Focused Acute Medicine UltraSound (FAMUS) HANDBOOK

Abdominal Module

V1.1

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1) Introduction to FAMUS:

In many parts of the world ultrasound is learnt as part of the undergraduate medical curriculum, but within the United Kingdom it has traditionally been practised under the auspices of radiology departments. With the increasing availability of ultrasound machines that are portable and relatively cheap, there has been much interest in the use of Point of Care Ultrasound (POCUS). There is significant potential for POCUS to both facilitate clinical decision making and increase patient safety, particularly during invasive procedures. It is now considered mandatory for chest drains for pleural effusion to be undertaken with ultrasound guidance, and central line insertion has long been facilitated by the use of ultrasound. Specialties have started to develop their own training and governance standards; Emergency Medicine has incorporated the Focused Assessment with Sonography in Trauma (FAST) protocol within their curriculum, and Intensive Care Medicine has recently published Core Ultrasound Intensive Care (CUSIC). The Royal College of Radiologists have issued standards relating to individual system examinations, and there is good evidence for the utility of protocolised chest ultrasonography (the 'BLUE protocol') in the adult patient presenting with acute respiratory failure. There has not previously been an ultrasound curriculum designed to aid the management of the unwell adult medical patient outside of Critical Care.

Within Acute Medicine, a recent trainee survey conducted by this group, highlighted enthusiasm among trainees for some form of ultrasound training to be a core part of the Acute Internal Medicine (AIM) curriculum. In addition, clinicians on the Acute Medical Unit (AMU) support the use of ultrasound on the AMU and the development of specific guidelines for AMU clinicians.

We present here the Focused Acute Medicine Ultrasound (FAMUS) Handbook developed specifically for physicians on the AMU to aid in the management of the breadth of patients who present to Acute Medicine.

2) Abdominal Module:

Attempting to image the abdomen using ultrasound can be daunting due to the technical ability required, the complex abdominal anatomy and significant anatomical variation. An appreciation of the different echogenicity of abdominal organs and artefacts such as acoustic enhancement and shadowing seen when scanning through the abdomen are key in interpreting the images obtained and making a correct diagnosis.

The difficulty in scanning is often the body habitus and position of the patient. Furthermore, having a technical ability along with an understanding of the ultrasound machine is critical to obtaining good quality images that can then be interpreted to influence clinical decision-making.

A key part of abdominal scanning is to appreciate the effects of preparation of the patient for elective scanning against that of scanning the patient at the bedside, point of care scanning. In essence bowel gas is difficult to predict and often challenges the most experienced sonographer to obtain good quality images. The fasted patient will often allow for an appreciation of the gall bladder and biliary system and a patient who is able to fill their bladder will enable better images of the bladder and urinary system when scanning.

Generally, the probe for abdominal scanning is a low frequency (generally 3-5 Mhz) curvilinear probe. It is essential to ensure there is correct usage of the depth to ensure that the organs being scanned are viewed without too much ‘dead space” below the organs being scanned. It is also essential to utilise the gain effectively to allow focus on a particular organ along with manoeuvring the focus or multiple foci again to enhance the images and area being scanned to aid interpretation. It is therefore necessary to understand how to operate the machine being used. This will maximise the quality of images produced, particularly when scanning the acutely unwell patient. Particular attention to Depth; Gain; Focus/Zoom is required.

I. Seven-Point Focused Abdominal Ultrasound

Access to high quality departmental ultrasound in UK hospitals is generally very good and there is rarely a need for detailed imaging at the bedside. Comprehensive scanning of abdominal organs and pathology should be left to the experts - usually sonographers or radiologists - who undertake regular scan lists on high performance equipment.

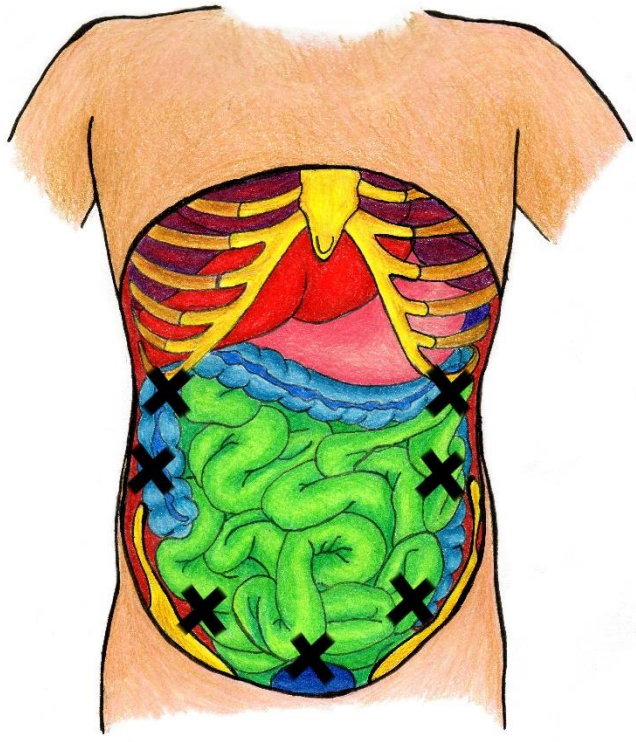
The FAMUS abdominal module has been designed to enable acute physicians to gather useful diagnostic information quickly and to improve the safety and efficiency of urgent bedside abdominal procedures for sick medical patients.

Two specific focus areas of abdominal ultrasound have been identified which are covered in a reproducible seven-point scan. By way of answering specific questions detailed on the data-sheet the operator should be competent to:

1) Assess the presence and/or degree of peritoneal free fluid [ascites]

2) Assess the kidneys and bladder to rule in/rule out urinary tract obstruction

Figure 1. Seven Point focused abdominal ultrasound: Right upper quadrant (1= longitudinal; 2= transverse plane); Left upper quadrant (3=longitudinal; 4=transverse plane); 5=Suprapubic; 6=Right flank; 7=Left flank



II. Abdominal Organs

To be able to capture the precise views required the operator will need to have a basic understanding of the appearance of other abdominal structures and organs which may act as landmarks or acoustic windows when imaging the free peritoneal spaces and the urinary tract.

The mnemonic '**PLiSK**' is useful to remember the descending order of echogenicity in healthy abdominal organs: from the brightest **P**ancreas →**Li**ver →**S**pleen→ the least echogenic **K**idney.

Liver

The normal liver is easily visible as a large, smooth edged, homogeneous textured organ with the left lobe seen primarily in the epigastrium, and caudate and right lobes in the right upper quadrant and flank. It is bordered superiorly by the brightly reflective diaphragm. Liver should be more echogenic than the renal cortex at a similar depth though excessive echo-brightness might suggest fatty infiltration. Portal and hepatic vessels are visible in normal liver architecture, but visible intra-hepatic ducts suggest dilatation and obstruction.

Gallbladder

When patients are fasted, the gallbladder will appear as a thin-walled, black (anechoic) pear shaped structure lying centrally beneath the liver. Sludge, brightly reflective gallstones or polyps may be visible within the gallbladder. Acoustic enhancement by bile may make distal structures appear bright.

Spleen

The spleen is homogeneous textured and crescent shaped with a smooth convex surface adjacent to the diaphragm and an irregular edged hilum abutting the stomach and left kidney. Generally, it is best seen in the 9^{th} – 11^{th} intercostal spaces in the left mid-axillary line. Bear in mind that interposing aerated lung may obscure the window hence scanning on expiration may improve views.

Uterus

When scanning the bladder in female patients the uterus should be visible in the midline posterior to the bladder. The body of the uterus (myometrium) should appear homogeneous in texture with a thin bright line of endometrium visible down the centre. It may be anteverted towards the bladder or retroverted towards the rectum into the pouch of Douglas, of which it forms the anterior border.

III. Assessment of Peritoneal Free Fluid

While other focused ultrasound protocols e.g. FAST require urgent identification of peritoneal fluid to signify intra-abdominal haemorrhage, the unwell medical patient is more likely to develop free fluid in the abdomen due to ascites, usually from liver disease, but also malignancy or cardiac failure. The appearances of blood and ascites may have subtle differences but the techniques and probe positions required to visualise them are the same. Confirming the presence of ascites clinically can be challenging in the acute setting. Sonographic confirmation at the bedside can improve diagnostic accuracy and guide safe diagnostic and therapeutic abdominal paracentesis, which may be urgent e.g. in the sick liver patient.

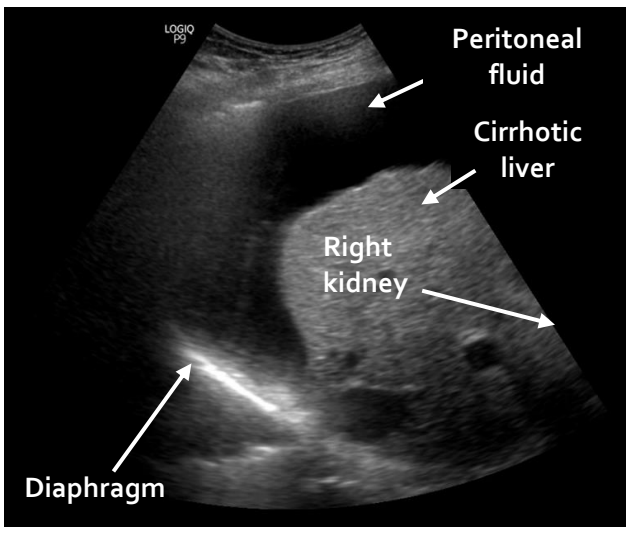
Patient Position

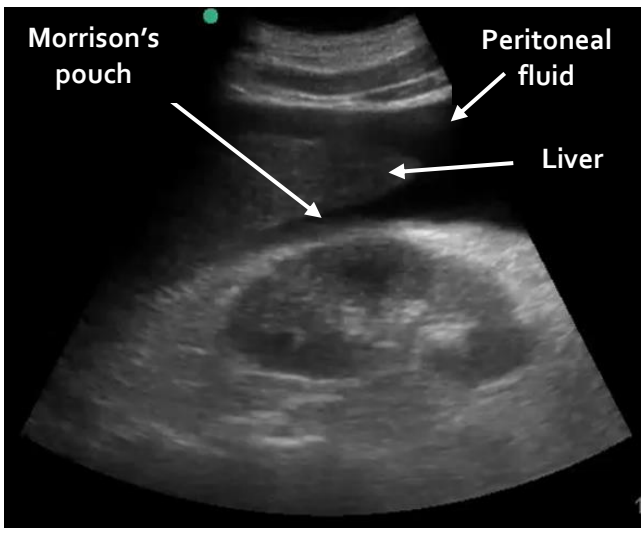
Supine

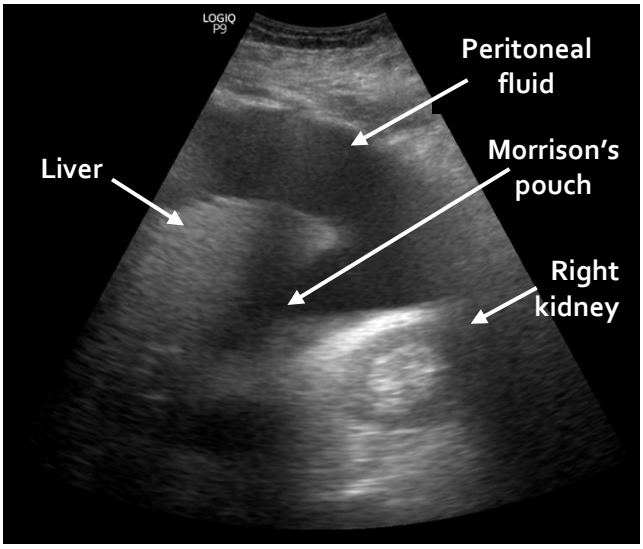
Probe Position

A. Right upper quadrant

Figure 2. Scanning points 1 (longitudinal plane) & 2 (transverse plane)





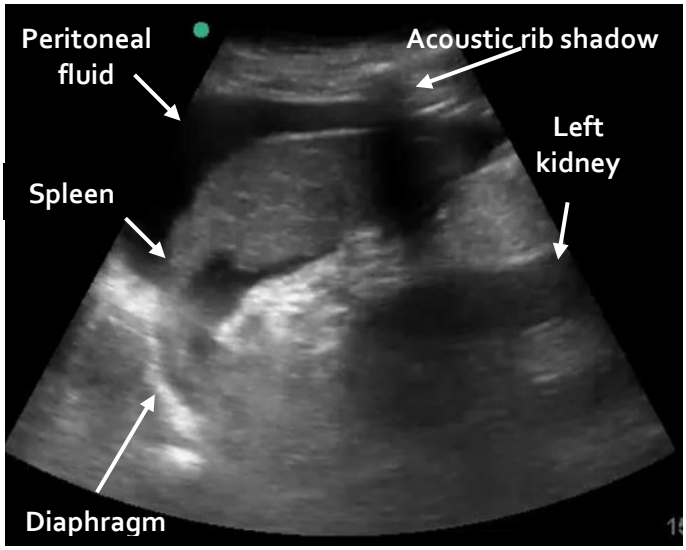


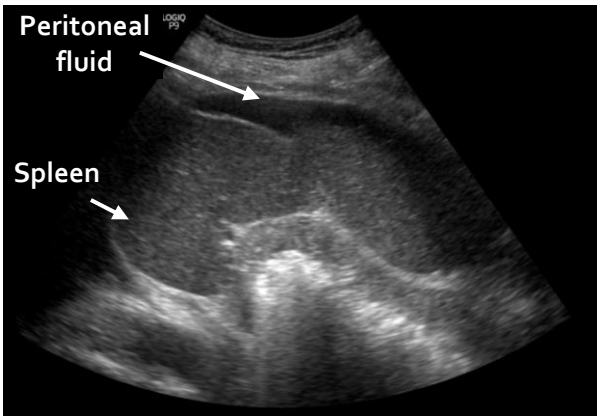
Diaphragm, Liver, R Kidney, Morrisons's Pouch

Small volumes of fluid may only be seen in Morrison's pouch between the liver and right kidney. As volume increases fluid will surround the liver and adjacent bowel and fill the sub-diaphragmatic space.

B. Left upper quadrant

Figure 3. Scanning points 3 (longitudinal plane) & 4 (transverse plane)



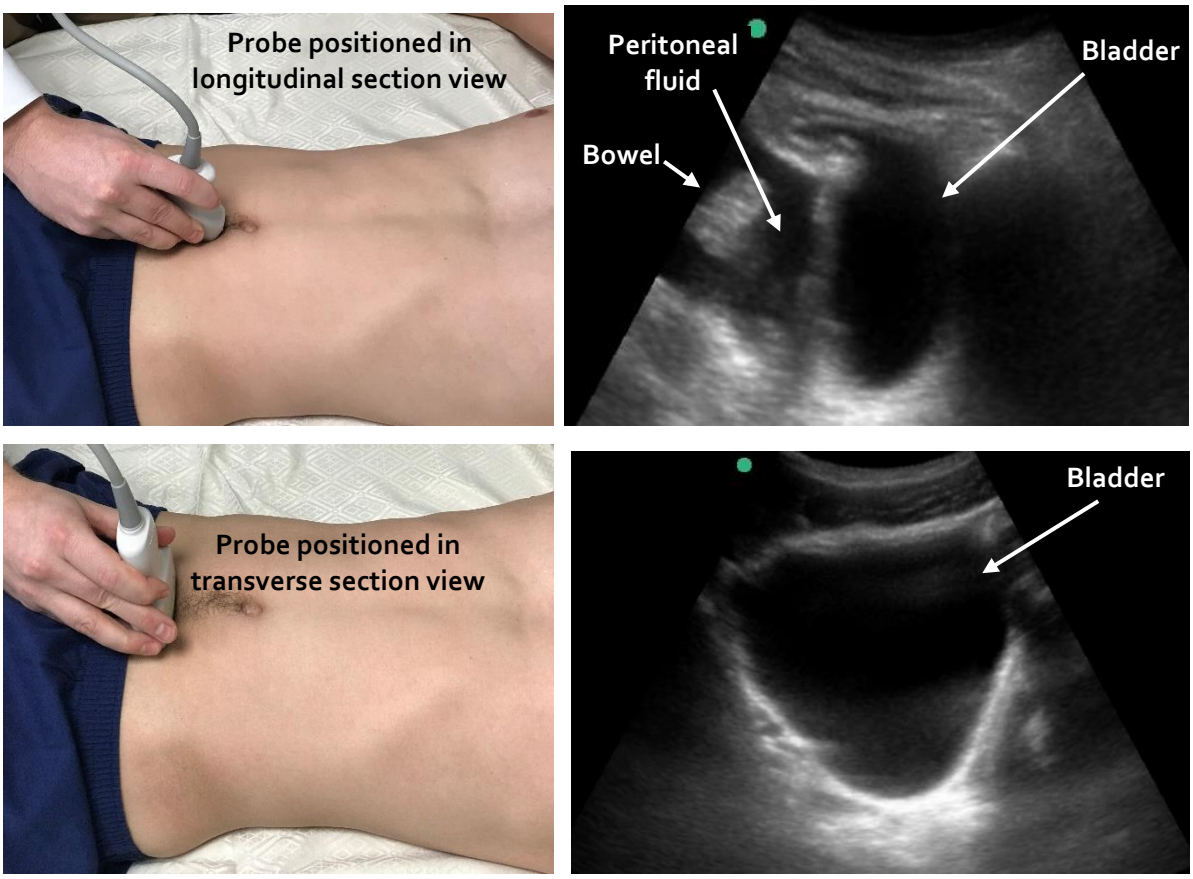


Diaphragm, Spleen, L Kidney, Spleno-renal recess

Depending on its origin and patient position fluid may first appear around the superior aspect of the spleen beneath the diaphragm or in the spleno- renal recess. Significant hepatomegaly or splenomegaly may preclude those quadrants as sites for therapeutic drainage.

C. Suprapubic – longitudinal and transverse views

Figure 4. Scanning point 5 (Suprapubic longitudinal & transverse planes)



Bladder

Look posterior to the bladder (and pouch of Douglas in females) for evidence of free fluid in both planes. A full bladder and its acoustic enhancement will help to pick up smaller volumes.

While these are the most sensitive points for picking up small volumes of fluid, many patients will have much larger volume ascites with fluid detectable throughout the peritoneal cavity and visibly surrounding small and large bowel.

If ascites is detected and fluid removal necessary, it is useful to slide the probe in an oblique position across the left and right lower quadrants and flanks to find the deepest (and therefore potentially safest) pocket of fluid to attempt needle paracentesis or drainage. It may assist the operator for the patient to lean 20-30° towards the side being imaged.

Bear in mind that the depth of fluid at any point will be dependent on probe position, the patient's position and gravitational dependency of the fluid. If further scanning requires the patient to move, the position and fluid depth should be reconfirmed with ultrasound immediately prior to commencing the procedure.

IV. Focused Assessment of Urinary Tract

The primary objective of a focused ultrasound examination of the urinary tract is to rapidly rule in or rule out urinary tract obstruction. In completing the seven-point abdominal scan, the operator should also be able to describe the likely level and severity of obstruction thus guiding further management.

The commonest forms of urinary tract obstruction seen in acutely ill patients are bladder outflow obstruction and unilateral ureteric obstruction. Urinary stasis in both situations predisposes to bacterial infection which can quickly lead to sepsis if left unmanaged. Likewise, increased retrograde pressure can cause acute kidney injury which will not recover without relieving the obstruction, be it temporarily or definitively.

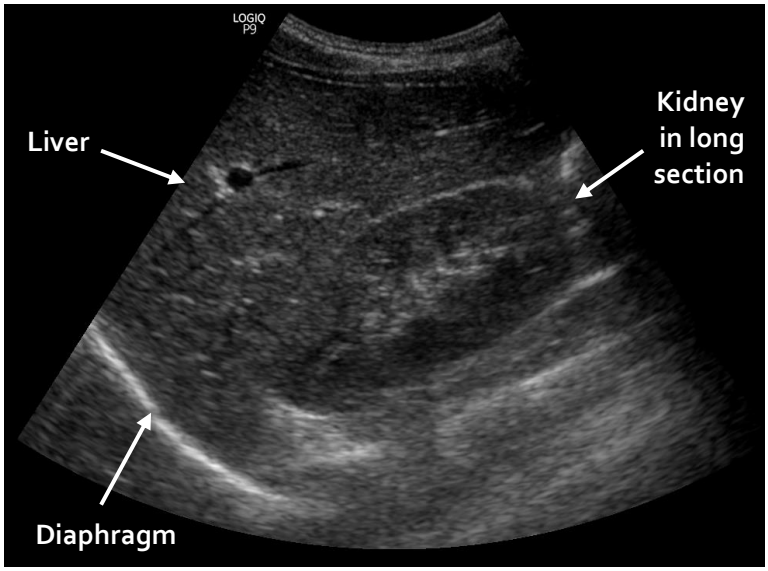
Competency in urinary tract ultrasound will require an understanding of both normal and abnormal appearances of kidney and bladder. This will enable the operator performing the scan to identify and classify the main types of obstruction and therefore classify hydronephrosis and gross bladder distension.

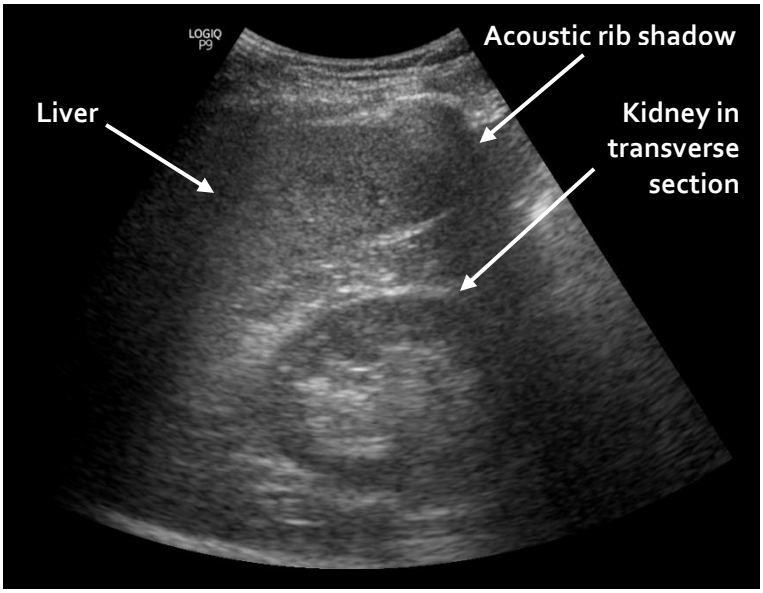
As with other areas of focused ultrasound, operators will inevitably pick up abnormal appearances in the urinary tract which lie outside the defined curriculum. Common abnormalities of the kidney might include cysts, polycystic kidneys, stones, abscess or even tumour. While the description and interpretation of these pathologies may be beyond the scope of our course, it is recommended to always describe and document any abnormal findings, save images where possible and refer the patient on for definitive imaging as appropriate.

A. Kidneys

Patient position: Supine / Lateral

Figure 5. Scanning Points 1&2 (Supine/Lateral)





Scan Technique

In scanning any organ, the kidney must be visualised in its entirety in two planes – longitudinal (LS) and transverse (TS) sections. It is customary to locate the kidney in LS first and this can usually be found in the flank just posterior to the mid-axillary line with the tip of the probe pointing slightly back in a posteriorly oblique angle. Remember the kidneys are retroperitoneal and as such are further back than people often realise.

With the threat of obscuring bowel gas ever-present in abdominal ultrasound, different techniques may be required to see the whole kidney. Remember to use acoustic windows - the right lobe of the liver and the spleen can offer good views through to the kidneys while avoiding interposition of large bowel. It may help to move the patient between a supine and lateral decubitus position while sliding the probe antero- medially or posteriorly. Also deep inspiration and breath holding can be helpful to push the kidneys down into view and improve the image.

Once the kidney can be seen well in LS, manoeuvre the probe to achieve maximum pole-pole length and save an image. Then sweep through the organ in that plane to ensure the whole kidney has been seen.
Rotate the probe 90° anti-clockwise to see the kidney in TS. Save an image at the hilum where renal vessels and ureter may be seen. Sweep through kidney from top to bottom.

Normal kidney appearance

The kidney is enclosed by a fibrous capsule and Gerota's fascia which are visible as a thin hyperechoic line between the liver and kidney. Within the capsule lies the renal parenchyma made up of cortex and medulla. The cortex should be less echogenic than the liver of the same depth (nb PLiSK) and contains regularly spaced hypoechoic medullary pyramids. The central sinus complex of vessels and collecting system surrounded by fat is hyperechoic compared with surrounding parenchyma.

Figure 6. Schematic and ultrasound image showing Right kidney and adjacent structures

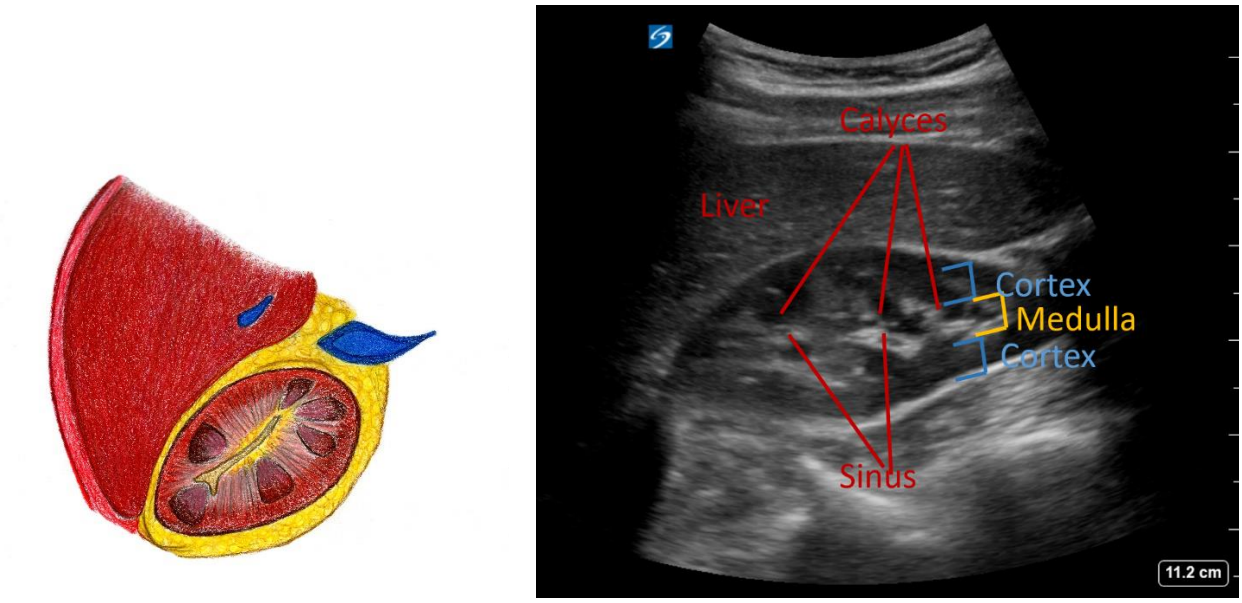
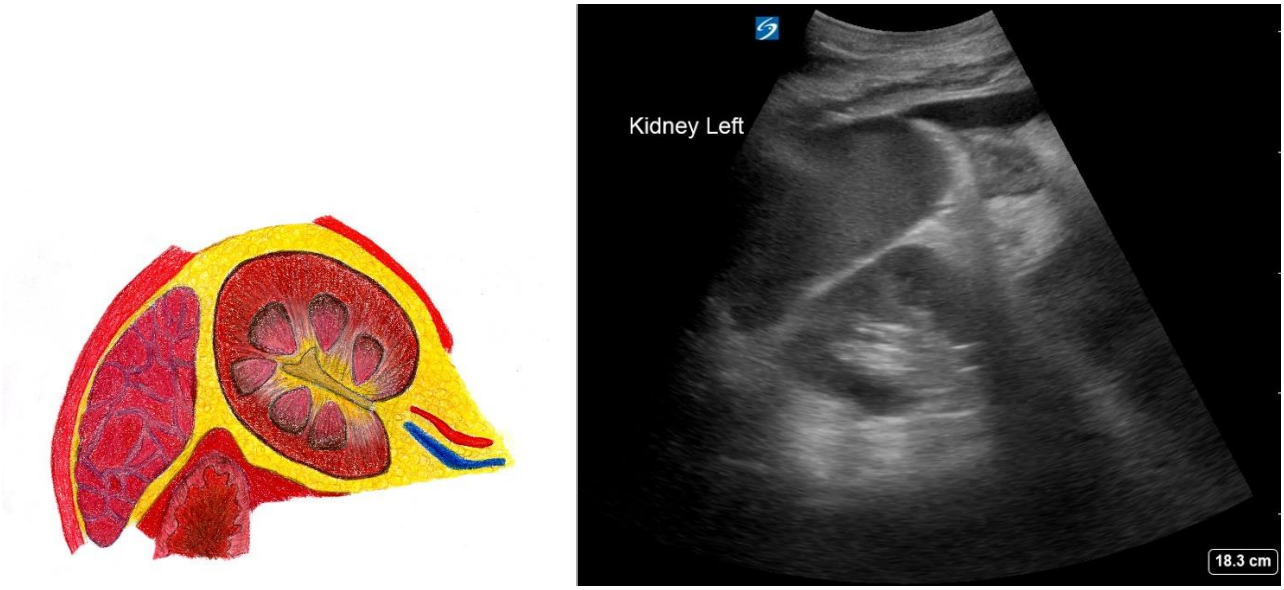


Figure 7. Schematic and ultrasound image showing Left Kidney and adjacent structures



Hydronephrosis

Mild/Grade 1:	Renal pelvis dilatation; no/mild calyceal dilatation; no parenchymal atrophy
Moderate/Grade 2:	Moderate pelvis and calyceal dilatation; early parenchymal atrophy may be present
Sever/Grade 3:	Gross pelvic and calyceal dilatation; loss of normal architecture; cortical atrophy

Figure 8. Schematic showing Mild, Moderate and Severe Hydronephrosis

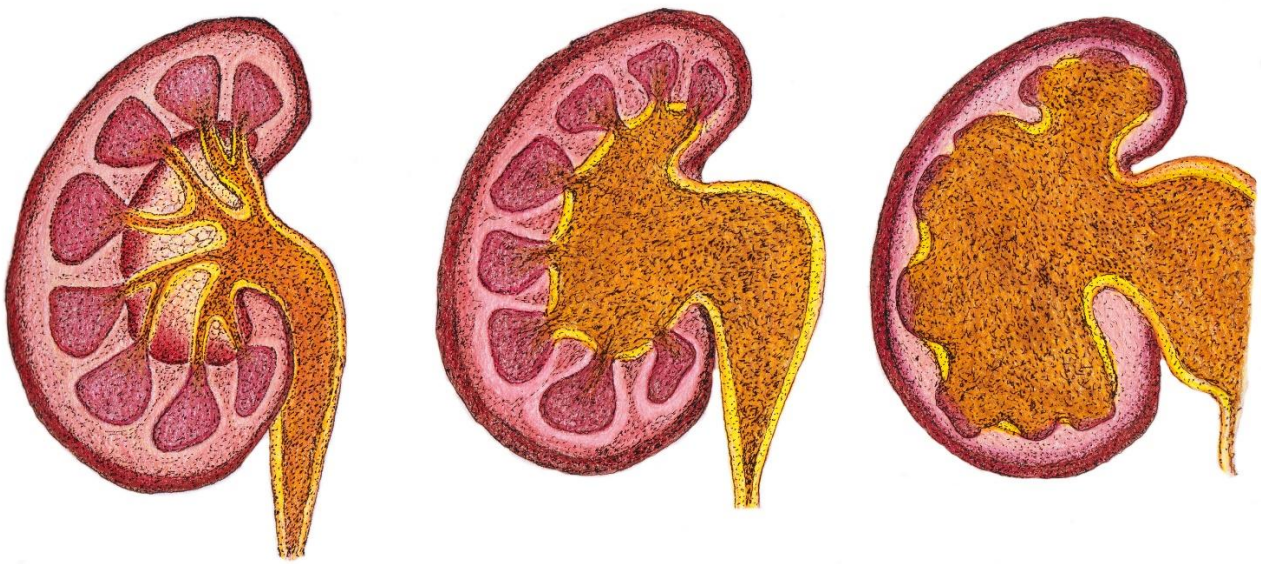
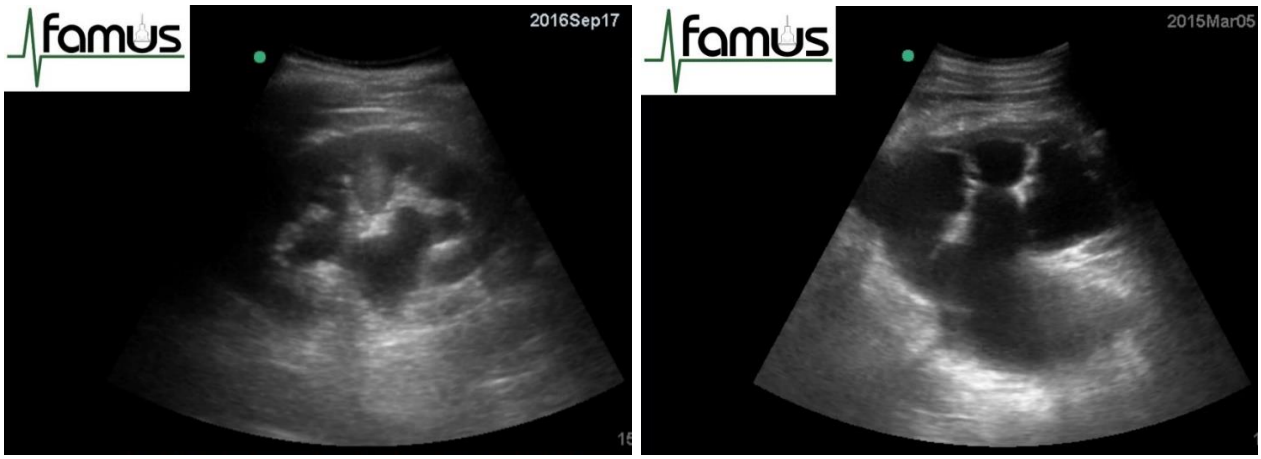


Figure 9. Ultrasound images showing Moderate and Severe Hydronephrosis



B. Bladder

An adequately distended bladder will appear as a trapezoid anechoic structure in transverse section just superior to the symphysis pubis. It should be thin walled and free of stones or debris. It is easy to mistake reflected echoes at the back of the bladder for sediment so remember to adjust your gain/TGC.

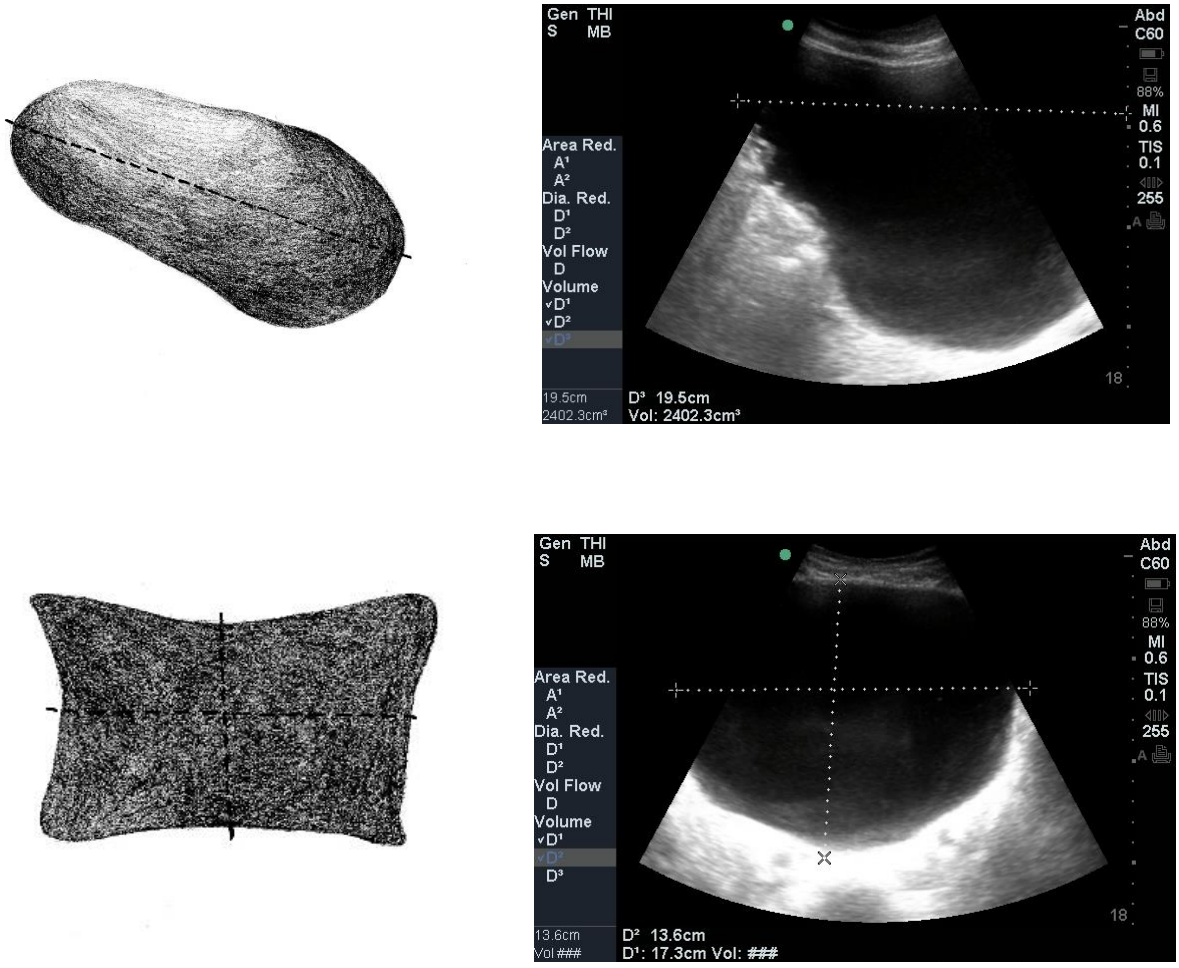
As with other organs we recommend scanning through the entirety of the bladder in both LS and TS and recording images in the midline. If it is not adequately distended the normal bladder wall will appear thickened.

If bladder outflow obstruction is present, a diagnosis of acute urinary retention is most often made clinically and confirmed either via urethral catheterisation or bladder ultrasound. While the normal bladder volume can be somewhere between 400 and 600ml, single ultrasound measurements of bladder volume - an algorithmic approximation – may not be accurate and without asking the subject to empty their bladder will not prove or disprove urinary retention.

Clearly the extremes of bladder volume will be informative and a grossly distended bladder which cannot be voided supports the diagnosis of outflow obstruction. Post-void volume measurements may be useful in patients with persistent urine infection, but can be misleading in the acutely unwell or septic patient.

Note, most ultrasound machines will be able to calculate a volume based on maximal depths in two planes with three calliper measurements to enable the calculation of absolute volume.

Figure 10. Schematic and ultrasound images of bladder in longitudinal plane (top images) and transverse plane (bottom images)



V. Reporting Sheet: Abdominal/Renal Ultrasound

Focused Acute Medicine Ultrasound (FAMUS)

Reporting sheet – abdominal/renal ultrasound

Trainee name: Date:

Patient identifier:

Image quality: Good Adequate Poor

Abdominal and renal ultrasound focused scan	
Right kidney identified?	Yes □ No □
Morison's pouch identified?	Yes □ No □ Fluid present □
Left kidney identified?	Yes □ No □
Splenorenal recess identified?	Yes □ No □ Fluid present □
Liver including hemidiaphragm identified?	Yes □ No □
Spleen including hemidiaphragm identified?	Yes □ No □
Bladder identified? Distended?	Yes □ No □ Yes □ No □
Free fluid identified around bladder inc Pouch of Douglas?	Yes □ No □
Any evidence of hydronephrosis? Degree of hydronephrosis if present	Yes □ No □ Mild □ Moderate □ Severe □
Site identified for ascitic tap/drain if required?	Yes □ No □
Comments/further details and conclusion of the scan:	
Trainee reflection on scan (optional) e.g how did the scan affect management	
Mentor/Supervisor comments:	

Signed (trainee):

Signed to confirm above findings (mentor/supervisor):

Initial to confirm trainee suitable to commence mentored practice (only required once): (minimum 10 supervised scans)

Is a Departmental scan required? Yes □ No □ Requested? Yes □ No □

Once completed trainee must maintain logbook of countersigned report sheets. Please remember not to remove patient confidential information from Trust property