

# Emergency Ultrasound Course

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**ED Course Manual 2:  
EFAST**

**Extended Focused  
Assessment  
*with* Sonography  
*in* Trauma**

## The Questions:

1. Is there free fluid (FF)
  - a. In the pleural space?
  - b. In the pericardial space?
  - c. In the peritoneum?
2. Is there a pneumothorax (PTX)?

## Introduction

Extended Focused Assessment with Sonography in Trauma (EFAST) has supplanted FAST as the standard of care in bedside imaging of the trauma patient.

It is a means of detecting:

- free intraperitoneal fluid
- free pleural fluid
- free pericardial fluid
- pneumothorax (PTX).

It relies on the principle that in the supine patient:

- free fluid (FF) sinks: blood collects in certain anatomical sites.
- Free air (PTX) rises.

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### TOP TIPS:

1. **Pneumothorax** (PTX = air in the pleural space) collects at the **anterior** chest in the supine patient.
2. **Haemothorax** (HTX = blood in the pleural space) collects at the **posterior** lung bases in the supine patient.
3. **The amount of fluid** is important in the pleural and peritoneal spaces, but less so in the pericardium.

What does this mean?

- a. **Pericardial blood** collects rapidly in trauma. The pericardium doesn't have time to stretch to accommodate it. You don't need much to cause a tamponade!

- b. But there's more room to move in the pleural and peritoneal spaces. So if you see just a tiny bit of fluid in these spaces in a shocked patient, then **look elsewhere for the cause of the shock**.
  - c. The only exception is patients that have not been lying flat- eg the shocked patient with a ruptured ectopic pregnancy may have only a little FF in Morison's Pouch. That's because she has been standing up and all the fluid is in the pelvis.
  - d. **Free blood is only black (anechoic) if it's fresh**. If it's been there for awhile (eg the patient with ruptured EP that has been slowly bleeding) the blood may have clotted and it will no longer be black: i.e. you may miss it.
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## Where does fluid collect in the *supine* patient?

**Haemothorax** (blood in the thorax) collects posteriorly. The further around the back of the thorax you place the probe, the sooner you'll see it.

**Haemopericardium** (blood in the pericardial space) collects first below the left side of the heart.

**Haemoperitoneum** (blood in the peritoneum) will first collect in certain potential spaces in the supine patient:

1. Right upper quadrant (RUQ): in the supine abdomen, FF will first collect around the liver. This will be in one or more of the following spaces:
  - a. Morison's pouch (between the liver and the right kidney)
  - b. The anterior recess (in front of the liver tip)
  - c. Between the diaphragm and the liver (subphrenic space)
2. Left upper quadrant (LUQ): FF may collect around here, in one of the following areas:
  - a. Between the diaphragm and the spleen (subphrenic space)
  - b. The lienorenal interface (between the spleen and left kidney)
3. Pelvis: FF will collect in the Pouch of Douglas (rectovesical pouch in the male) deep to the bladder.

## Why use ultrasound?

- Traumatic cardiac tamponade and massive haemothorax may be rapidly fatal if not detected and treated in the ED.
- Physical examination is unreliable for detection of cardiac tamponade / PTX / HTX haemoperitoneum in the ED setting
- FAST is:
  - easy to learn. Reliable and repeatable results can be achieved after as little as 10 proctored scans.
  - non-invasive, rapid, repeatable and can be performed at the bedside.

- 90% sensitive and up to 99% specific for traumatic haemoperitoneum.
- US can be used to guide emergent pericardiocentesis and intercostal catheter placement.

## Cautions and contraindications

- The only absolute contraindications to performing EFAST scan are:
  - the presence of a more pressing problem (such as airway obstruction): don't get in the way of the primary survey unless the team leader asks you!
  - a clear indication for emergency laparotomy (in which case FAST is not indicated): eg stab to abdomen and shocked
- Although EFAST is the standard of imaging in trauma, it is indicated only if it will affect patient management. For example, in the **stable** patient with blunt abdominal trauma, a negative FAST gives no information about solid organs or hollow viscus injury. Such patients may require other imaging such as CT and/or small bowel series.
- Children and pregnant patients: EFAST is even more useful in children than adults, because it does not use ionising radiation. However, recall that the threshold for operative intervention in paediatric blunt abdominal trauma is higher than for adults.
- Timing: A very early scan may be **falsely negative** as sufficient intra-abdominal blood may not have collected in the dependent areas. Furthermore, occasionally a late scan may be falsely negative as clotted blood is of similar echogenicity to liver and may not be easily identified in Morison's pouch.
- Operator: the accuracy of FAST is operator-dependent and the inexperienced scanner should be particularly wary of *ruling out* FF.

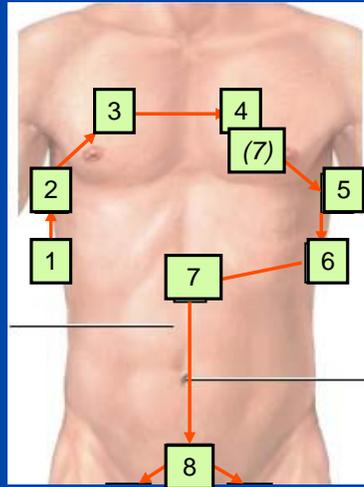
## Probe and Scanner Settings

- Probe: overall, a curved, low frequency (4-7MHz) probe should be used: this will suffice for all the compartments.
- If time permits or your initial views are lousy, try:
  - Linear probe for PTX
  - Curved probe for HTX and abdomen
  - Sector probe for cardiac view
- Depth:
  - 5cm for anterior lung (PTX)
  - 15cm for HTX and haemoperitoneum
  - 20cm for subcostal heart

## EFAST: The Views

### WINDOWS

- Sequential exam of:
  - Right upper quadrant
  - Right chest-lower
  - Right chest-upper
  - Left chest-upper
  - Left chest-lower
  - Left upper quadrant
  - Pericardium
  - Pelvis



### In which *order* will I scan?

It depends on clinical context. If you suspect injury to thorax, scan that first. If you suspect a tamponade, scan that first. Etc.

## The windows in detail

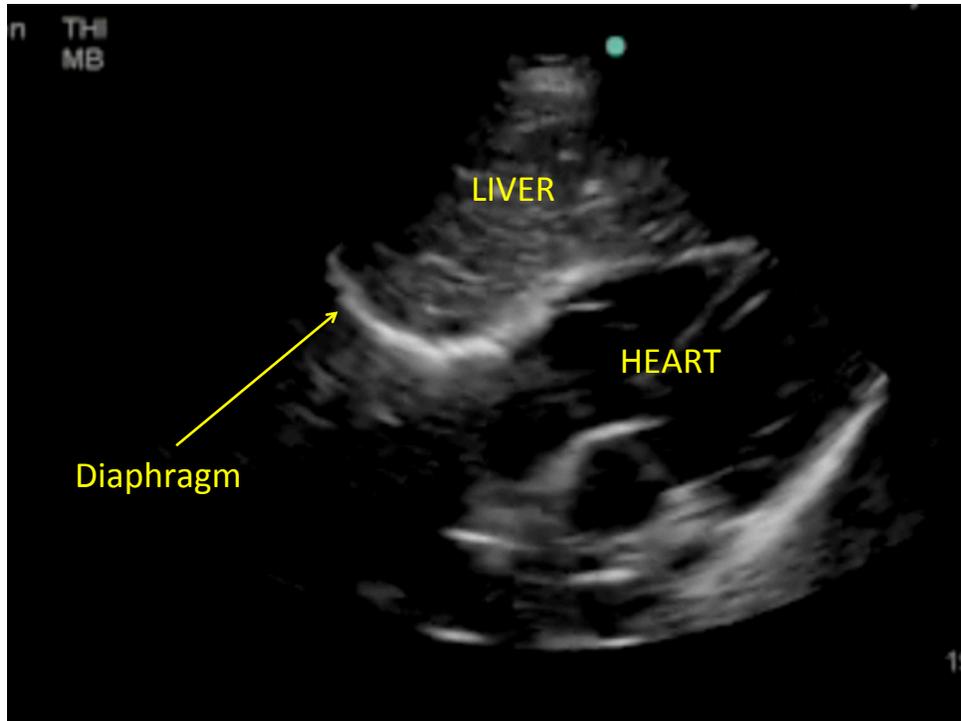
### 1. Pericardium: is there pericardial fluid? (see *CRITICAL CARE MANUAL* for more details)

- Window: the easiest window is the subcostal / subxiphoid view. (If this doesn't work, try the parasternal or apical windows.)



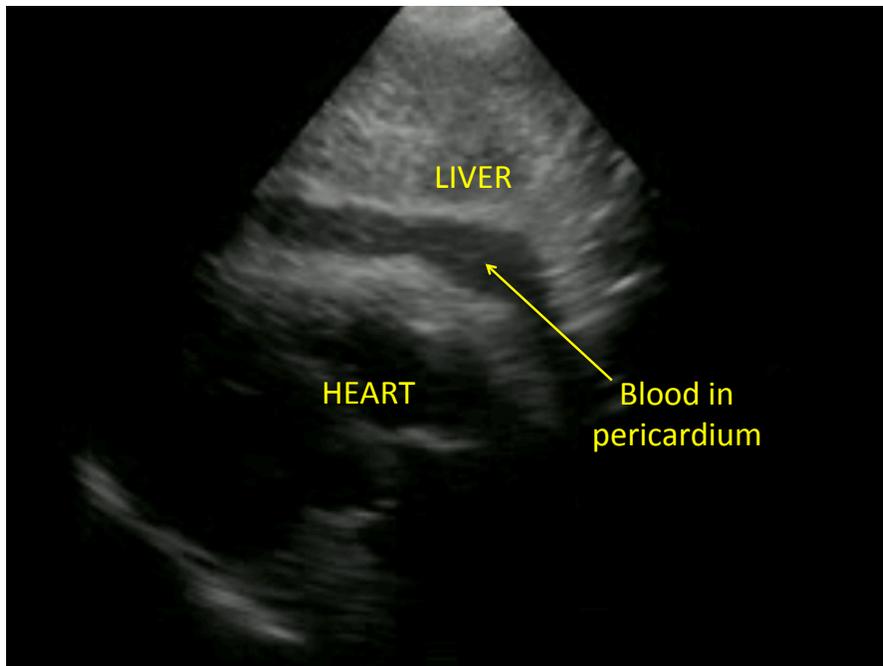
PROBE POSITION: SUBCOSTAL SCAN

- Set depth to 20cm.
- Lay the probe almost flat on the patient's epigastrium and angle it towards the head. Advance the probe towards the xiphisternum.
- Find the liver image on screen. Deep to this, one should see the heart beating.



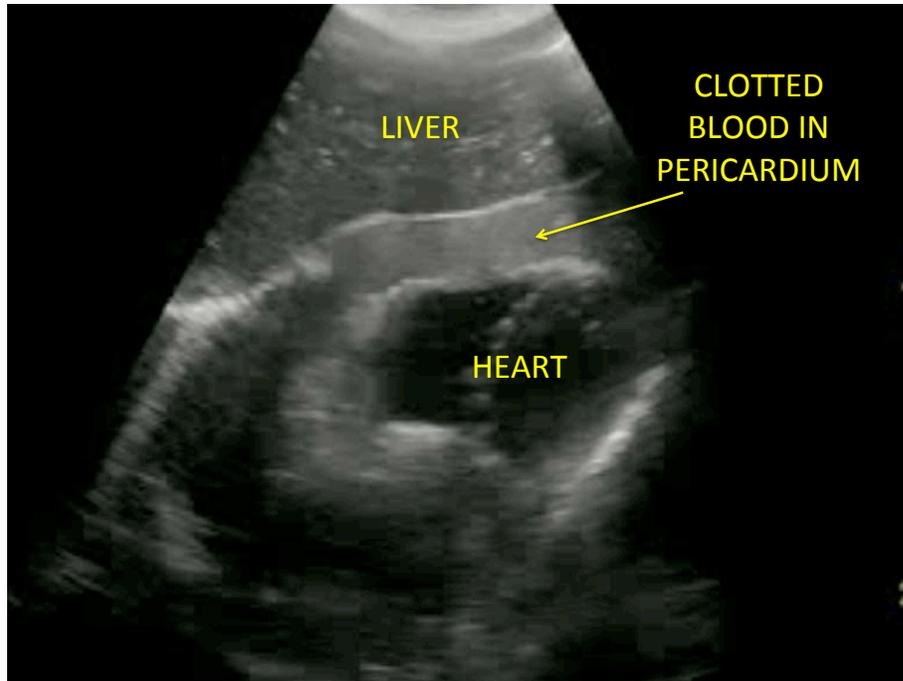
NEGATIVE SUBCOSTAL IMAGE: NO PERICARDIAL FLUID

- Pericardial fluid appears as a black stripe around the heart if the blood is fresh.



SUBCOSTAL CARDIAC WINDOW  
PERICARDIAL BLOOD

- If the blood has clotted, it will appear grey or even heterogenous.



SUBCOSTAL CARDIAC WINDOW  
CLOTTED PERICARDIAL BLOOD  
IMAGE COURTESY OF HENRY CURTIS

- In true cardiac tamponade the IVC distends, and the right ventricle will collapse during diastole. However, this can be difficult to assess for the non-echocardiographer, so *clinical* likelihood of tamponade (shock + chest trauma) must be taken into consideration when acting on a positive scan. [FOR MORE DETAILS ON PERICARDIAL FLUID & TAMPONADE, SEE *CRITICAL CARE MANUAL*]

### **CAN'T SEE THE HEART?**

#### **Try these 2 tips:**

1. Scan during a maximal inspiration: this will push the air-filled bowel out of the way.
2. Bend the patient's knees: this will relax the abdominal wall muscles.

## 2. Right & left upper quadrants (RUQ / LUQ): is there free peritoneal fluid?

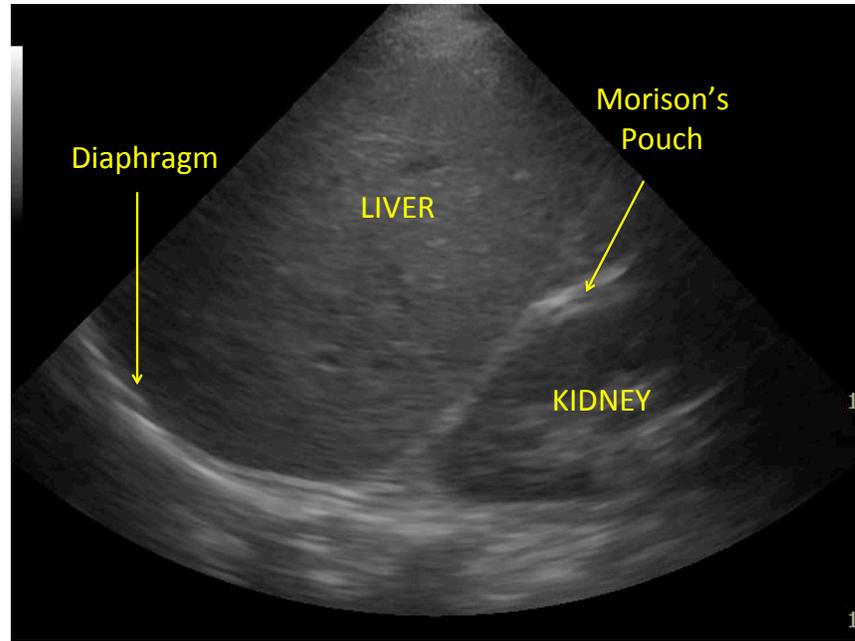
### a. Scanning the RUQ

- Begin with the probe parallel and between the ribs where the costal margin meets the mid-axillary line on the right of the patient.



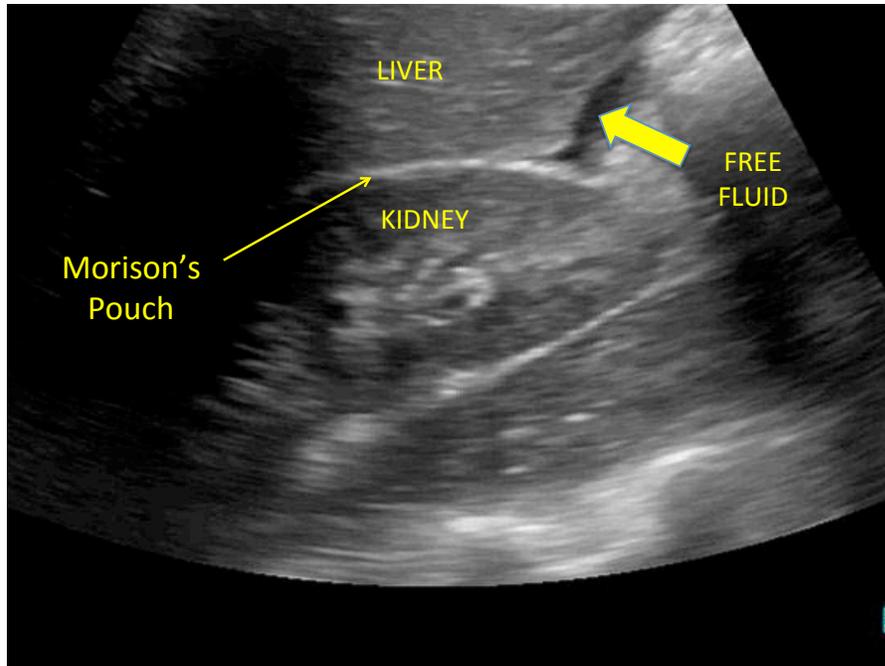
PROBE POSITION: RUQ WINDOW

- This window uses the liver as an acoustic window and should demonstrate right kidney, liver, diaphragm (highly echogenic) and right lung base for pneumo/haemothorax.
- Sweep the probe anteroposteriorly and alter the probe angle to parallel the ribs until you obtain a clear view of Morison's pouch.



NEGATIVE RUQ IMAGE: NO FREE FLUID

- Scan all the way through the kidney
- Scan down to the tip of the liver
- Scan as much of the hemidiaphragm as possible (tip: ask the patient to take a deep breath)
- **This is because you haven't ruled out FF until you've seen all around the liver and kidney.**



POSITIVE RUQ: BUT FREE FLUID (FF) IS SEEN JUST AT TIP OF LIVER.  
MORISON'S POUCH FALSELY NEGATIVE.

**FF will appear black (anechoic) unless clotted (see warnings above).**

**b. Scanning the LUQ**

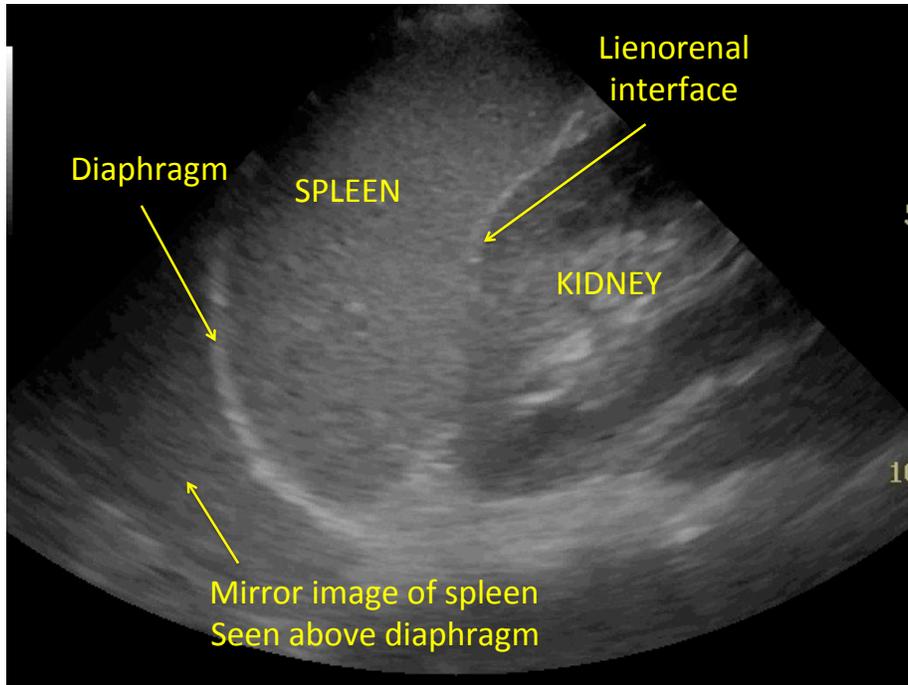
- Probe is on the left side: as for RUQ but higher (ribs 9-11) and more posteriorly, in the posterior axillary line. **This is the 'knuckle on the bed' window.**



PROBE POSITION: LUQ WINDOW

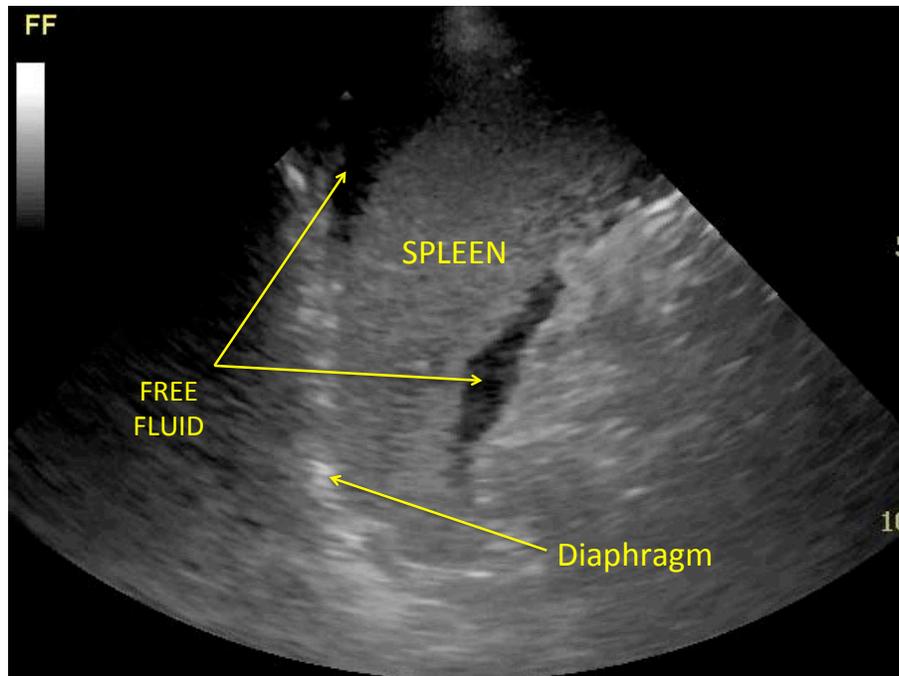
KEEP YOUR KNUCKLES ON THE BED

- The spleen is smaller, more posterior and higher than the liver, so this side is always trickier than the RUQ
- Sweep the probe and alter its angle as above, until you obtain a clear view of left kidney, spleen, diaphragm and left lung base.



NEGATIVE LUQ IMAGE: NO FREE FLUID

- If you still can't find the spleen, ask the patient to take a deep breath.
- FF will appear as a black stripe in the lienorenal interface or between the spleen and the diaphragm (subphrenic FF).



POSITIVE LUQ IMAGE: FREE FLUID BELOW THE DIAPHRAGM AND BELOW THE SPLEEN

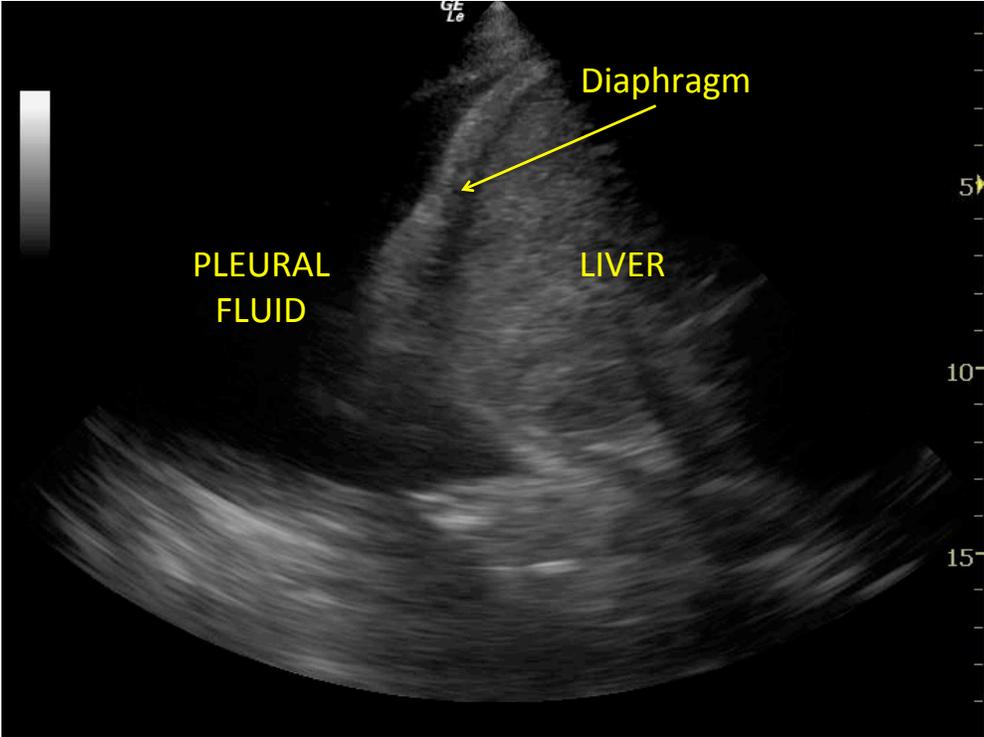
### 3. Right and left lung base: pleural fluid

- Slide the probe up a couple of rib spaces until the diaphragm is in the centre of the screen.



#### SCANNING THE POSTERIOR CHEST FOR HAEMOTHORAX

- As the patient breathes in, watch for the bright 'scatter' from air in the lung sweep down and obscure the image. This is called 'the lung curtain' and its presence means that there is no pleural fluid (such as haemothorax) at that site.
- Of course, there may still be a small amount of pleural fluid below this. So to increase your sensitivity, scan the most inferior part of the thorax. In the supine patient, this means 'scan as far posteriorly as possible, just above the diaphragm'.
- Fluid will appear black / dark / clotted, just above the diaphragm, and sometimes you will see the lung floating within a large effusion.



RIGHT HEMITHORAX: POSITIVE PLEURAL FLUID  
(PLUS A TRACE JUST BELOW THE DIAPHRAGM)  
Thanks to Dr Anj Amarasekara

**4. Right and left anterior lung: pneumothorax (PTX) (see lung chapter for details):**

- Air rises, so be careful to place the probe on the highest part of the thorax. In the supine patient, this means scan the anterior lung.



**SCANNING THE ANTERIOR CHEST FOR PNEUMOTHORAX**

- Probe and scanner settings as per lung US chapter, but you are only looking for PTX
- So decrease the depth to about 5cm



**SCANNING THE PLEURA:  
CURVED PROBE ON FAST PRESET, DEPTH 5CM  
RED ARROWS: COSTAL CARTILAGES**

YELLOW ARROW: PLEURAL LINE

*NB you can tell these are costal cartilages not ribs, because you can see the pleura running below them!*

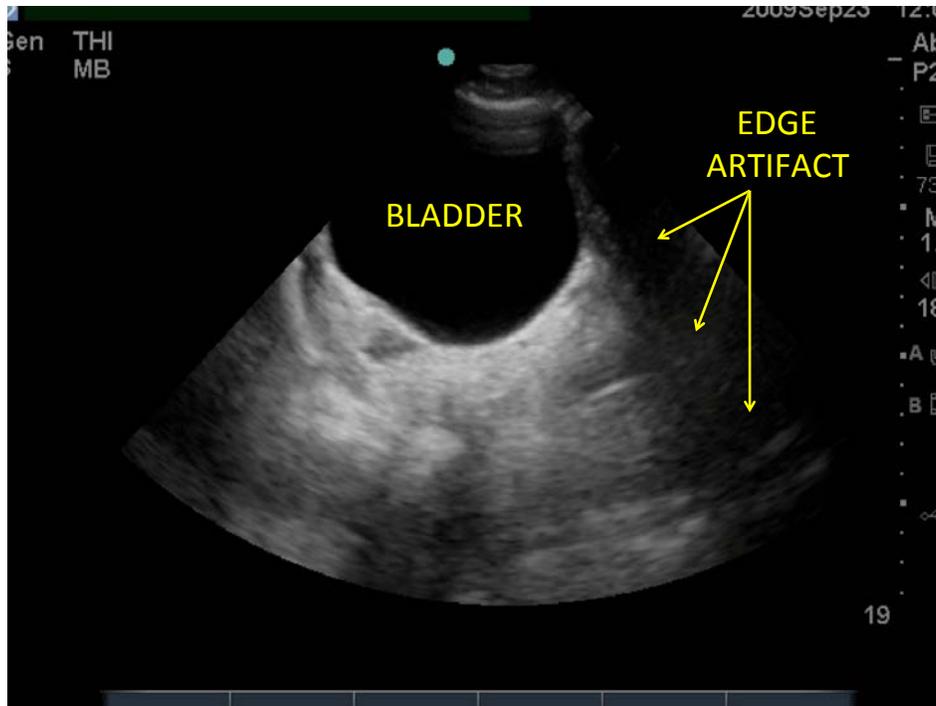
- If still in doubt, consider:
  - a. M-mode
  - b. Switching off Tissue Harmonic Imaging (THI)
  - c. Switching off multibeam / compounding

**5. Pelvis: sagittal & transverse views: free fluid**

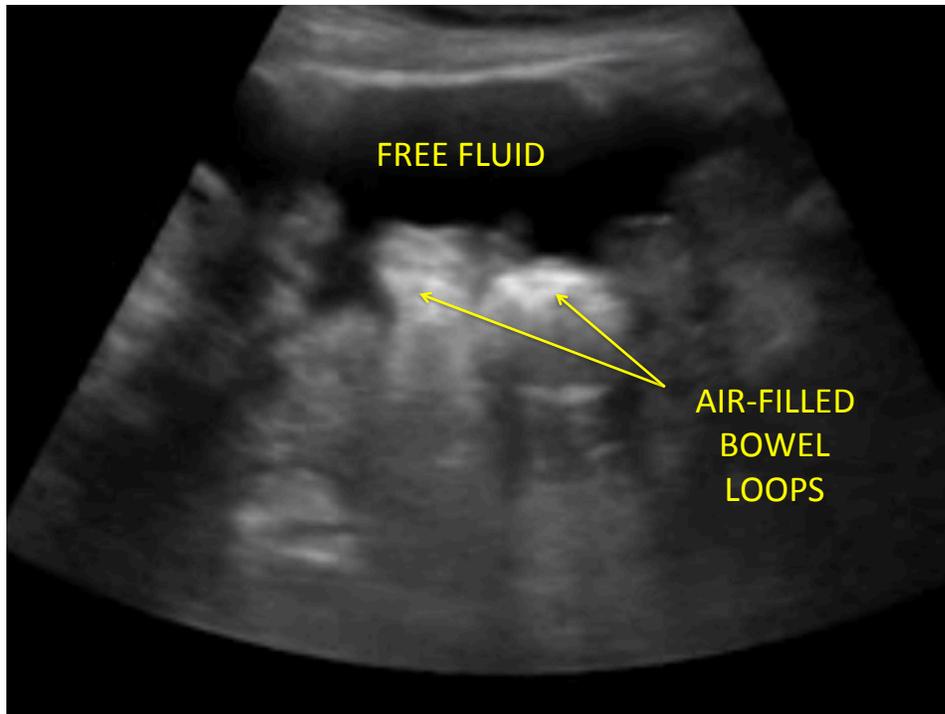
- For these views the fluid-filled bladder is the acoustic window. So, scan before catheterizing the patient if at all possible. Otherwise, be aware that your sensitivity will be reduced.
- Angle the probe down into the pelvis, and fan back and forth until you see the bladder



PROBE POSITION: TRANSVERSE SCAN OF PELVIS

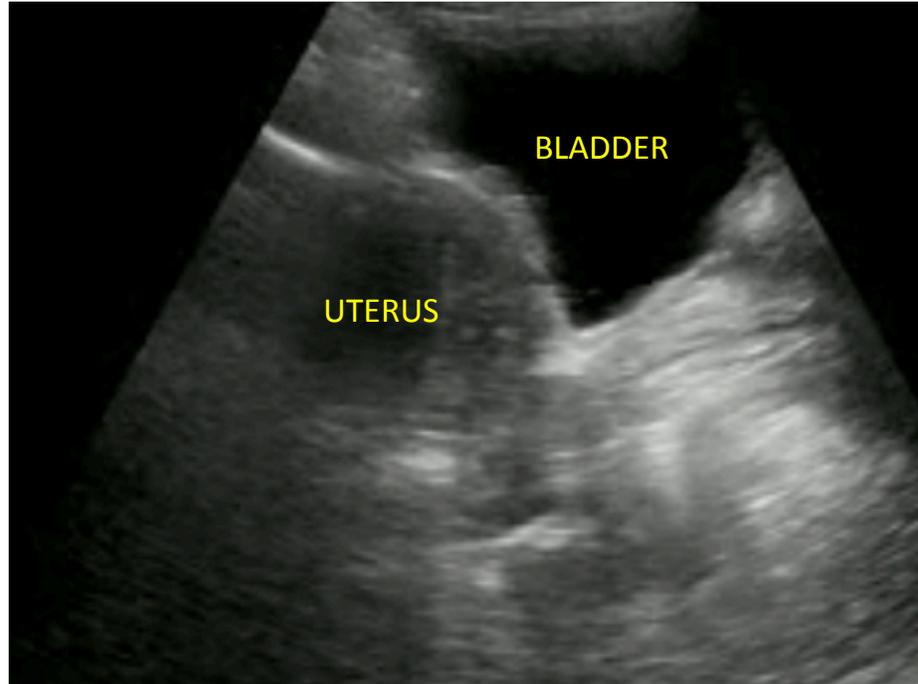


PELVIS: NEGATIVE TRANSVERSE SCAN  
WITH EDGE ARTIFACT  
(SEE **TOP TIPS** BELOW)



PELVIS: POSITIVE TRANSVERSE SCAN  
LARGE AMOUNT OF FREE FLUID

- Increase the depth so that you get a good view of the structures deep to the bladder.
- Scan in two planes, at 90 degrees to each other:
  - transverse plane (see images above)
  - sagittal plane (see image below)



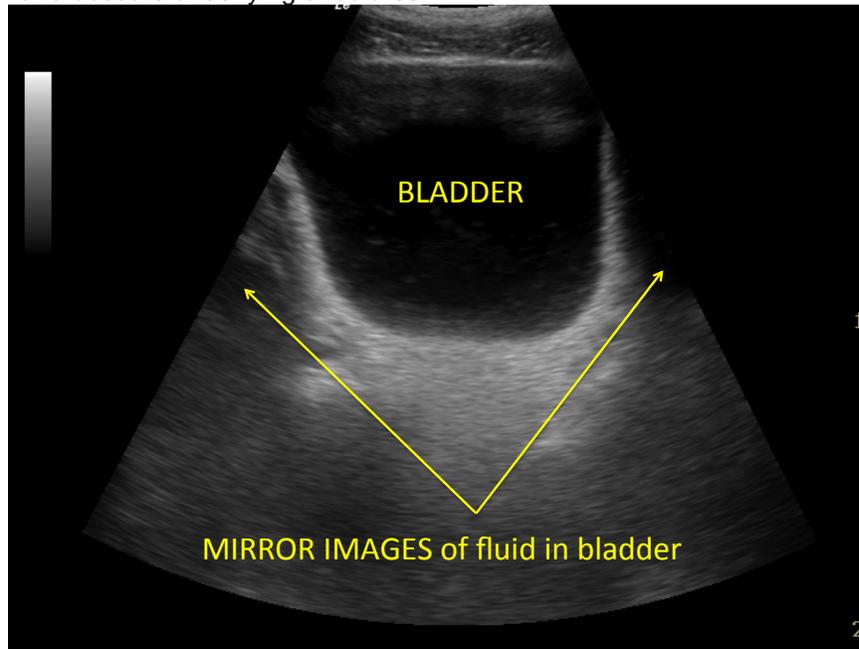
PELVIS: NEGATIVE SAGITTAL SCAN

- Scan all the way past the bladder, to be sure you aren't missing anything.
  - FF will be around the bladder or behind it (Pouch of Douglas).
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## TOP TIP: 2 ARTIFACTS TO LOOK OUT FOR AROUND THE BLADDER

### 1. MIRROR ARTEFACT

As noted in section 1 of this manual, the presence of a smooth, curved surface (in this case the bladder wall) with air on one side (in this case, in the bowel next to the bladder) creates perfect conditions for a mirror artifact. It is very common to see the FF in the bladder reflected outside it. This can mimic intraperitoneal FF and obscure underlying structures.



FALSE POSITIVE TRANSVERSE PELVIC IMAGE:  
MIRROR IMAGES OF FLUID APPEARS ON EACH SIDE OF THE BLADDER

### 2. EDGE ARTEFACT (see image above)

The lateral edges of any curved structure (such as the bladder) will cause sound waves to reflect off at such an angle that they simply don't return to the probe. This creates 'shadows' and obscures deeper structures.

### HOW TO DEAL WITH THESE TWO ARTIFACTS

Move the probe and re-scan from different sites over the bladder. For best results, scan THROUGH the bladder if at all possible. In practice, place the probe to the left of the bladder and scan through the bladder to image structures on the right, and vice versa. This will eliminate the artifacts from the area of interest.

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## EFAST: Handy Hints

- Pericardium:
  - There are three windows you can try: subcostal, left longitudinal parasternal, and apical
- RUQ & LUQ
  - When rib shadows get in the way:
    - Scan through the respiratory cycle
    - Try a sector probe (small footprint fits between ribs)

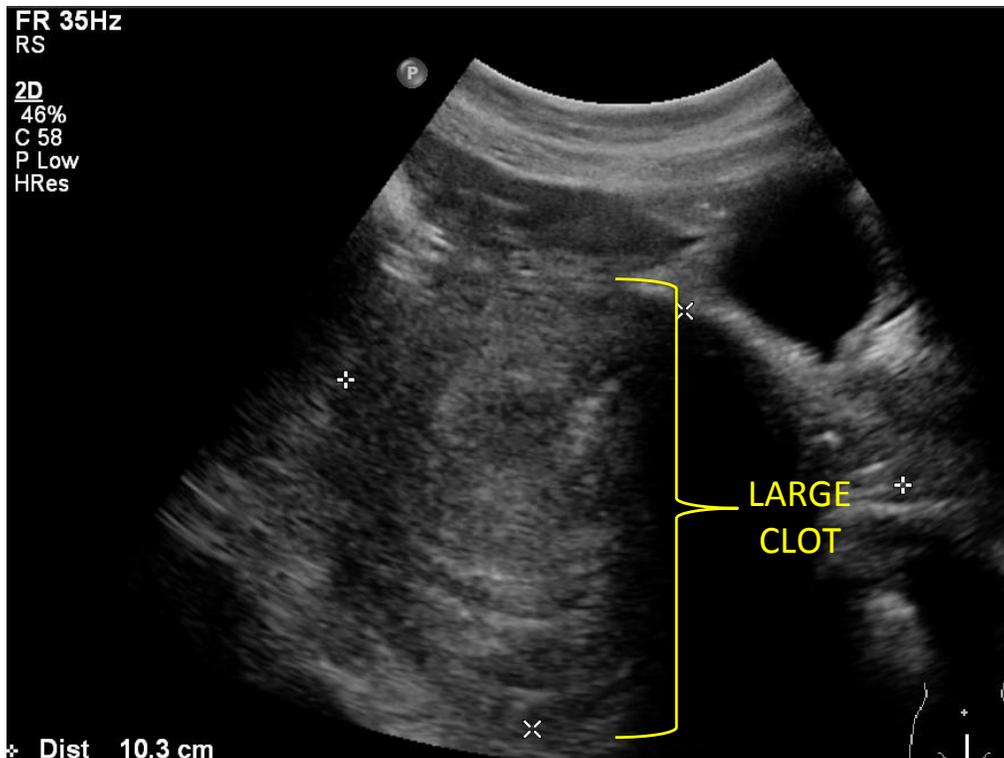
- Change the probe angle to parallel the ribs
- LUQ: the spleen and kidney are more posterior and more proximal than you think!

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## TOP TIP: FALSE POSITIVES & NEGATIVES FOR FREE FLUID

### False negative scans.

- In the presence of small amounts of FF, a single view of each window may be falsely negative. Hence, scan through a number of planes to rule out FF. if you still suspect FF, consider serial scans or other investigation.
- Like complex fluid, clotted blood isn't black. It may be (a) confusing the first time you see it, or (b) hard to see at all: for instance clotted pericardial blood may be isoechoic with the liver on a subcostal scan

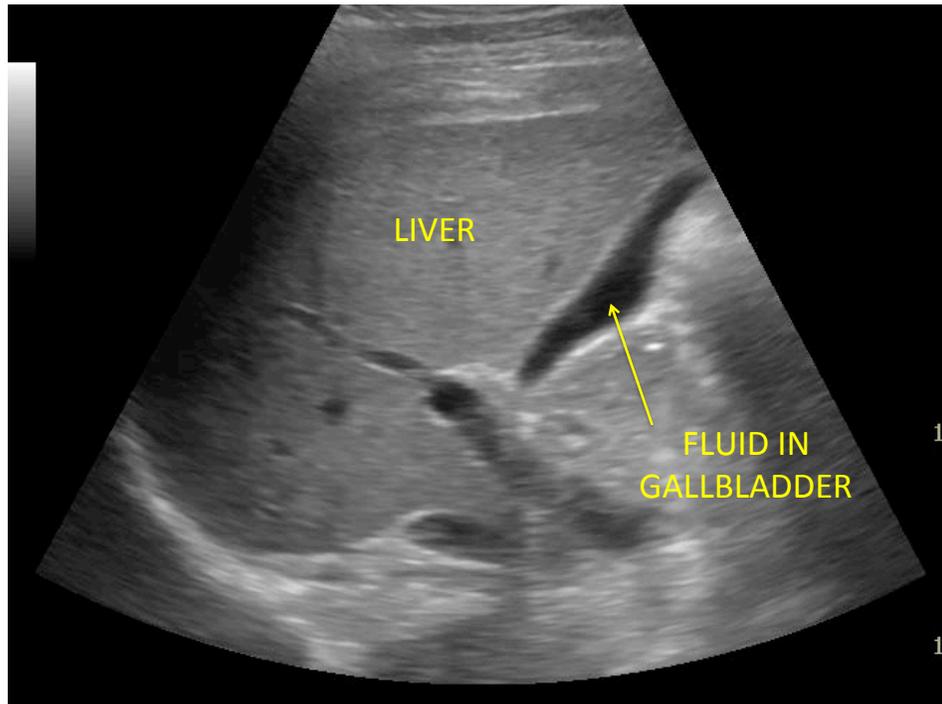


FALSE NEGATIVE PELVIC WINDOW  
LARGE AMOUNT OF CLOTTED BLOOD INDICATED.  
IMAGE COURTESY OF ROBYN TANTAU

- Always remember to **repeat** the scan if a stable patient becomes unstable.

### False positive scans.

- **Fluid in vessels / the GIT / gallbladder**
  - On the RUQ, fluid in the GB, IVC and portal vein can mimic FF
  - On the LUQ, fluid in the stomach can mimic FF
  - Anywhere in the abdomen, fluid in the bowel can mimic FF
  - But in all of these cases, the fluid is enclosed.
  - Just in case, scan any positive findings of FF through a number of planes and observe for peristalsis, pulsation and displacement with respiration. This allows FF to be differentiated from false positives due to fluid filled structures such as inferior vena cava, gallbladder and intraluminal bowel fluid.



FALSE POSITIVE RUQ:  
FLUID FILLED GALLBLADDER

- **Other causes for false positive peritoneal scans**
    - Fat in Morison's Pouch, separating the liver and kidney
    - Ascites
    - Mirror artifact (see **TOP TIPS** above)
  - **False positive pericardial scan**
    - Pericardial fat pad
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## What EFAST Can Tell You

EFAST can determine the presence of the following:

- Free intraperitoneal fluid
- Pericardial fluid
- Pleural fluid
- PTX

## What EFAST Can't Tell You

FAST cannot determine the following:

- **Source** of free fluid
- **Nature** of free fluid eg. blood versus ascites
- Presence of solid organ or hollow viscus injury
- Presence of retroperitoneal injury.

## Summary

- **EFAST is useful when assessing the traumatized torso.**
- **EFAST is indicated only if it will affect patient management.**
- **It does not replace sound clinical judgement.**
- **It must be used in conjunction with ATLS principles.**
- **If in doubt, turn off the machine and go back to being a doctor.**