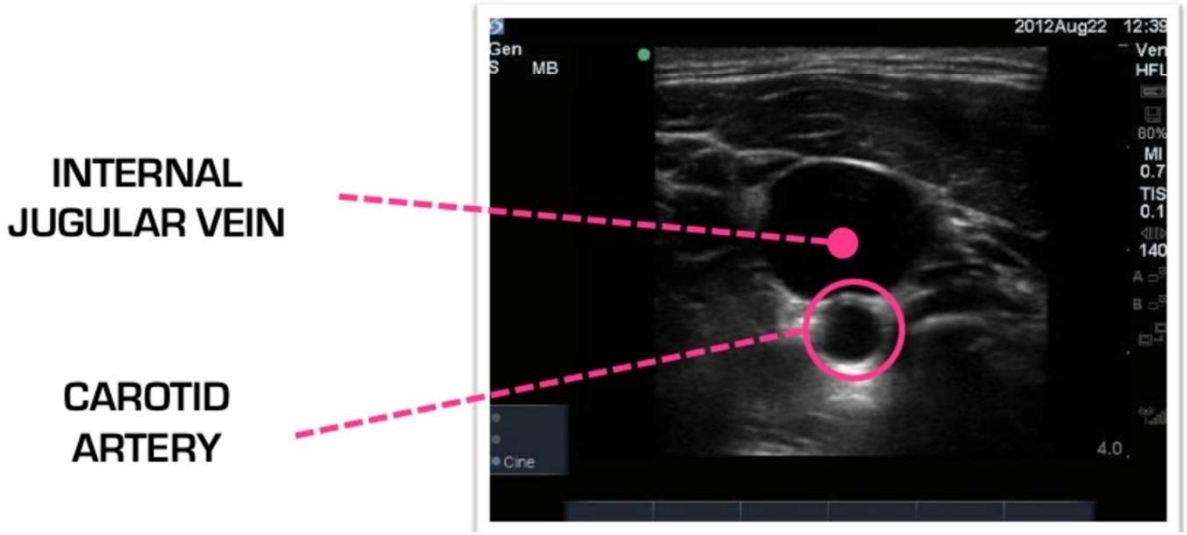
UNDERSTANDING THE IMAGE

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.



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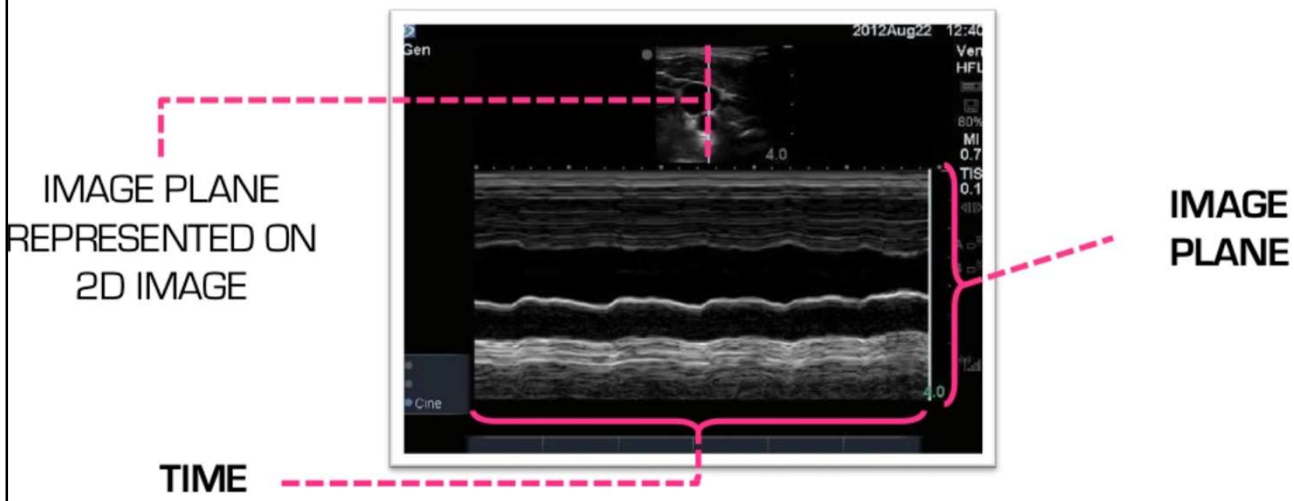
UNDERSTANDING THE IMAGE

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.



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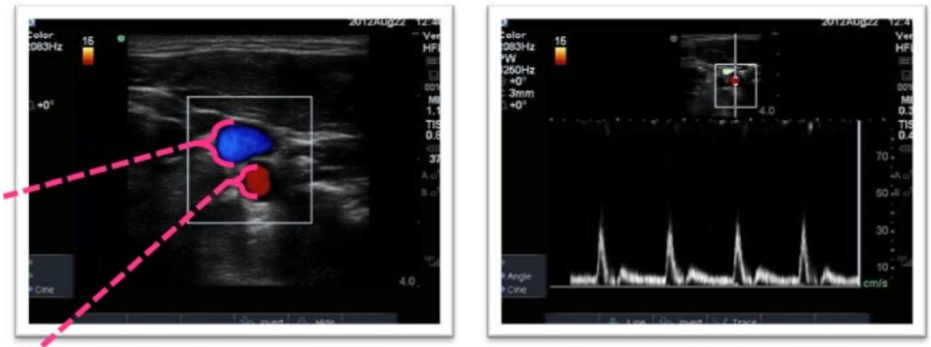
UNDERSTANDING THE IMAGE

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.

"BART" -Blue Away, Red Towards

BLUE REPRESENTS MOTION **AWAY** FROM TRANSDUCER

RED REPRESENTS MOTION **TOWARDS** TRANSDUCER



COLOUR DOPPLER

SPECTRAL DOPPLER

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Advantages of POCUS

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

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Disadvantages of POCUS

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

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Uses for Ultrasound

- Foreign body
- Cardiac arrest
- Appendicitis
- Fractures
- Hemoperitoneum
- Testicular torsion
- Hemothorax
- Abscess
- Urinary retention
- Ovarian cyst
- Tendon rupture
- AAA
- Arthrocentesis
- Ectopic pregnancy
- Pneumothorax
- CHF
- Optic nerve
- Vascular access
- Hypotension
- Epididymitis
- Hydronephrosis
- Hypoxia
- IUP
- Bowel Obstruction
- Hernia
- Ascites
- Cellulitis
- Joint effusion
- Thyroid

There are many!!

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Most common clinical uses:

- Undifferentiated shock/hypotension
- Respiratory distress/hypoxia
- Trauma
- Cardiac arrest

- ? Impact on mortality

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Our Focus

- **Cardiac Ultrasound**
  - IVC/Fluid Assessment
- **FAST (Focused Assessment Sonography in Trauma)**
- **Lung**
- Vascular
- Potpourri!

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POCUS in Medical Emergencies

1. Use a structured approach
2. Perform quickly at the bedside
3. Limited and focused exam

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Case #1

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

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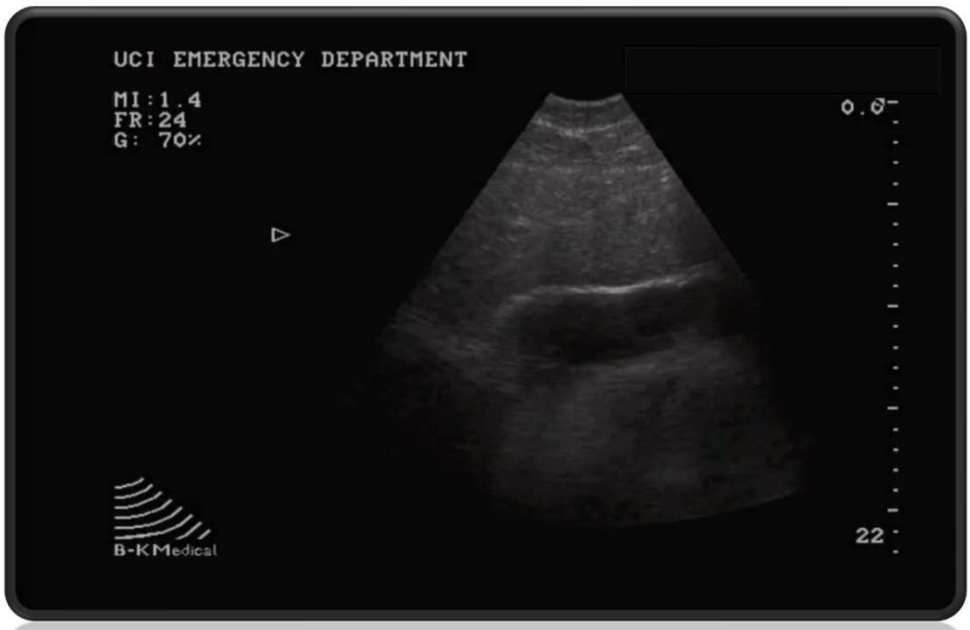
Case #1



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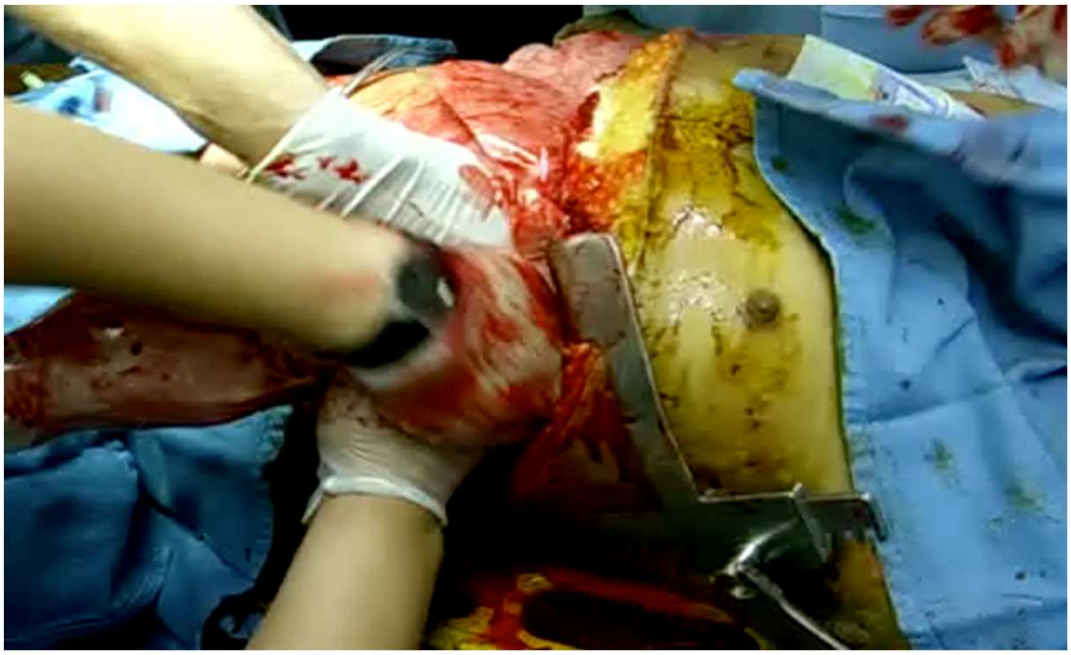
Case #1



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Cardiac Ultrasound

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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?**

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Four Views of the Heart

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

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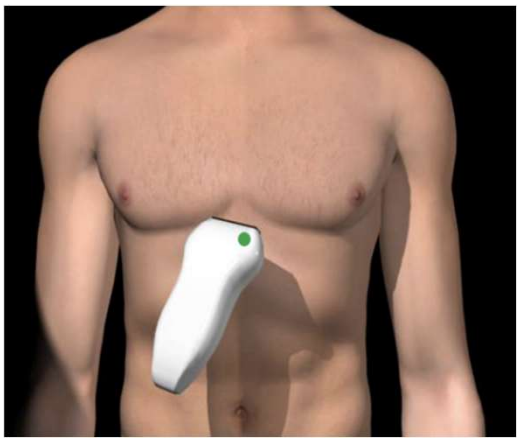
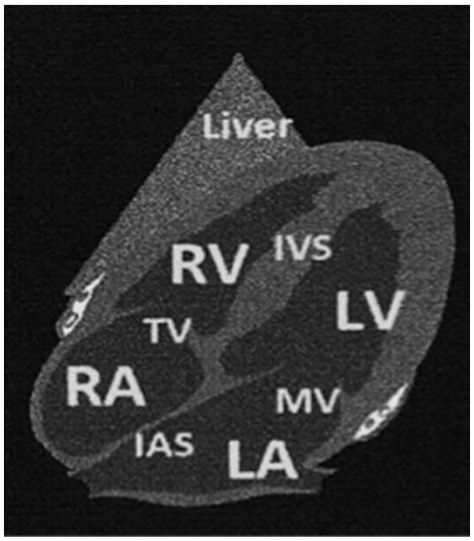
Subxiphoid View





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Subxiphoid View

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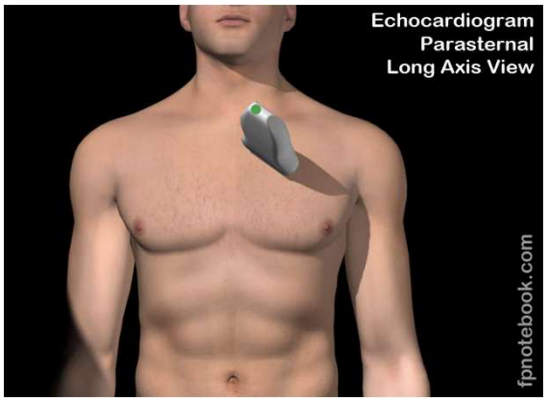
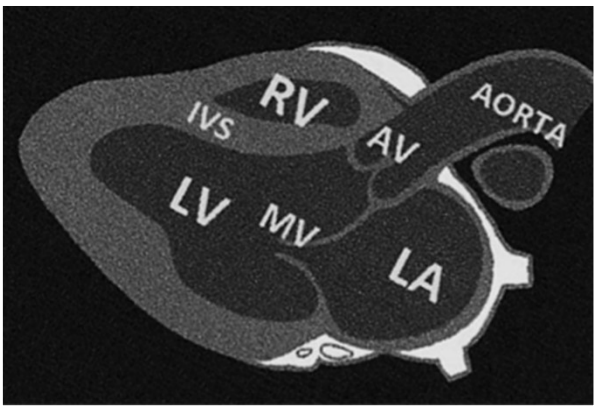
Parasternal Long View





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Parasternal Long View

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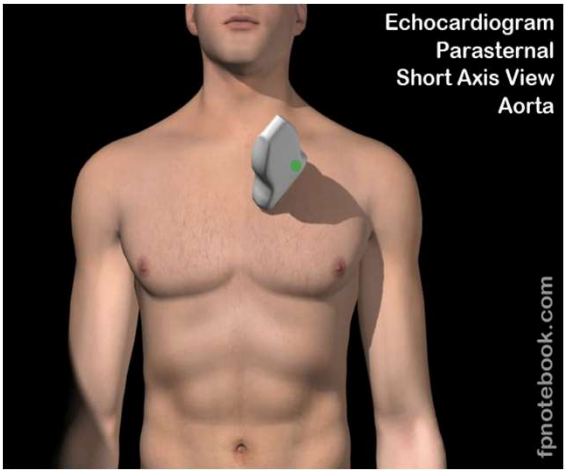
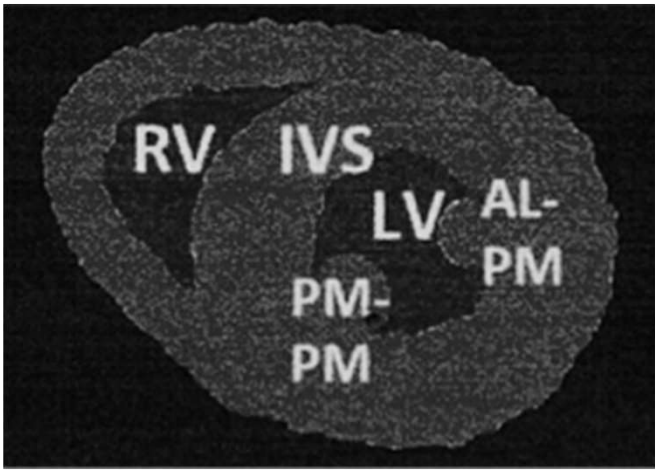
Parasternal Short View





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Parasternal Short View

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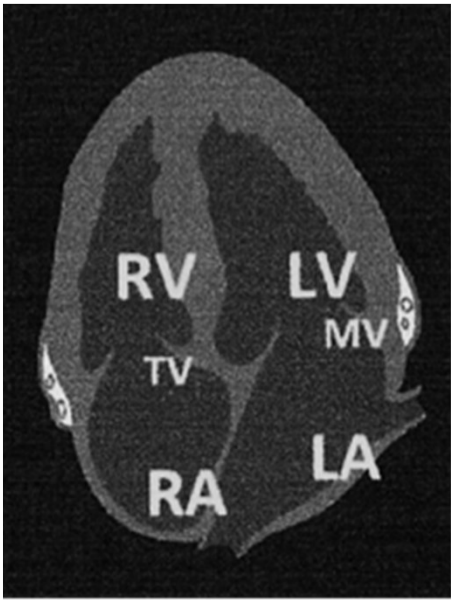
Apical (Four Chamber) View



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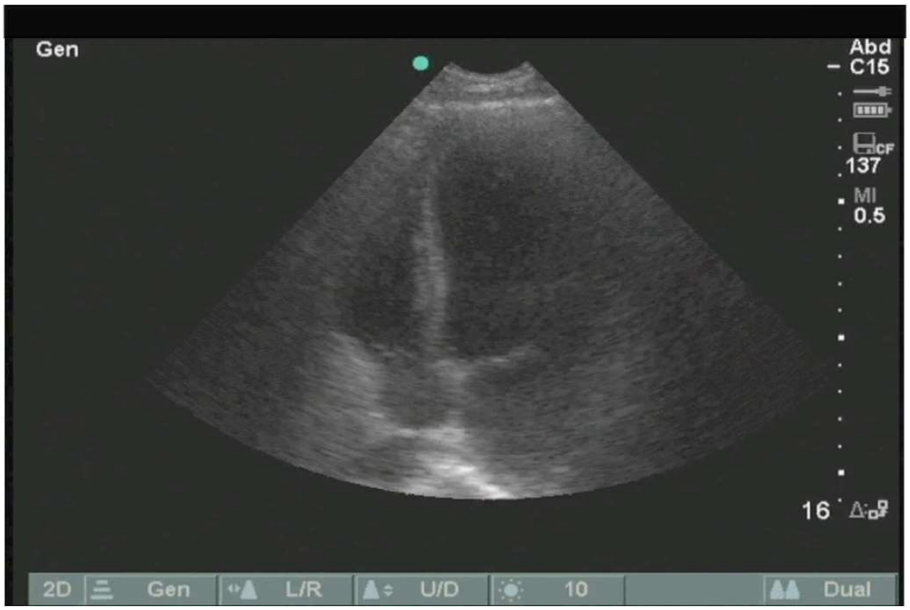

Apical (Four Chamber) View

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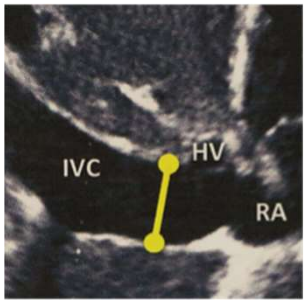
Evaluation of the IVC

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"

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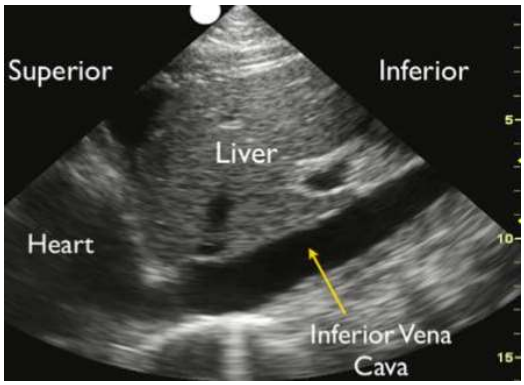
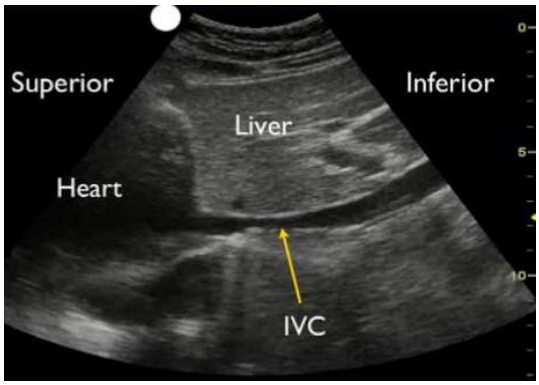
Evaluation of the IVC

Sensitivity: 63% Specificity: 73%





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

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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.

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Case #2

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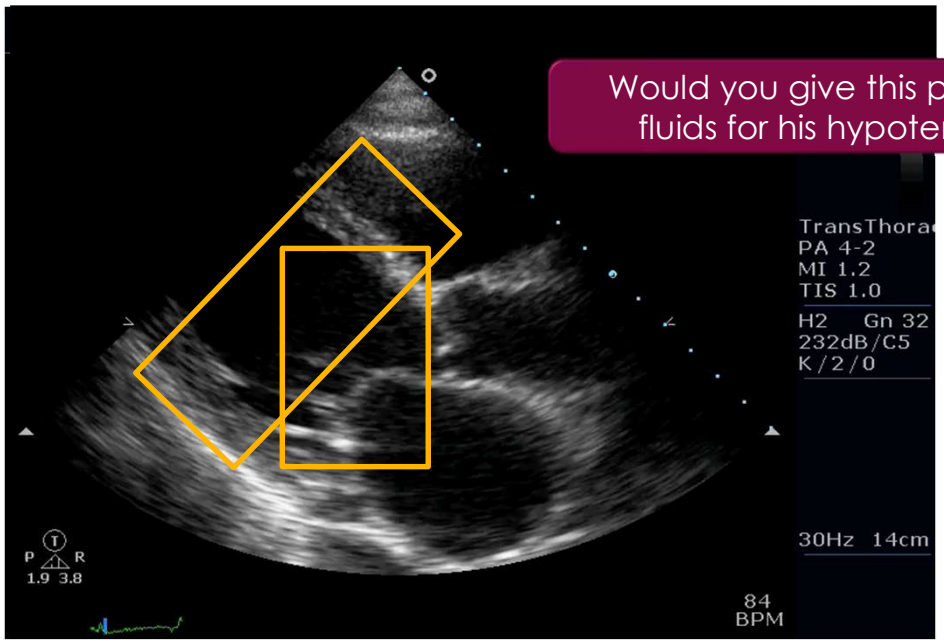
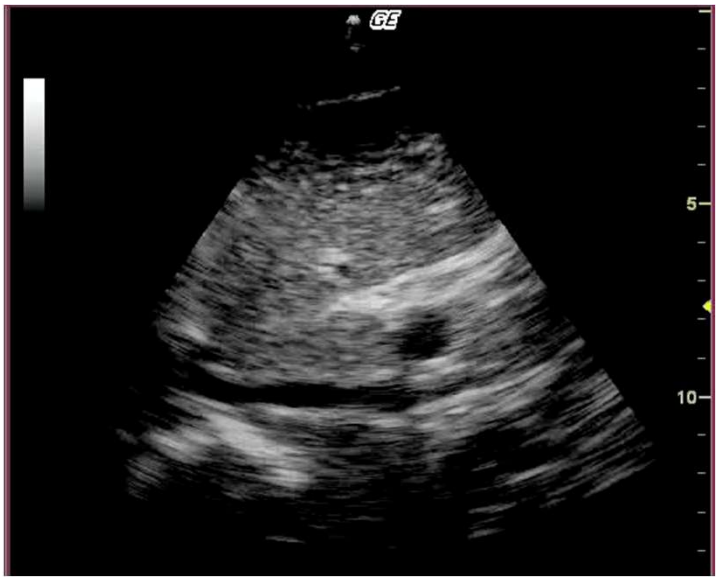
Case #2


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

39

Case #2



Patient's BP: 86/68

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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.

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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!!

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FAST

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

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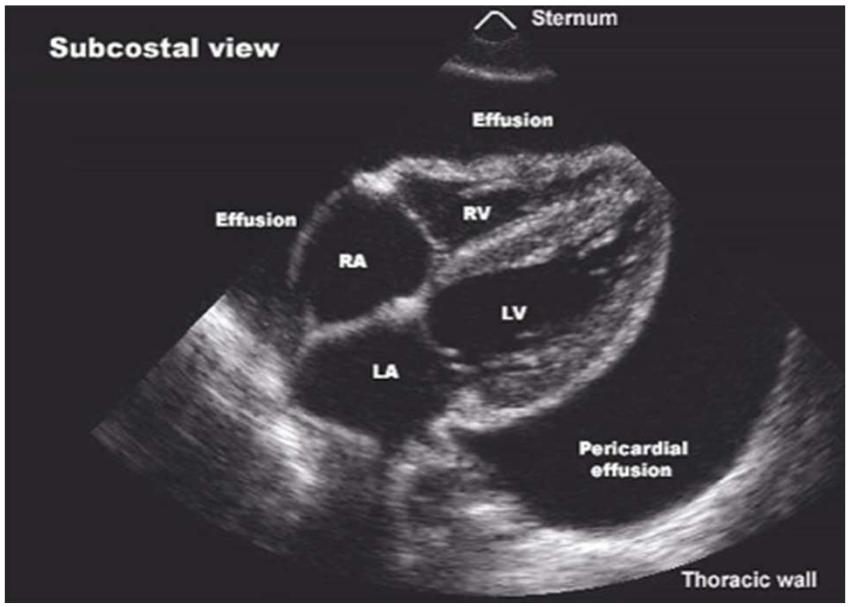
FAST – Pericardial



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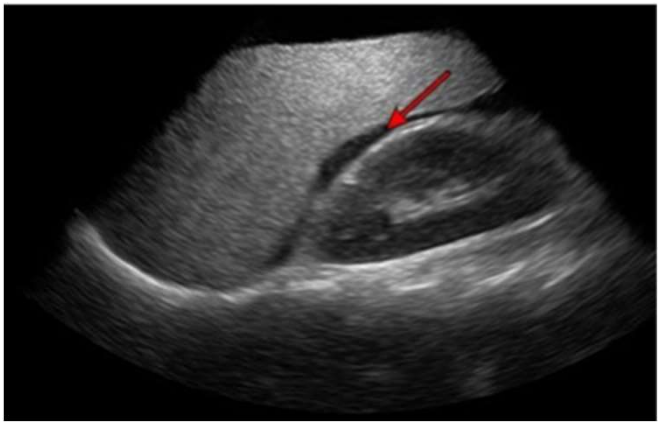
FAST – Hepatorenal



Morrison's pouch

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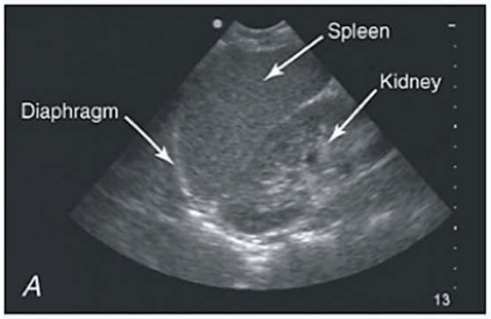
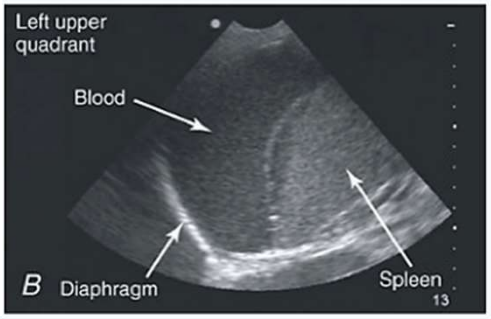
FAST – Splenorenal





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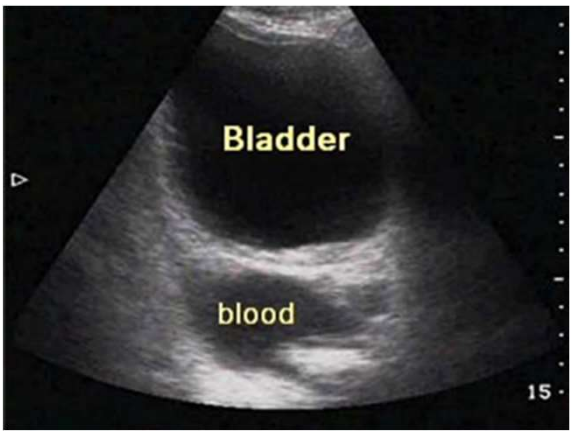
FAST – Rectovesicular



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Lung Ultrasound

- When a patient presents with shortness of breath – POCUS can help to distinguish a cardiac vs. pulmonary cause

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

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

Lung ultrasound can provide the correct diagnosis in **90.5% cases of acute respiratory failure

**Lichtenstein DA, Mezière GA.. Chest. 2008;134(1):117-125. doi:10.1378/chest.07-2800

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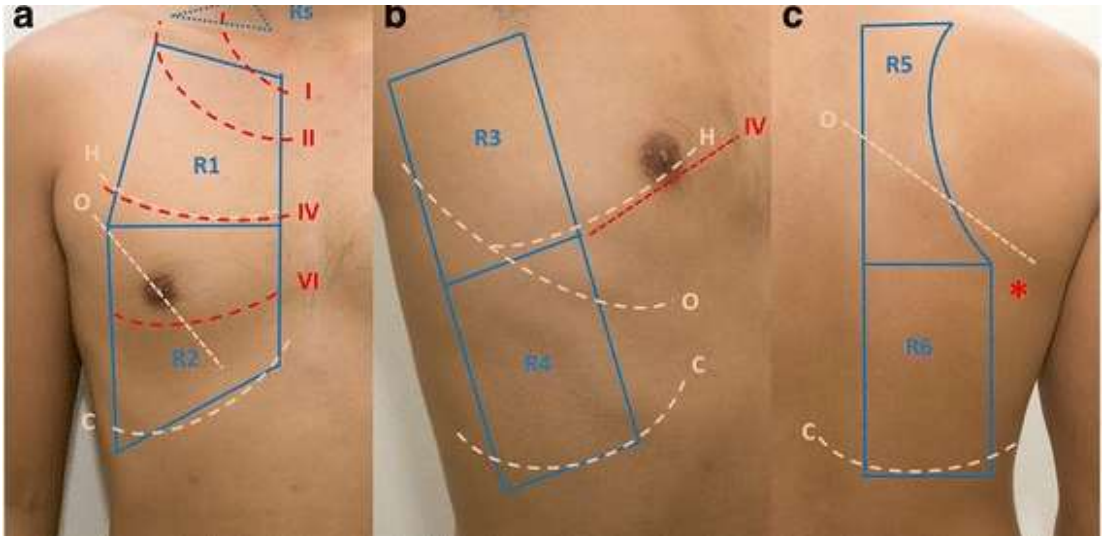
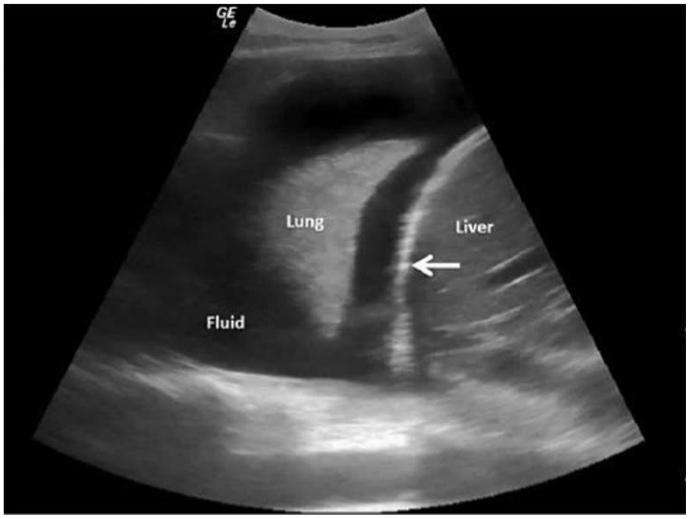
Lung Ultrasound



Lee FC. J Intensive Care. 2016 Aug 31;4(1):57. doi: 10.1186/s40560-016-0180-1

Lung Ultrasound



Pleural Effusion

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Lung Ultrasound

"B Lines" = Pulmonary Edema

vs. **A-lines** = horizontally oriented reverberation artifacts

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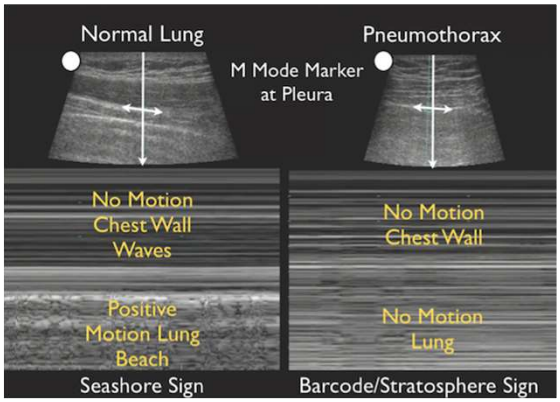
Pneumothorax

- Midclavicular, longitudinal
- Find the pleura between 2 ribs
  - Lung sliding = normal (rules out pneumothorax)
  - No sliding = Pneumothorax



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

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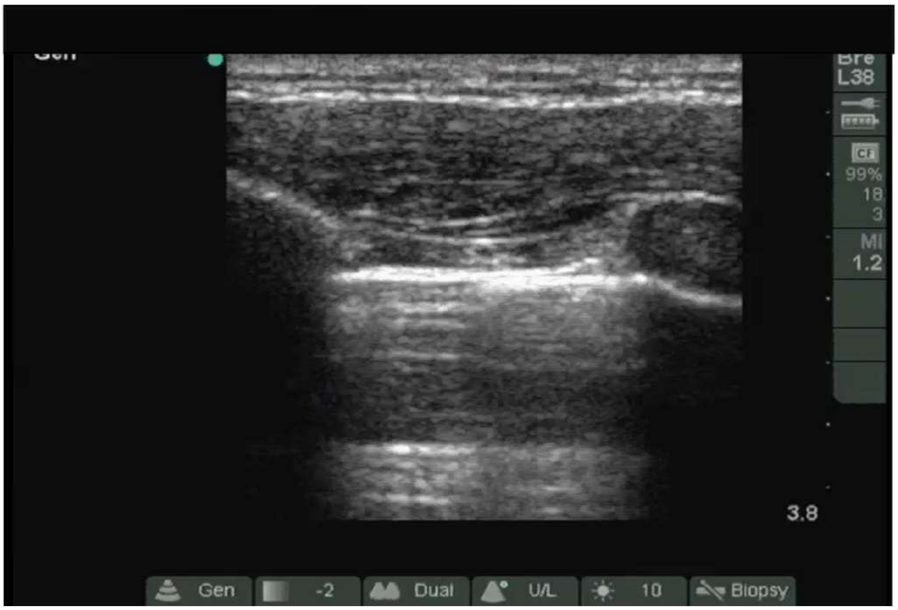
Normal Lung Sliding



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Which side demonstrates a pneumothorax?

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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.

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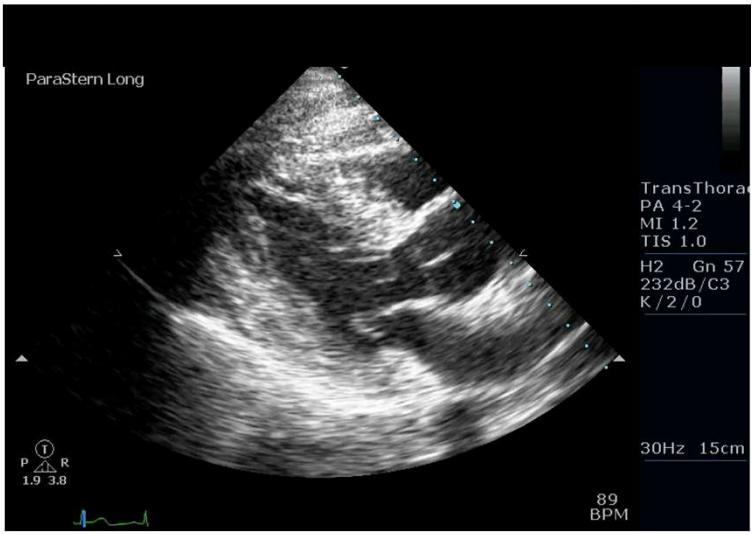
Case #3

Does she have a pneumothorax??

Case #3

Is it her heart??



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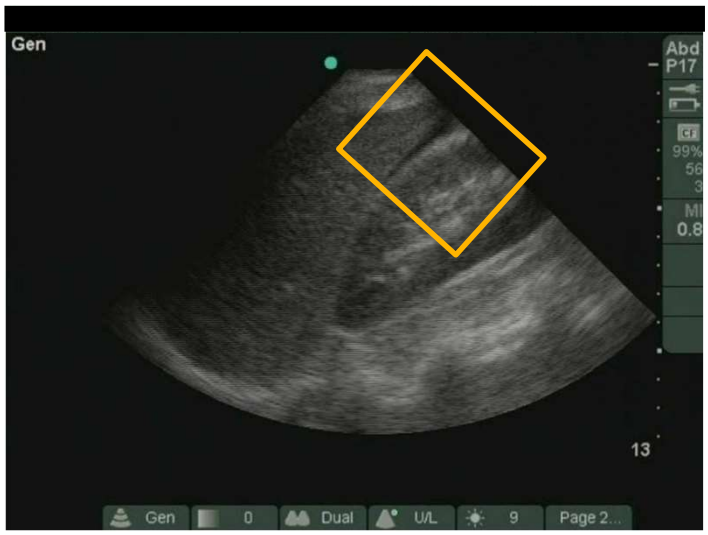
Case #3

Why is she hypotensive??

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



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Case #3


14:29:52
2CV 5.0M
DVA: 100%
29Hz MI = 0.4
END VAG
GDT/PS
R12
G70
C03
5:ENDOVAG

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POCUS for Shock

	Distributive	Cardiogenic	Hypovolemic	Obstructive
Heart	Spectrum from **hyperdynamic** to decreased left ventricular function	Decreased function/ "squeeze"	Hyperdynamic	Dilated right ventricle or pericardial effusion
IVC	Range from **collapsible** to dilated	Non-collapsible	Collapsible	Non-collapsible
Lung	Negative	B lines present	Negative	Focal or Negative
Abdomen	Negative	Negative	Evaluate for hemorrhage	Negative

Melgarejo. Point of Care Ultrasound: An Overview. American Academy of Cardiology 2017

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How can I use this in the office?

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

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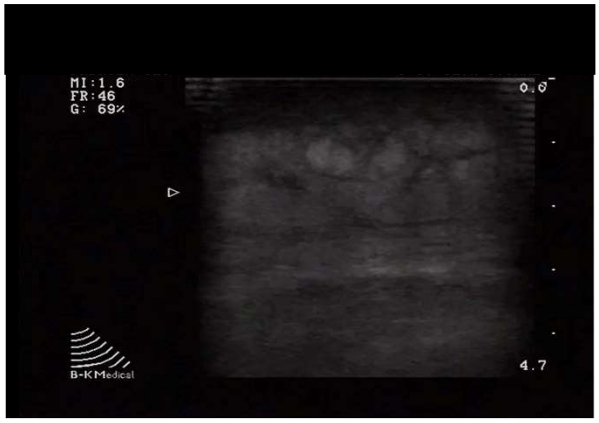
Cellulitis vs. Abscess?

Cellulitis



Abscess

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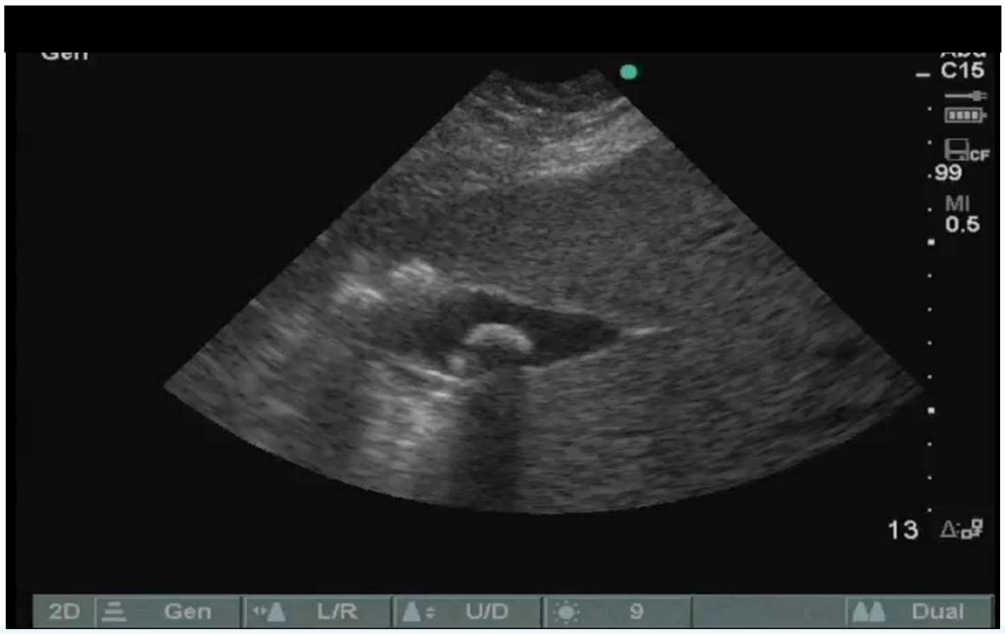
42 yo female with nausea and RUQ pain



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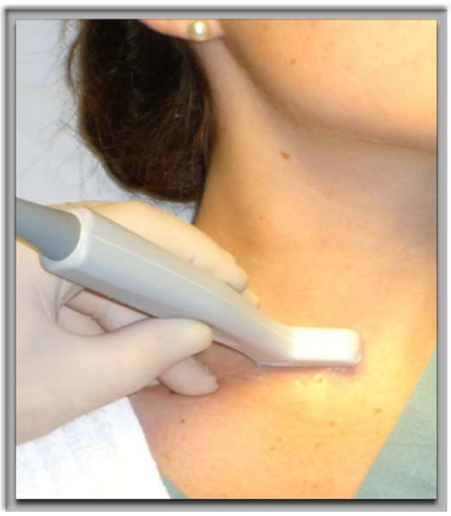
Central Line Placement



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How am I going to learn to ultrasound?!?

Keep it simple!

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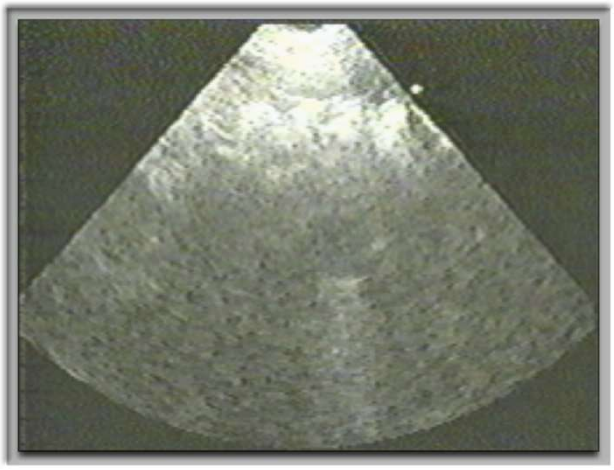
Typical Learning Curve

Step #1:
Snow storm



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Typical Learning Curve

Step #2:
"I see gallstones!!"

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Typical Learning Curve

Step #3:

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

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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! ☺

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Questions??

Anderson.Adrijana@mayo.edu

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