

THE
Point of Care
ULTRASOUND
HANDBOOK

Bowman | Boitnott | Miesemer



**The RUSH Exam:
FOAMed edition**





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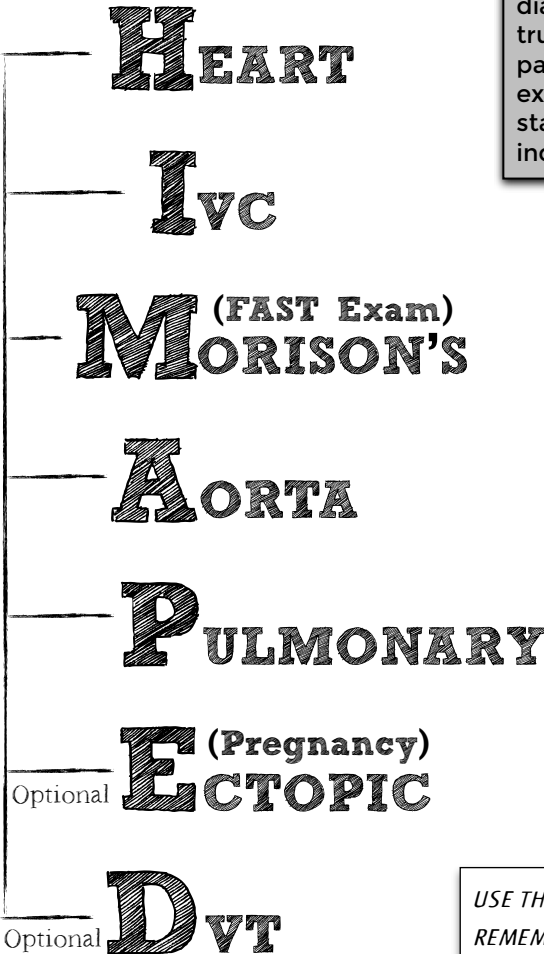


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Rapid Ultrasound for Shock and Hypotension (RUSH)

Patients who have unexplained tachycardia, tachypnea, hypotension or are in cardiac arrest may benefit from the RUSH exam to identify potentially treatable causes such as: **AAA, pulmonary embolism, CHF, sepsis, ruptured ectopic pregnancy, hypovolemia, pneumothorax, hemothorax, and hemoperitoneum.**

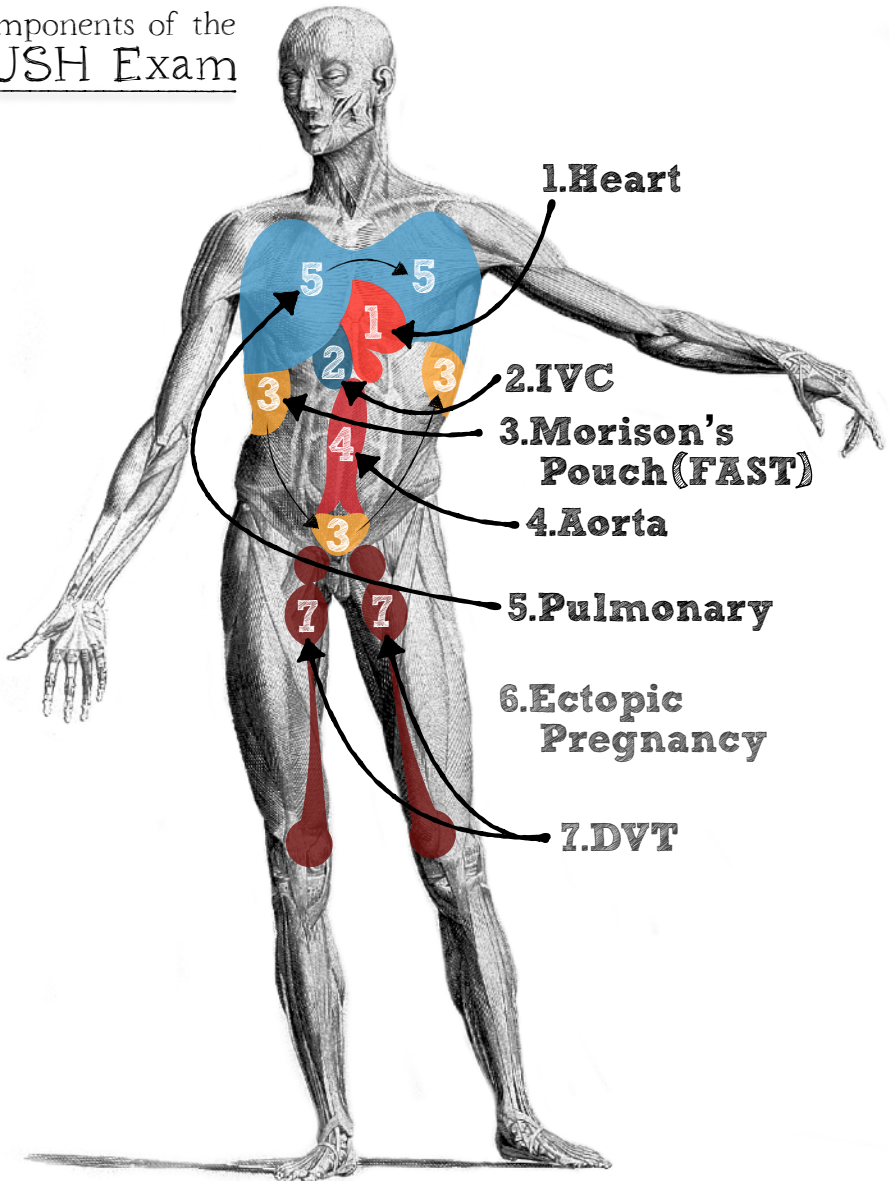
Tip: The complete RUSH exam is a standardized diagnostic approach for the truly undifferentiated shock patient. Use more focused exams such as the serial fluid status assessment or other individual exams when possible.



USE THE MNEMONIC "HIMAP-ED" TO REMEMBER THE STEPS OF THE RUSH EXAM

Rapid Ultrasound for Shock and Hypotension (RUSH)

Components of the RUSH Exam



Cardiac

Probe	Phased	Exam Mode	Cardiac or FAST	Starting Depth	16 cm
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The point-of-care cardiac ultrasound exam is used to identify cardiac tamponade, look for causes of shock, and to assess overall cardiac function in the undifferentiated sick patient. When combined with the lung and IVC exam the cardiac exam can help guide initial treatment.

Approach to the Exam:

1 Look for Tamponade

2 Assess global cardiac function

3 Compare the size of the ventricles

TAMPONADE

- Evaluate for free fluid around the heart. Be careful not to mistake the anterior fat pad for free fluid. If fluid is found, evaluate the right heart for signs of tamponade.

CARDIAC FUNCTION

- Evaluate overall cardiac function. Good mitral valve motion in the parasternal long axis view can be a helpful indicator of good cardiac output.

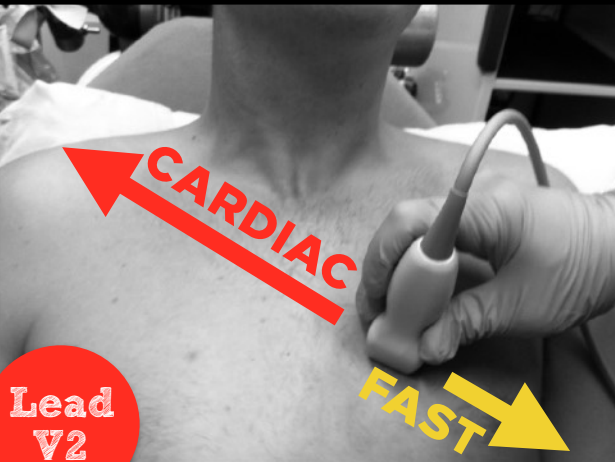
RIGHT VS LEFT

- The right ventricle should be visibly smaller than the left ventricle. If it is not consider the patient history. If long standing COPD or pulmonary HTN, this is likely chronic. If they have new onset SOB this may be signs of an acute pulmonary embolism. Evaluate as such. Consider a DVT exam.

Cardiac - Parasternal Long Axis (PLAX or PSL)

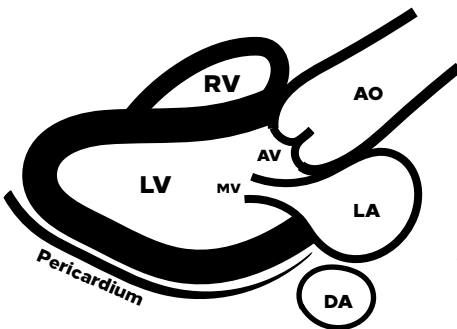
The parasternal long axis view (PLAX) is a great starting point for cardiac POCUS. Use the location of ECG lead V2 to place the probe. The PLAX view is great for identifying cardiac function, but be sure not to confuse an anterior fat pad for an effusion.

Parasternal Long Axis (PLAX)

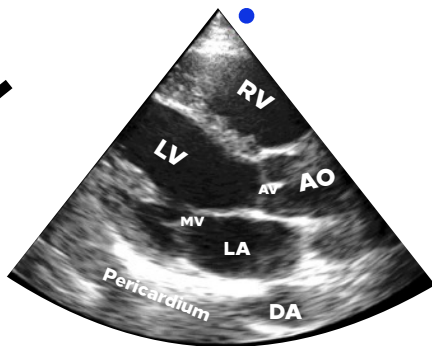


The Orientation Dilemma:
One of the most confusing aspects of the PLAX view is the orientation marker. Radiologists and cardiologists use different imaging conventions. Therefore when the machine goes into cardiac mode it flips the image. This means to maintain the same image orientation, the probe needs to be pointed in different directions depending on if you're in cardiac mode or any other mode. Hence the two orientation directions.

ORIENT THE PROBE TOWARDS THE RIGHT SHOULDER IN CARDIAC MODE AND TOWARDS THE LEFT HIP IN ALL OTHER MODES



*THE MITRAL VALVE "SLAPPING"
THE SEPTUM IS A SIGN OF
GOOD CARDIAC FUNCTION*

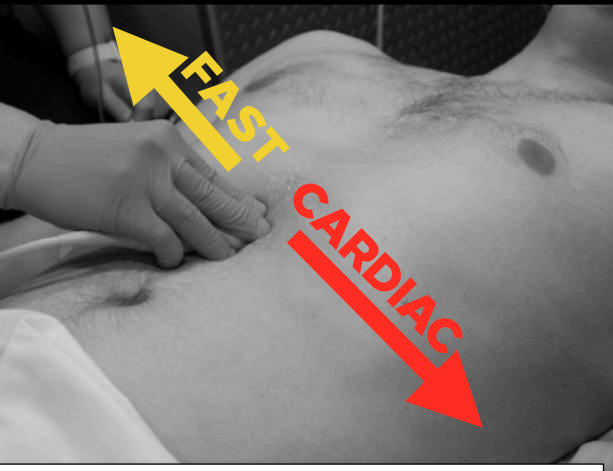


*NOTICE THE RIGHT VENTRICLE IS
ALWAYS ON TOP AND IS SMALLER
THAN THE LEFT VENTRICLE*

Cardiac - Subxiphoid View (SUBX)

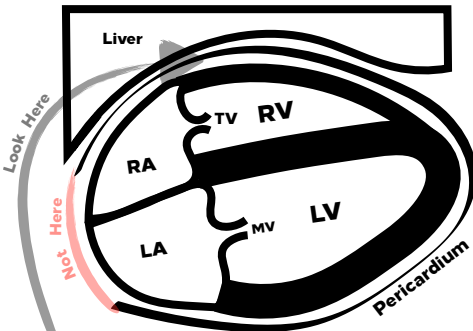
The subxiphoid view is the other mainstay of cardiac POCUS. This view is commonly used in the FAST exam as it is more sensitive for pericardial fluid. It can also be easier to obtain in COPD patients whose lungs may obscure the PLAX view. Be comfortable with both views.

Subxiphoid (SUBX)

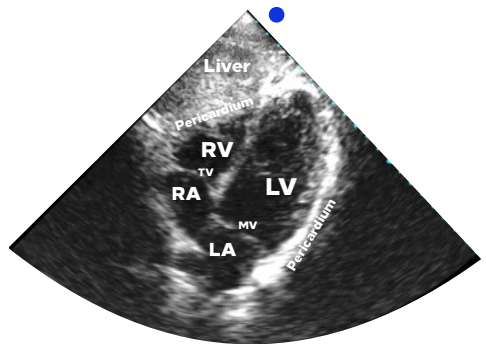


USE A SCOOPING MOTION TO GET UNDER THE XIPHOID. NO FINGERS UNDER THE PROBE AS IT SHOULD BE NEARLY FLAT

How much fluid is bad?:
The SUBX view is the most sensitive for picking up PCE. It is so sensitive that it can pick up a physiologic amount of fluid. So how much free fluid is bad? Knowing the anatomy can help. The top of the image in SUBX is the lowest part of the heart, where fluid will collect first. Pathologic free fluid will then collect and move around the apex of the heart. Beware, loculations can limit this. Also, the area near the atria has many vessels that can mimic free fluid accumulations to the novice sonographer.



THE SUBXIPHOID VIEW IS THE MOST SENSITIVE FOR PICKING UP TAMPONADE

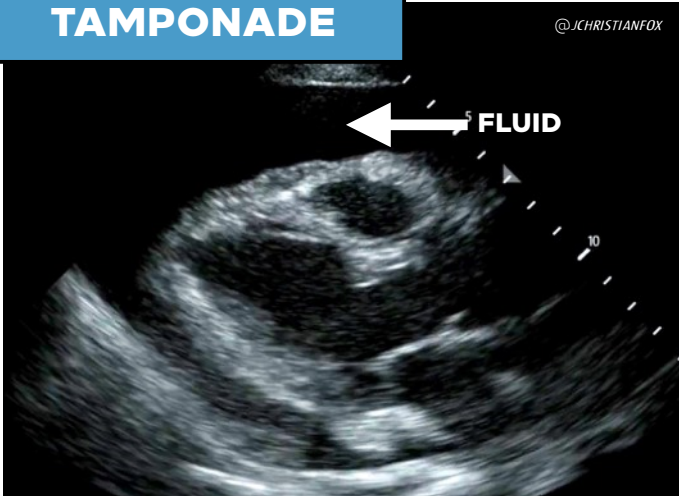


NOTICE THE RIGHT VENTRICLE IS ALWAYS ON TOP AND IS SMALLER THAN THE LEFT VENTRICLE

Cardiac - Tamponade

Identifying cardiac tamponade is one of the most valuable uses of POCUS. While a full echo is required to truly quantify compartment pressures in some borderline cases, there are some basic and easy to spot signs that should not be missed.

TAMPONADE

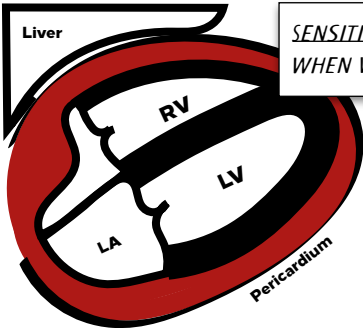


@JCHRISTIANFOX

The big ones: Very large effusions are rarely a cause of acute tamponade. Often the large effusions have taken months to develop, by this time the pericardium has stretched to accommodate them. Medium sized effusions are much more likely to be a problem as they have likely accumulated over hours to days, not enough time for the pericardium to adapt to them.

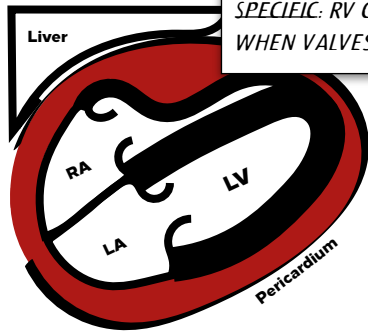
THESE ULTRASOUND FINDINGS IN AN UNSTABLE PATIENT ARE INDICATIONS FOR AN EMERGENCY PERICARDIOCENTESIS.

3.19.14 PM
made in Ocarit



SENSITIVE: RA COLLAPSE WHEN VALVES ARE CLOSED.

Diastole



SPECIFIC: RV COLLAPSES WHEN VALVES ARE OPEN.

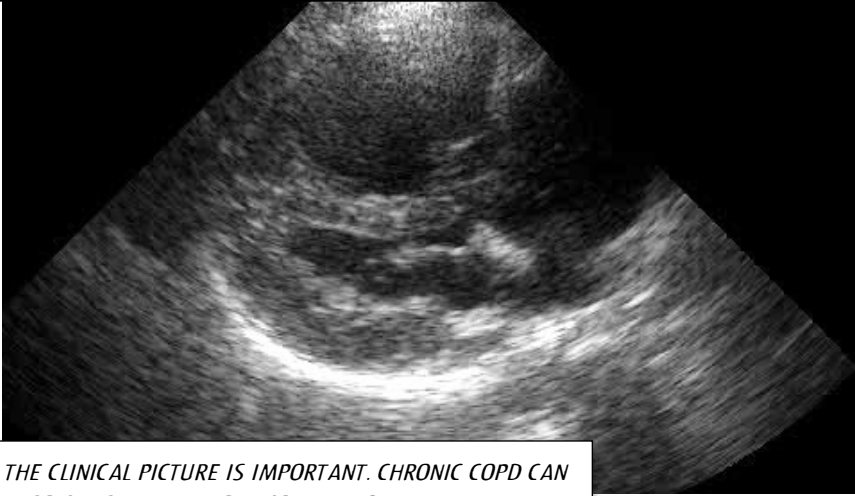
Systole

Cardiac - Pulmonary Embolism

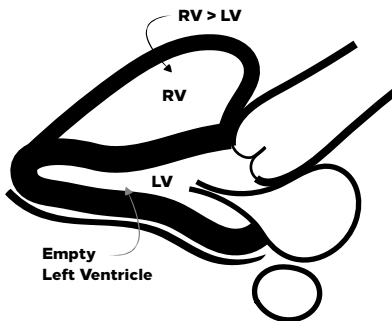
Pulmonary embolism identification on echo hinges upon determining acute vs chronic pulmonary hypertension and the signs thereof (cor pulmonale). This can be difficult, but with the easy ability to clinically correlate your findings provided by POCUS, it is possible to do.

PULMONARY EMBOLISM

DAVE SPEAR MD



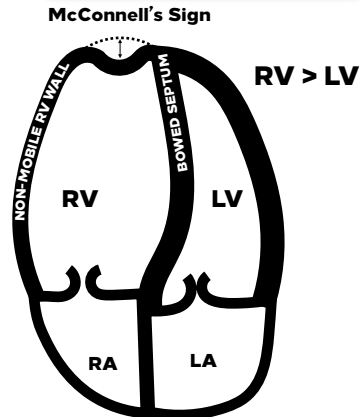
THE CLINICAL PICTURE IS IMPORTANT. CHRONIC COPD CAN ALSO CAUSE THE RV TO BECOME LARGER THAN THE LV.



CONSIDER CHECKING FOR D-SIGN
IN THE PARASTERNAL SHORT VIEW

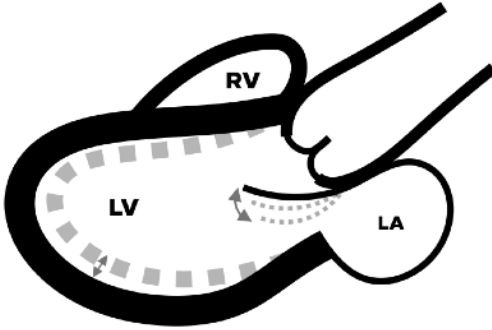
FOR THE DIAGNOSIS OF ACUTE PE
THE IVC MUST ALSO BE ENLARGED

SUGGESTIVE FOR ACUTE RV STRAIN



Cardiac - Visually Estimating EF%

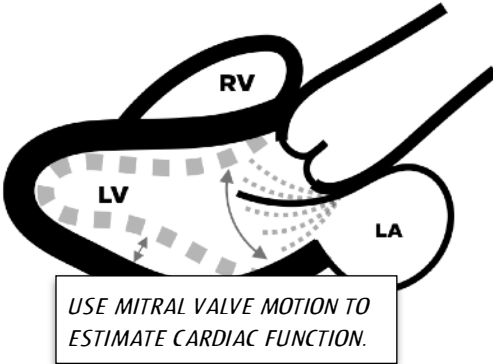
There are many ways to estimate ejection fraction (EF%) using ultrasound. While not nearly as accurate as actually measuring it, it is possible to pick out the extremes of cardiac function by nothing more than eyeballing it.



Poor Heart Failure?

Compared to cardiologists, emergency physicians were able to visually identify low EF% with a sensitivity of 93.7% and specificity of 87.9%

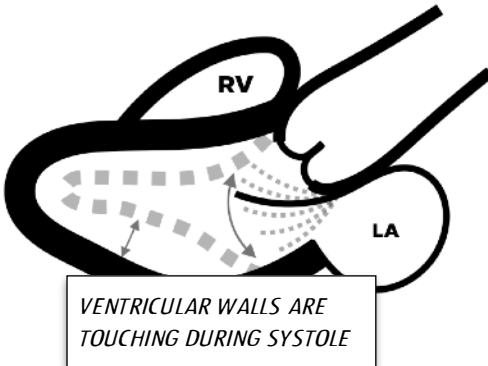
-Unluer et al, 2014, WJEM



USE MITRAL VALVE MOTION TO ESTIMATE CARDIAC FUNCTION.

Normal Non-contributory

Mitral valve motion can be a good marker of cardiac function. Measuring this is called the E-Point Septal Separation (EPSS). Informally seeing good mitral motion is an indicator of good EF%.



VENTRICULAR WALLS ARE TOUCHING DURING SYSTOLE

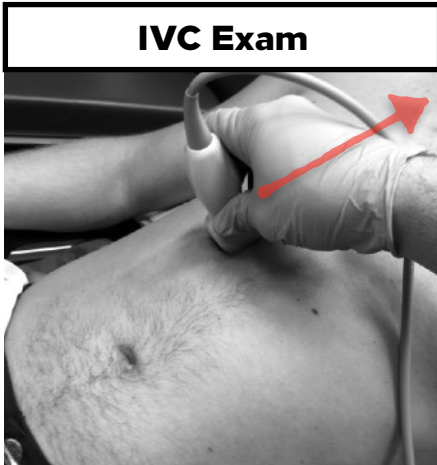
Hyperdynamic Sepsis? Hypovolemia?

While only 33% sensitive, a hyperdynamic EF% on initial presentation to the emergency department was 94% specific for sepsis.

- Jones et al, 2005, Shock

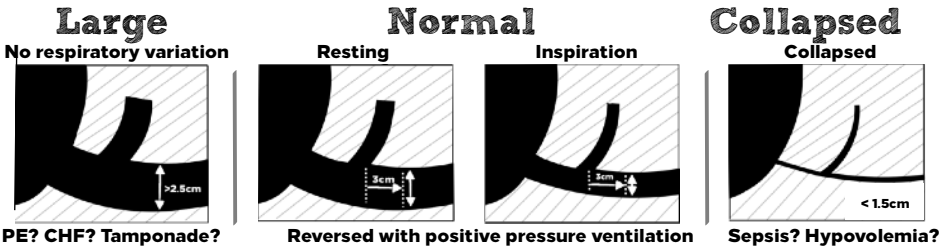
Inferior Vena Cava (IVC)

Examining the IVC gives an estimate of central venous, right atrial and right ventricular end diastolic pressures. The IVC provides information on fluid status, as well as right ventricular and cardiac function.



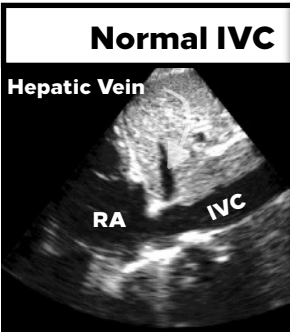
IVC Exam

- 1 Place probe to the right of midline with the marker towards the head.
- 2 Identify the IVC and align the probe along its lengthwise
- 3 If spontaneously breathing, let the patient breath normally
- 4 If IVC is large, have patient sniff 3 times to assess for complete loss of collapsibility



IVC MEASUREMENT IS MOST USEFUL AT THE EXTREMES AND SHOULD NOT BE USED TO CALCULATE A QUANTITATIVE CVP NUMBER

CLINICAL JUDGEMENT COMBINED WITH SERIAL IVC ASSESSMENTS IS THE BEST APPROACH



Normal IVC

Hepatic Vein

RA

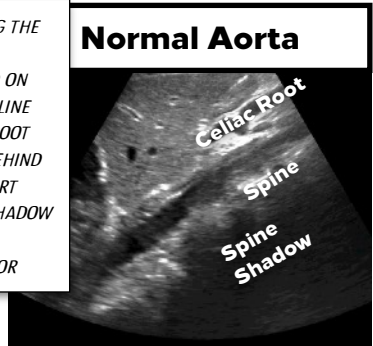
IVC

IDENTIFYING THE IVC:

- LOCATED TO THE RIGHT OF MIDLINE
- HEPATIC VEIN GOES INTO THE RIGHT ATRIUM
- CAN VISUALIZE TISSUE POSTERIOR

IDENTIFYING THE AORTA:

- LOCATED ON THE MIDLINE
- CELIAC ROOT
- DIVES BEHIND THE HEART
- SPINE SHADOW BLOCKS POSTERIOR



Normal Aorta

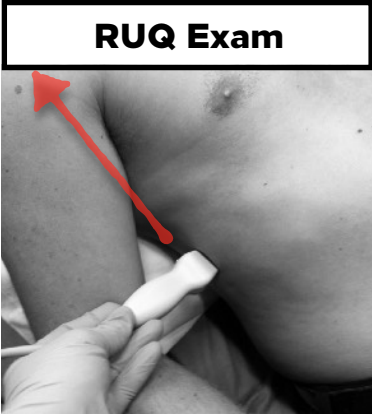
Celiac Root

Spine

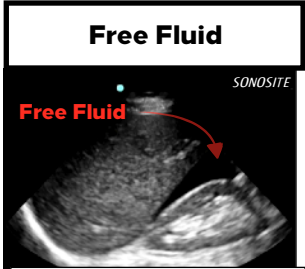
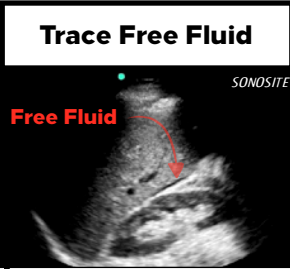
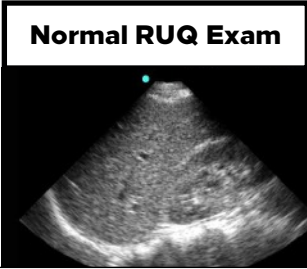
Spine Shadow

RUQ (Morison's Pouch)

The RUQ (Morison's Pouch) window is relatively easy to obtain. Be sure to visualize the kidney and obtain clips/images from the diaphragm, down through Morison's Pouch, and through to the caudal tip of the liver.



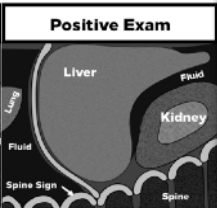
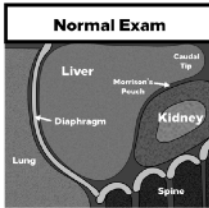
- 1** Place probe on the patients right side midaxillary with marker towards head. Touch your knuckles to the cot.
- 2** Angle the probe to identify the kidney and Morisons pouch. Save a clip.
- 3** Slide the probe towards the head to visualize the diaphragm and assess for spine sign. Save a clip.
- 4** Slide the probe towards the feet to visualize the caudal tip of the liver. Save a clip.



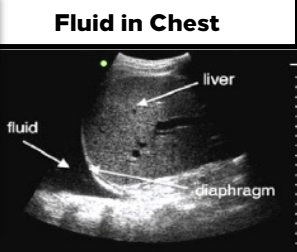
SOME MEDICAL CONDITIONS MAY MIMIC BLOOD IN THE ABDOMEN, SUCH AS ASCITES FROM LIVER FAILURE. IT IS IMPORTANT TO SCREEN YOUR PATIENTS FOR POTENTIAL MEDICAL CAUSES OF A POSITIVE FAST EXAM.

IT TAKES UP TO 500 CC OF FREE FLUID FOR THIS EXAM TO BE POSITIVE. **A negative exam does not mean your patient is not bleeding!**

FRESH BLOOD WILL APPEAR BLACK, WHILE CLOTTED BLOOD MAY TAKE ON A MORE GRAYISH APPEARANCE.



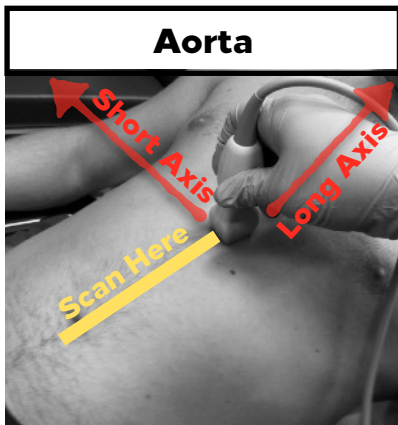
SPINE SIGN: AIR IN THE LUNGS DESTROYS THE IMAGE OF THE SPINE ABOVE THE DIAPHRAGM. IF THE SPINE IS VISIBLE ABOVE THE DIAPHRAGM THERE IS FLUID IN THE CHEST.



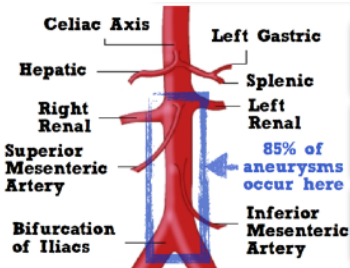
Aorta

Probe	Phased/Curved	Exam Mode	ABD or FAST	Starting Depth	11-16
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AAA's are more common in older smokers, but some genetic conditions can predispose younger patients as well. They are often asymptomatic until rupture. Mortality goes up every hour after.



- 1 Apply a line of gel down the midline from the xiphoid to the umbilicus.
- 2 Place probe on the patients midline just below the xyphoid process with the marker towards the patients right. (Short Axis)
- 3 Identify the IVC and the aorta with spine behind it.
- 4 With firm, steady pressure, scan down the length of the aorta and through the iliac bifurcation. Apply manual traction to move the umbilicus to the right if needed. Save a clip.



< 3cm	Normal Aorta
3 - 5cm	requires follow up
5.5 - 7cm	surgical candidate
> 7cm	RUPTURE RISK: SURGERY!

YOU MUST SCAN THROUGH THE ILIAC BIFURCATION TO RULE OUT AAA

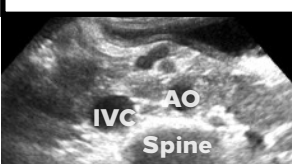
Iliac artery aneurysm: > 1.5 cm

Normal Aorta - Long



SCROTAL ECCHYMOSIS, AKA. BRYANT'S SIGN, CAN BE AN EARLY INDICATOR OF A RUPTURED AAA.

Normal Aorta - Short



CORRECT IDENTIFICATION OF THE AORTA IS EXTREMELY IMPORTANT. IT IS EASY TO MISTAKE THE IVC FOR THE AORTA. LOOK FOR THE SPINE & SHADOW BEHIND IT.

AAA - Short

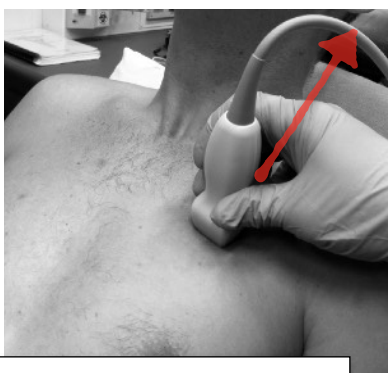


MEASURE FROM OUTSIDE TO OUTSIDE. MEASURING THE INNER LUMEN WILL GREATLY UNDERESTIMATE THE SIZE OF THE AAA DUE TO THE LARGE CLOT BURDEN COATING THE WALLS.

Pulmonary Ultrasound

Probe	Any	Exam Mode	Lung or FAST	Starting Depth	6 cm
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The pulmonary ultrasound serves two purposes. First, to identify if the lung is ventilated and “up” via sliding lung sign (SLS). Second, to identify pulmonary pathology such as a wet lung (edema) a consolidated lung (pneumonia) or a dry lung (normal or COPD/RAD).

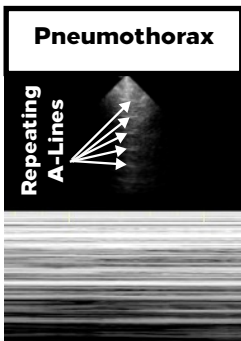
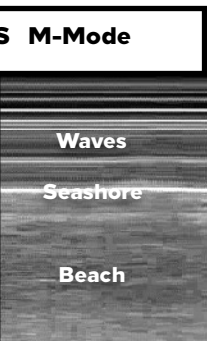
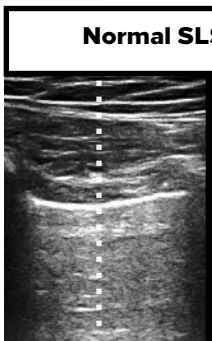
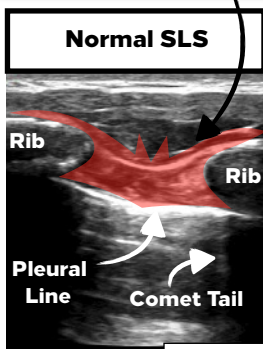


- 1 Place probe in the 2nd to 3rd intercostal space, midclavicular, with the marker towards the head.
- 2 Identify the rib interspace “batwing sign”. Look for SLS. Label and save a clip.
- 3 Repeat the exam on the other side. Label and save a clip.
- 4 If looking for edema or pneumonia repeat exam midaxillary bilaterally. Save clips.

DONT GET TOO CLOSE TO THE HEART

IF YOU'RE HAVING DIFFICULTY FINDING SLIDING LUNG SIGN YOU CAN USE M-MODE, BUT IT IS NOT A NECESSITY.

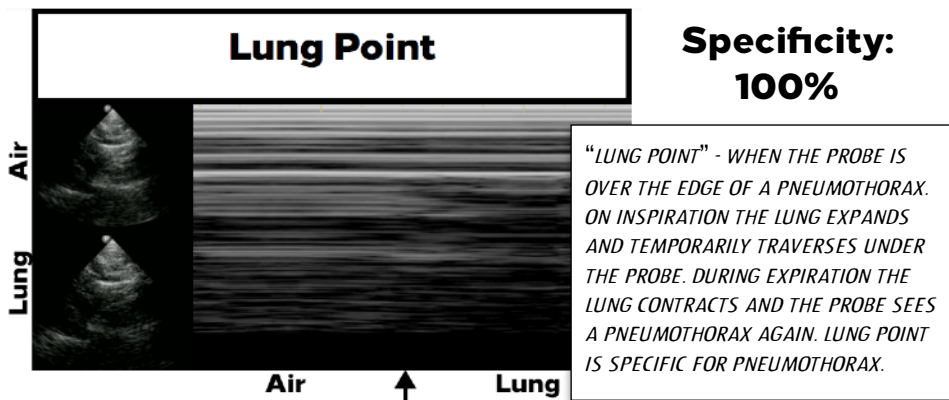
BIZARRE LOOKING SET OF BATWINGS, BUT THAT'S WHAT THEY CALL THIS SIGN.



“SEASHORE” SIGN AKA “WAVES ON A BEACH” IS THE NORMAL SLS FINDING IN M-MODE

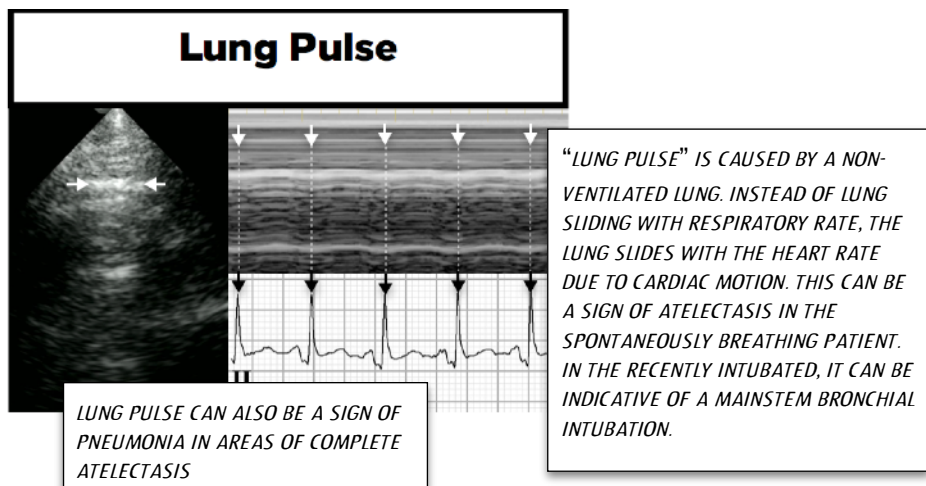
“BARCODE” SIGN IS INDICATIVE OF A PNEUMOTHORAX ON M-MODE

Confirming a Pneumothorax

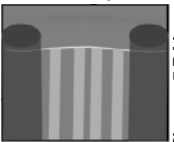
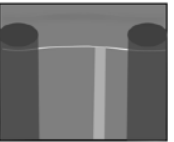
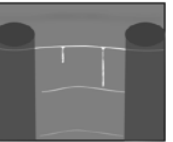
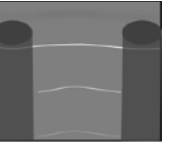
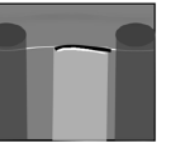

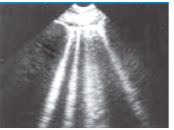
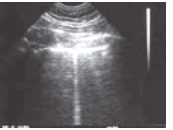
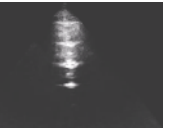



LUNG POINT CAN BE A LITTLE TRICKY, SO TAKE YOUR TIME. BEWARE THE LEFT UPPER CHEST, THE HEART CAN MIMIC BOTH LUNG POINT AND LUNG PULSE IF YOU GET TOO CLOSE TO IT.

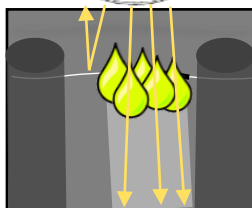
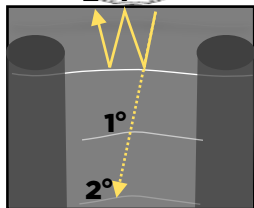
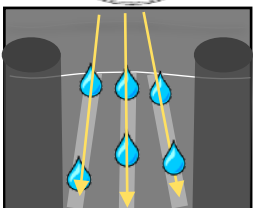
Identifying a missed intubation



Pulmonary Ultrasound

B Sign	B Line	Comets	A Lines	C Line
Pulmonary Edema	Some Fluid	Normal	Normal/Dry or PTX	Pneumonia
				
				
Sensitivity: 97%			PTX = Pneumothorax	Specificity: 100%

B Sign = > 3 B Lines



B Lines

Rib Rib

B Lines

Edema

A Lines

Pleura

A Lines

Dry Lungs

C Lines

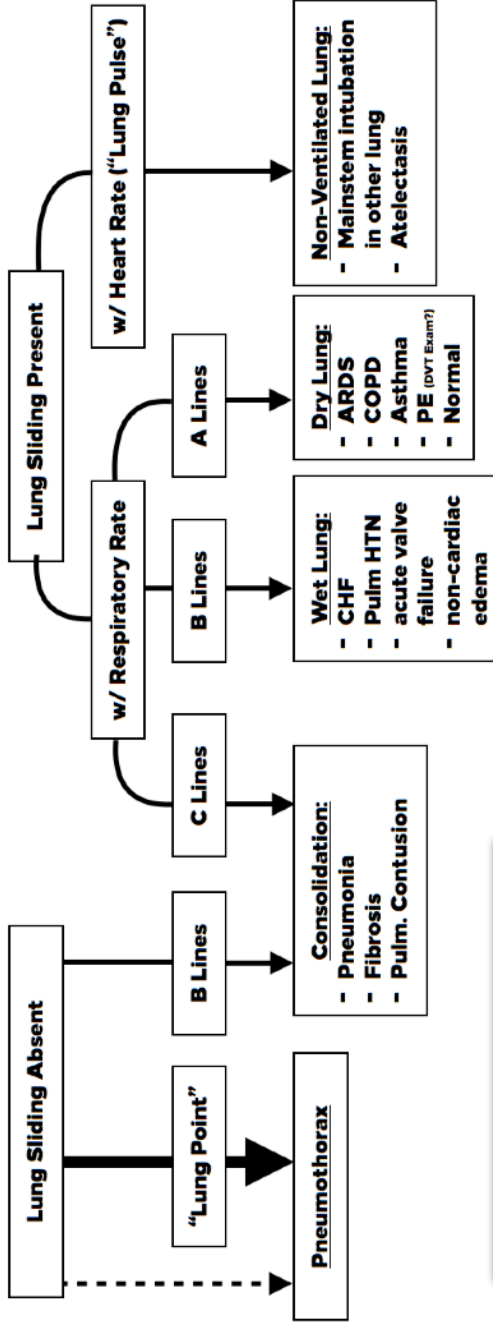
Consolidation

C Line

Consolidation (Pneumonia)

A THICK, IRREGULAR PLEURAL LINE COMBINED WITH A THICK, VERTICAL HYPER-ECHOIC STRIPE IS A C LINE. "AIR BRONCHOGRAMS" FURTHER CONFIRM THE DIAGNOSIS OF PNEUMONIA.

Approach to pulmonary ultrasound:



ALL FINDINGS REQUIRE CLINICAL CORRELATION.
ADAPTED FROM THE BLUE PROTOCOL.

Intra-Uterine Pregnancy

Probe	Phased or Curved	Exam Mode	OB	Starting Depth	16 cm
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Determining IUP helps rule out ectopic pregnancy (heterotopic pregnancy is extremely rare). Definition of an IUP= GS + YS or Fetal Pole, surrounded by a thick myometrium (EMM > 8 mm in 2 planes). Double decidual sign is not a reliable sign of IUP.

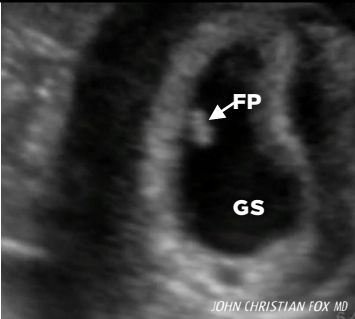
Gestational Sac (GS)



GS + Yolk Sac (YS)



Fetal Pole

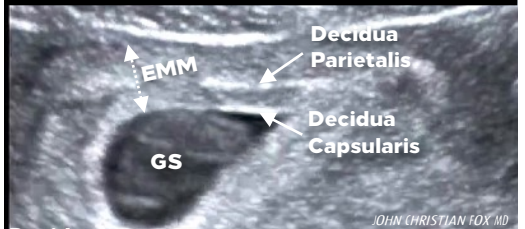


Stages of an IUP

4.5 Weeks	Gestational Sac	
4-6 Weeks	Double Decidual Sign	
5-6 Weeks	Yolk Sac	B-Hcg 1500 (TV) 3000 (TA)
6 Weeks	Fetal Pole / FHR	B-Hcg >3000

FETAL POLE OF >5MM SHOULD FIND HEART BEAT IN TRANSVAGINAL (TV)

Double Decidual Sign



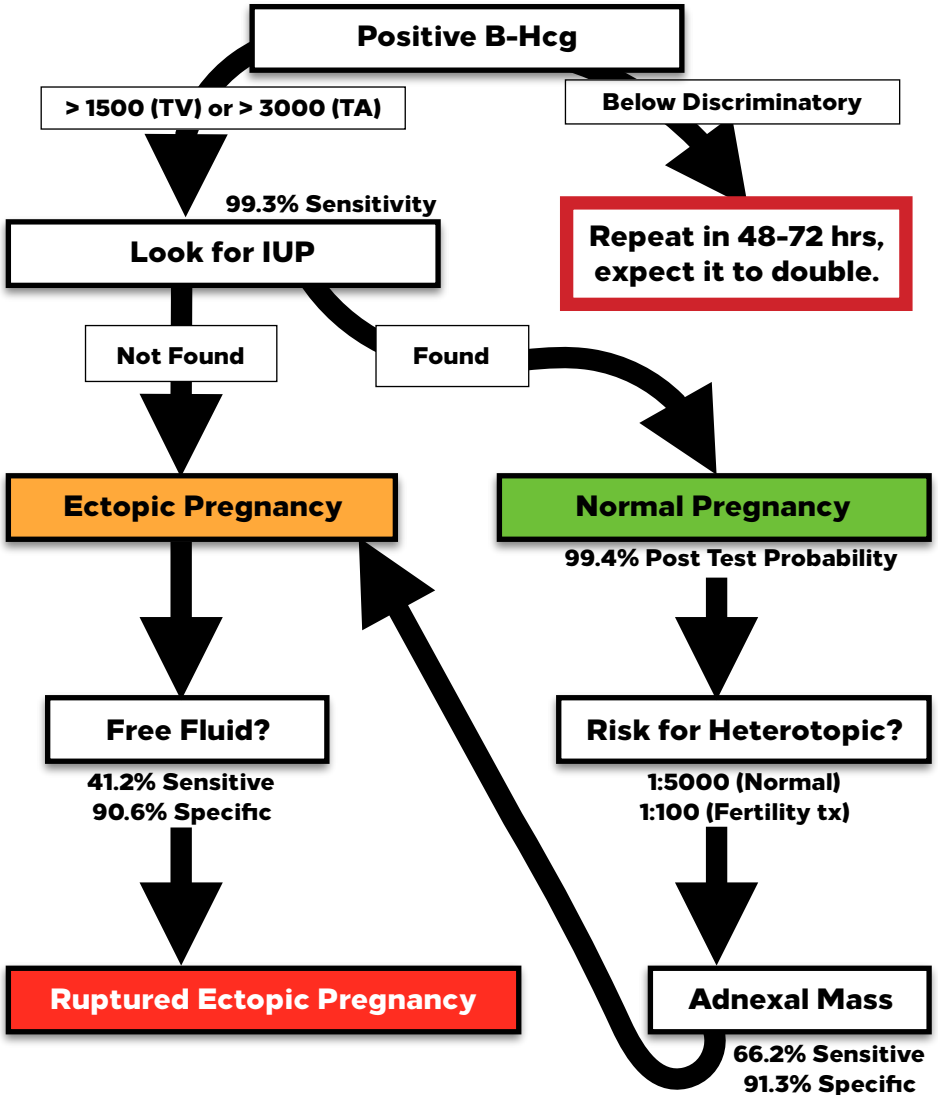
ENDOMYOMETRIAL MEASUREMENTS (EMM) SHOULD BE GREATER THAN 8MM IN THE THINNEST PLACE IN TWO PLANES.

Ruptured Ectopic Pregnancy

Probe	Phased or Curved	Exam Mode	OB	Starting Depth	16 cm
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Ruptured ectopic pregnancy is the leading cause of mortality in the first trimester and is responsible for ~10% of all pregnancy related deaths. Keep this diagnosis in mind.

Ectopic Flow Chart

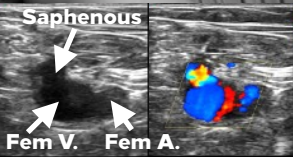


DVT

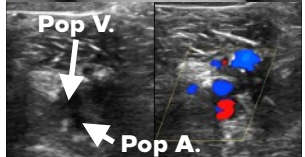
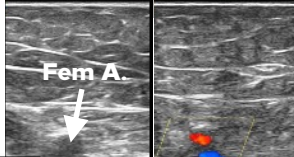
Probe	Linear	Exam Mode	Vascular	Starting Depth	4 cm
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The DVT exam can be conducted as part of the RUSH exam. If there is any concern for possible PE, the presence of DVTs should be assessed for. 50% of DVT's can go on to cause PEs.

- 1 Remove the patients pants and drape for modesty. Position the legs in a frog leg position.
- 2 Label the image as left or right, place the probe in the inguinal crease with marker to right. Identify the saphenous junction.
- 3 Turn on color doppler, apply and release pressure. The goal is to compress the vein completely without compressing the artery. Save a clip.
- 4 Repeat at the femoral and popliteal arteries. Repeat on the opposite leg. Any absence of complete vein compression is considered a positive exam.

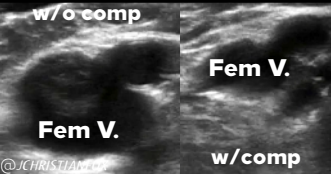


BE SURE TO INCLUDE THE SAPHENOUS JUNCTION IN YOUR CLIP, THIS IS A COMMON SITE OF DVT.

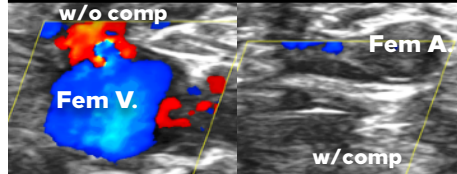


POSITIONING IS KEY TO THE POPLITEAL, IF YOU ARE STRUGGLING, TRY REPOSITIONING THE KNEE.

Non-compressible: DVT



Compressible: Normal Exam



About our book

This is just a small excerpt from our new book, **The Point of Care Ultrasound Handbook**. We hope you like it! We want this effort to be something useful to carry with you for both the basic and advanced point of care ultrasound clinician. It started out as something for EMS ultrasound but has since evolved into something useful for medical students, residents, nurses, paramedics and pretty much anyone doing or interested in doing point of care ultrasound. We packed it full of greatness from the very basics of ultrasound up to advanced measurements, covering cardiac, OB, pulmonary, abdominal, and many other POCUS topics. All with plenty of tips, tricks and useful information to go around on your journey to POCUS nirvana. Please be sure to check us out at a conference or reach out to us on twitter, we would love to hear from you!

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The Point of Care Ultrasound Handbook

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