POCUS Critical Care Workshop Pre-reading

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Point of care surface ultrasound can be lifesaving for emergency care of critically unwell patients.

Five commonly used techniques are described below, which will be covered in the workshop.
1. Cricothryoid puncture
2. Cardiac ultrasound
3. Lung ultrasound
4. Gastric ultrasound
5. DVT ultrasound

The two-hour workshop will be conducted as follows:
1 instructor / 5 delegates / 1 live human volunteer model
The instructor will demonstrate the scan– 5 minutes
Then delegates will copy (2-3 minutes)

1. Cricothyroid puncture

Surface ultrasound may be used to identify the correct site for percutaneous subglottic airway access and to guide access in real-time in principle; the technique is similar to ultrasound-guided vascular access. Cricothyroid subglottic tracheal access is usually performed in an emergency, when orotracheal intubation has failed or when it is deemed that orotracheal intubation will fail. Although the standard method for identification of the cricothyroid membrane and trachea for planned and emergency percutaneous subglottic intubation is by palpation, correct identification is generally poor. In one study, the success rate by palpation alone was only 30%. This is particularly so if there is an inflammatory process involving the neck. Using ultrasound, the mean time to accurately identify the membrane by emergency physicians was only 25 seconds. Ultrasound location of the subglottic airway may be particularly useful in patients with obesity or abnormal anatomies such as pretracheal infection or scarring. The site and depth of the cricothyroid membrane should be routinely identified and marked before attempts at intubation are made in patients with a predicted difficult intubation. This would facilitate emergency cricothyroid access if required, such as after failed intubation or inability to oxygenate. Alternatively, a cricothyroid cannula may be safely placed under local anaesthesia prior to oral intubation attempts.

Cricothyroid puncture

Either the longitudinal or transverse ultrasound approach may be used. The cricothyroid membrane appears as a thin but brightly echoic line between the cricoid and thyroid 2 cartilages and their accompanying shadowing. The tracheal rings below the hyoid bone have a characteristic ‘line of beads’ appearance. The procedure can be assisted by either using ultrasound to mark the safest needle entry site on the skin (static) or to guide the needle into the trachea in real-time (dynamic).

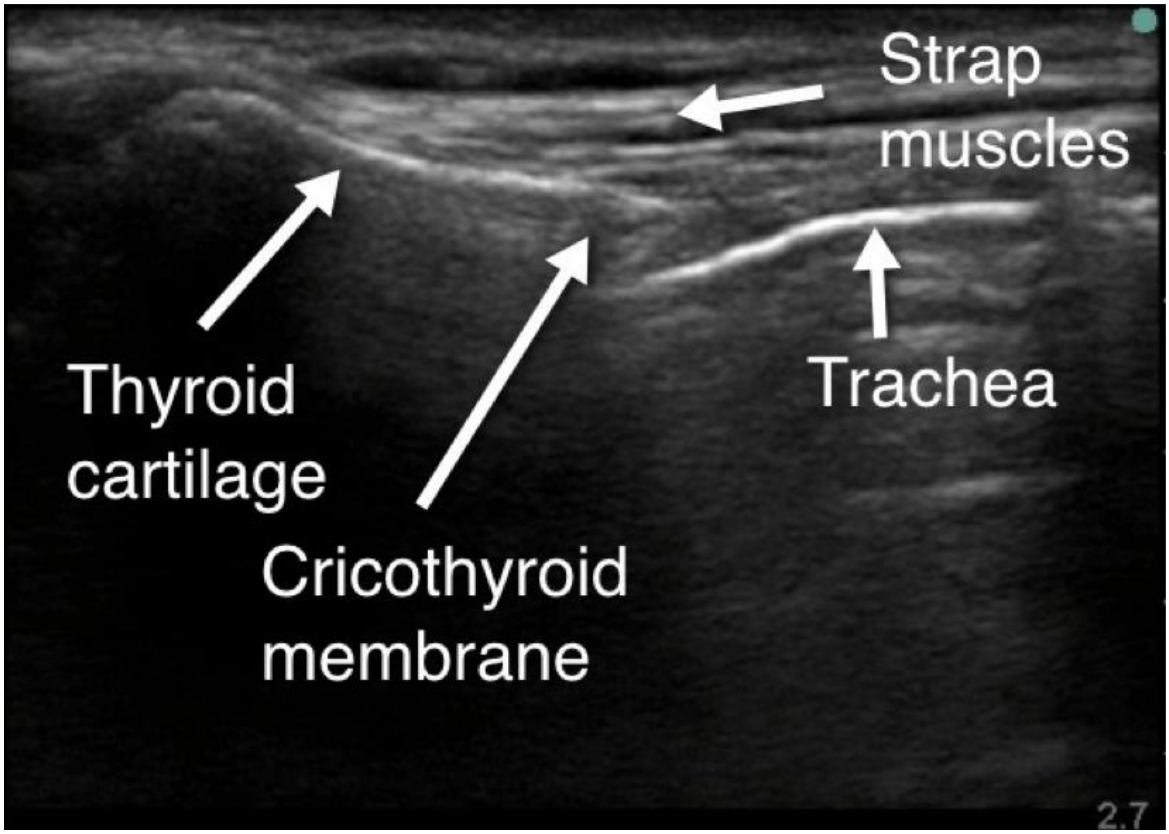


Figure – long axis view of the airway

Static ultrasound technique

• Use a linear transducer for higher frequency and improved resolution.
• Stand at the head of the bed with the ultrasound machine facing you and as close to the patient as possible.
• Orient the probe such that movement of the probe laterally in one direction gives the corresponding change in image (left and right concordance).
• Apply the probe transversely showing a short-axis view of the larynx. The thyroid and cricoid cartilages are very easily palpated.
• Look for the cricoid and thyroid cartilages with an intervening horizontal bright cricothyroid membrane.
• Mark the skin for the subsequent cricothyroid puncture in a conventional manner (static ultrasound).

Dynamic ultrasound technique

• Locate the safest needle entry point as above, using sterile technique. Several types of sterile sheaths are available to place the probe.
• Holding the probe in one hand, insert the needle with the other hand at the midpoint of the transducer into the skin. Identify the needle tip on ultrasound and ensure that it is located directly above the target.
• Advance the needle under direct ultrasound guidance, ensuring that the needle tip is visible at all times. Failure to do so risks needle advancement in an undesired direction.
• When the needle tip reaches the airway dispense with the ultrasound equipment and proceed with your normal technique.

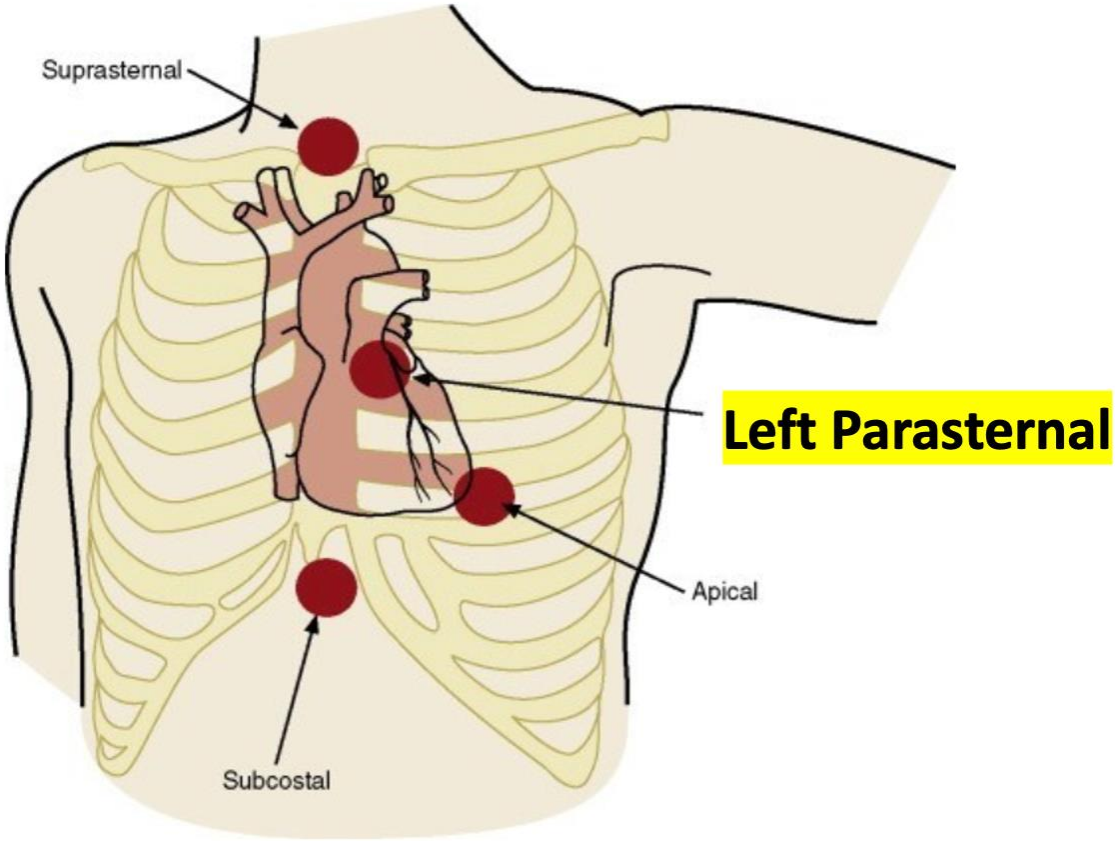
2. Cardiac ultrasound

Clinical examination has been shown to be unreliable in the assessment of shock. Focused cardiac ultrasound (FCU) has been demonstrated to increase the diagnostic accuracy of clinical examination from around 50% to 80%, enabling increased confidence in using FCU to direct acute resuscitation, such as identification of hypvolaemia, vasodilation (e.g. sepsis, anaphylaxis or response to anaesthetic drugs), left and right ventricular dysfunction, aortic stenosis, pulmonary hypertension and cardiac tamponade.

In this workshop, you will learn how to identify LV failure, vasodilation, hypovolaemia and aortic stenosis.

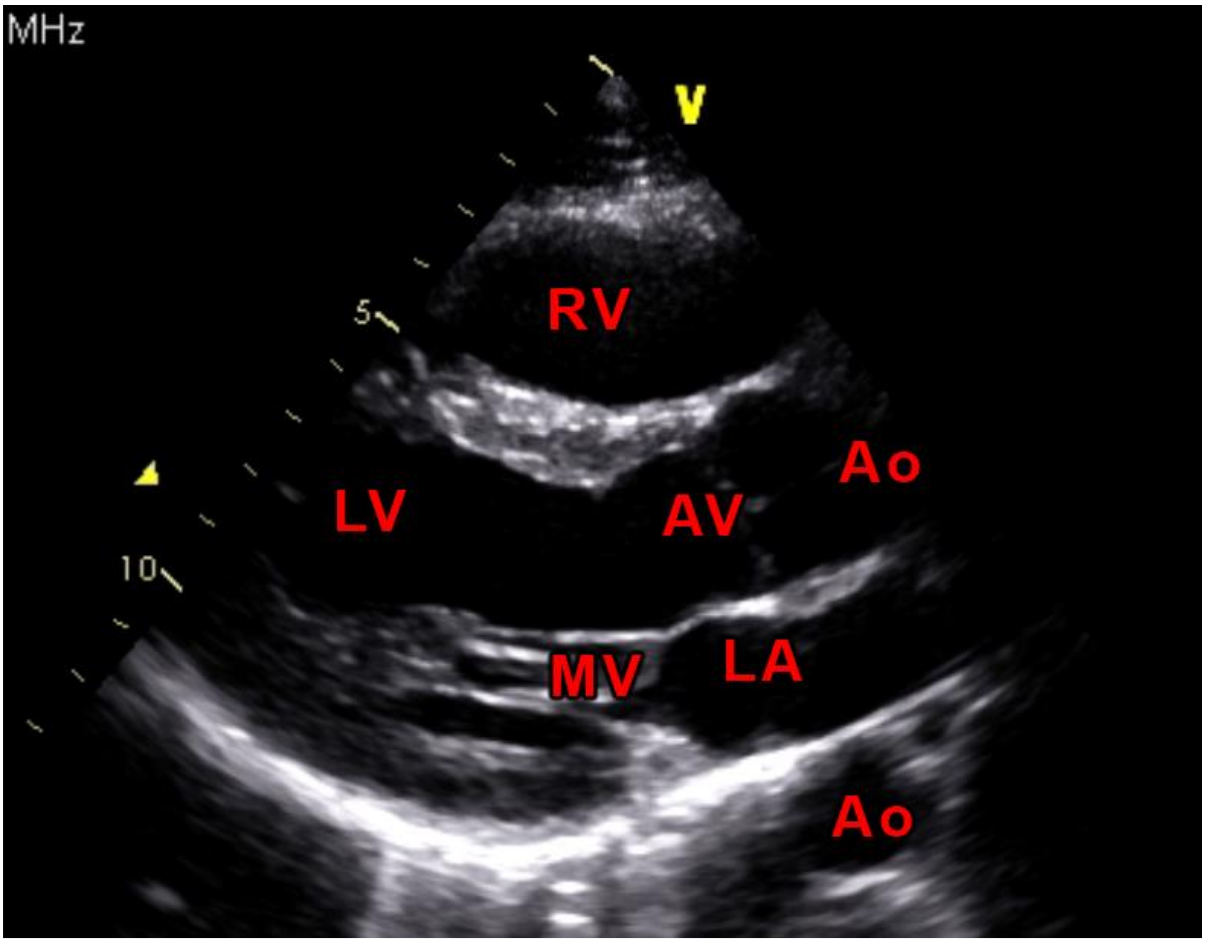
There are three commonly used transthoracic windows (figure below). **The parasternal long axis view** can identify these conditions and will be described here and practised at the workshop.

The left parasternal window is located around the fourth intercostal space just to the left of the sternal edge. The exact location depends on the position of the patient and the position of their heart in the chest. Various pathologies, especially lung disease, may make the exact position and alignment of the probe differ from patient to patient. For example, the window is often seen in the fifth intercostal space in supine patients, and in patients with hyperinflated lungs or unfolded aortas as the heart is pushed down in the chest.

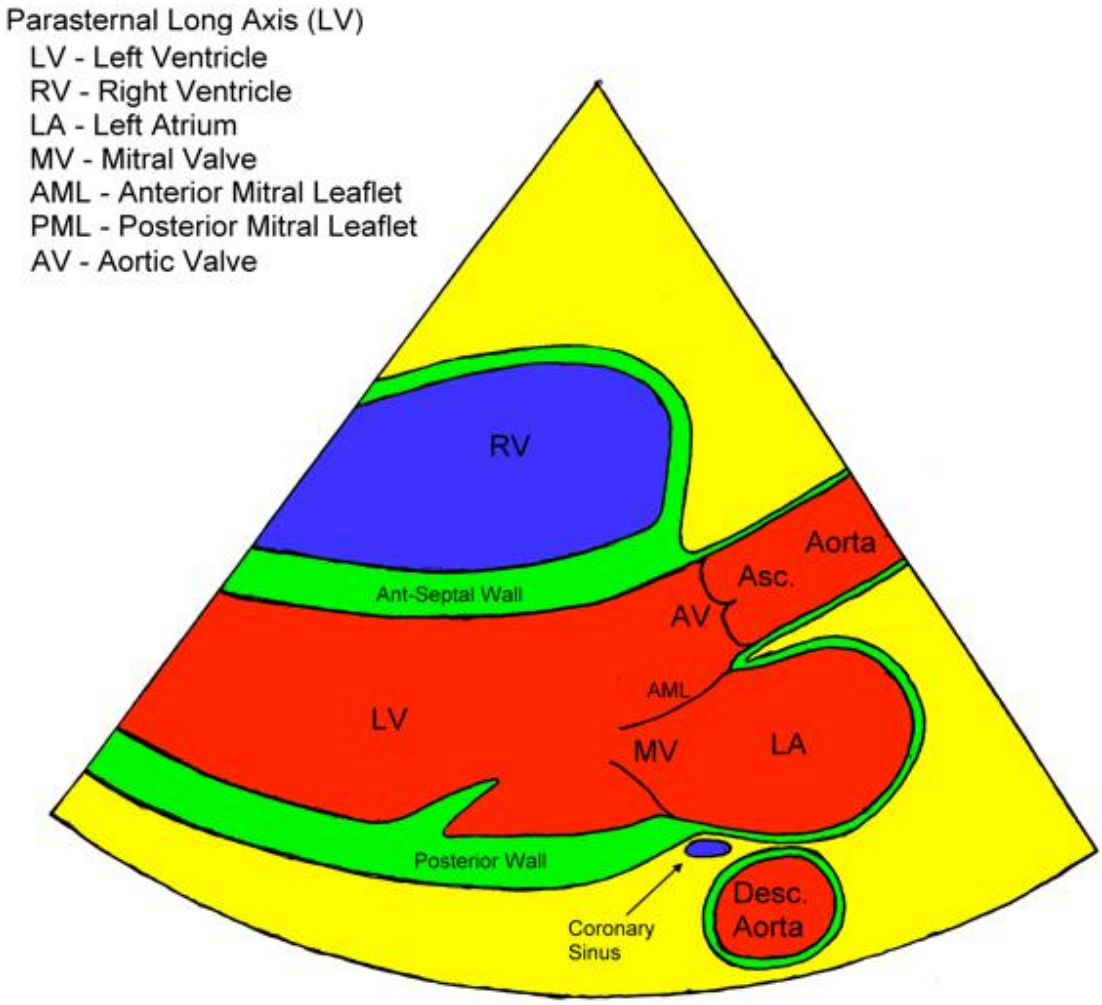


The optimum position of the patient is generally left lateral at an angle of 45° to 90°, although in some people a greater or lesser amount of lateral tilt is required. This window is often the starting point of an examination. Still, it is also the window most likely to fail in the setting of hyper-inflated lungs from positive end-expiratory pressure (PEEP) or airway disease or when there is air in the chest after cardiac surgery. Air in the mediastinum will typically resolve within 12–24 hours post-surgery allowing some degree of imaging after that time.

The PLAX view shows the mitral and aortic valves, the left atrium, left ventricle and proximal ascending aorta. The right ventricle (outflow tract region) is also seen. The walls of the left ventricle in any long axis view are the anteroseptal and the infero-lateral (posterior) walls.
The descending aorta can be seen adjacent (deep) to the left atrium, but this is not a feature of all long axis views.



Parasternal long axis view. LV; left ventricle, RV; right ventricle, AV; aortic valve, Ao; aorta, MV; mitral valve, LA; left atrium.



The PLAX view can be found by making sure that the index marker of the probe is pointed towards the right shoulder (think of the scan plane dissecting the right clavicle). This tends to align the sector scan with the natural angle of the rib interspace and will produce a parasternal long axis window in most people. However, in some patients the alignment of the ribs is very horizontal, leading to a rotation error. In this instance, the probe needs to be rotated in a clockwise fashion until the scan plane dissects the right clavicle. It may appear in some patients that the probe is crossing the rib rather than snugging inside the intercostal space. A long axis view of the left ventricle has both the aortic valve and the mitral valve in view at the same time.

A common error is to angle the probe a little towards the hip and for the tricuspid valve to be in view. The tricuspid valve can be recognised by its position at the entrance to the chamber under the probe. If the tricuspid valve is in view, it is necessary to angulate a little up towards the head to visualise the left ventricle. Once the mitral valve and left ventricle are in view, a combination of a little angulation and a little rotation is necessary to open up both the left ventricle and the left ventricular outflow tract. Ideally the left ventricle should be reasonably horizontal on the screen. If it is angled with the mitral valve in the bottom right of the screen and the apex towards 10 o'clock, moving up a rib space will make the left ventricle more horizontal. However, in many patients, because of lung obscuration, it is not possible to image from a rib space high enough to get the left ventricle horizontal and a compromise needs to be accepted.

The initial examination should be done with the depth setting near maximum to observe any more distant structures, particularly effusions, before reducing the depth to a more standardised distance (e.g., 14–16 cm). The consistent use of a standardised depth will allow for easier recognition of

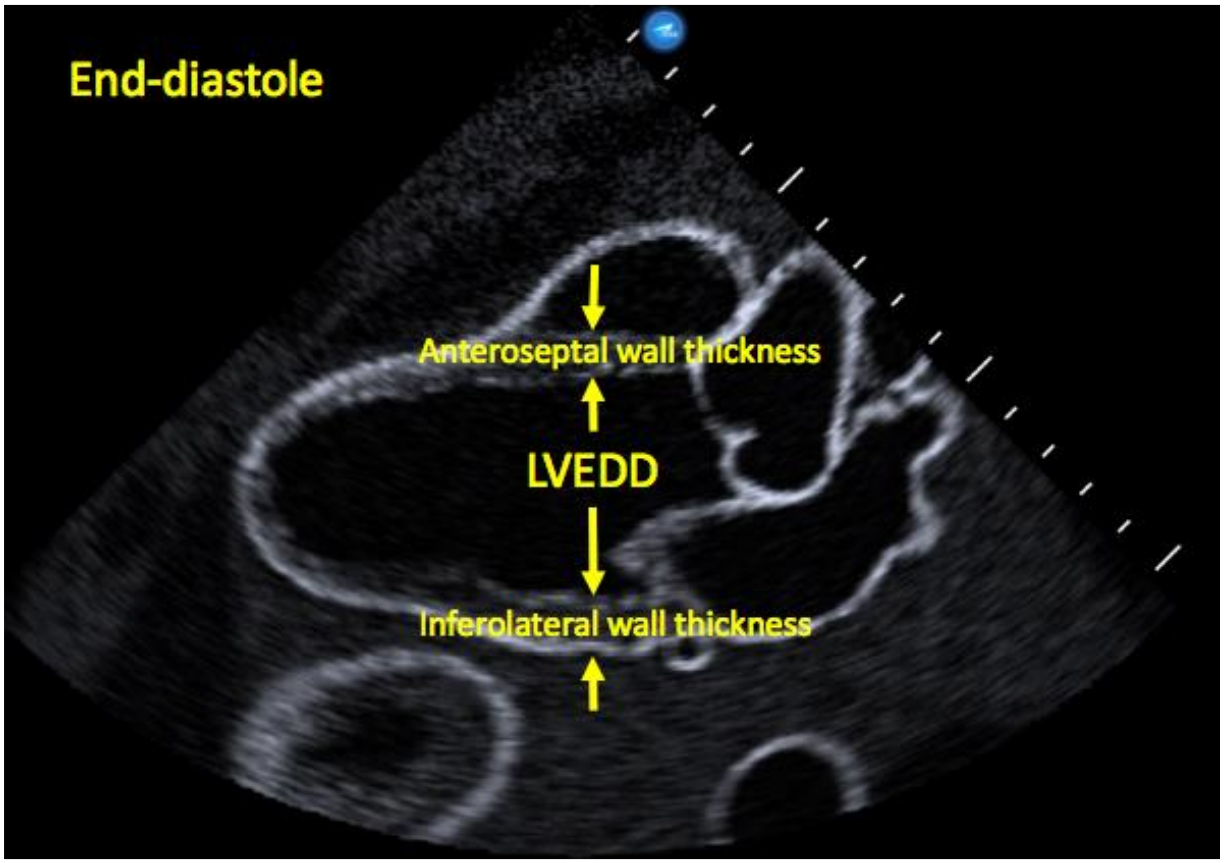
enlarged structures. By angling the transducer towards the right hip, the right atrium and ventricle can be seen. If angled towards the head (go past the aorta), the pulmonary valve can be seen in long axis.

In the absence of certain congenital heart lesions, when viewing the heart through the (left) parasternal window, the chamber next to the probe is always the right ventricle irrespective of the exact view. The right ventricle is the more anterior of the two ventricles. Accordingly, if when attempting to get the parasternal long axis view of the left ventricle, there is a valve visible on the screen and it is connected to the chamber immediately under the probe, you know that it is either the tricuspid valve or the pulmonary valve (much more likely to be the tricuspid valve).

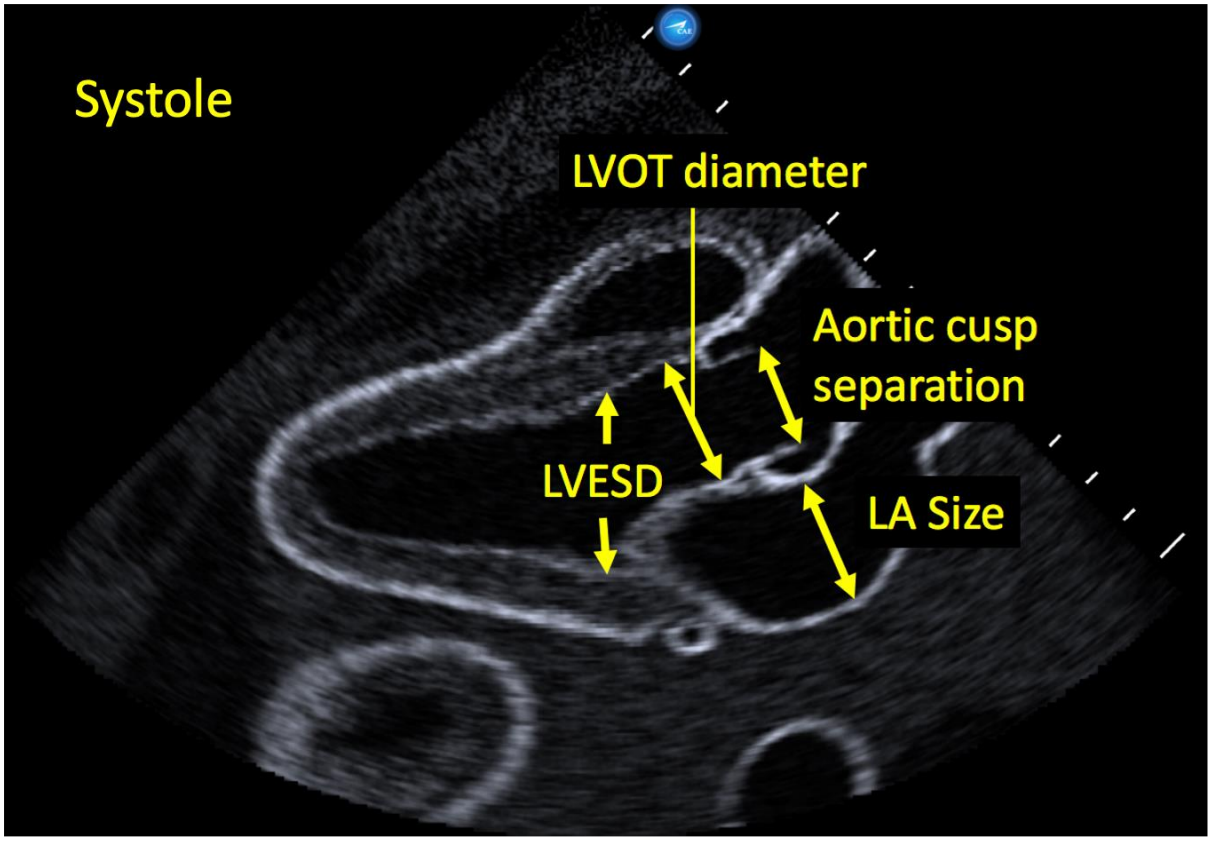
If the valve is opening into the chamber, it is the tricuspid valve, you have the right ventricular inflow view, and you know you have angled the probe too much towards the hips. Therefore, you need to angle the probe up a little towards the head. If the valve is opening away from the probe, it is the pulmonary valve and you have angled too much towards the head.

Assessment of pathology

Both volume assessment and LV and RV function are assessed quickly by measuring the LV chamber dimensions at end diastole and mid systole.



LVEDD = Left Ventricular End Diastolic Dimension
Hypovolaemia: LVEDD < 2.8 cm
Hypervolaemia: LVEDD > 6.6 cm



LVESD = Left Ventricular End Systolic Dimension

LV Fractional shortening (FS) = LVEDD – LVESD / LVEDD x 100 (%)
Normal range: 28 – 44%
LV failure: FS < 28%
Vasodilation: FS > 44%

Aortic stenosis (AS)

Findings associated with aortic stenosis include:
• Left ventricular hypertrophy (a wall thickness greater than 1.2 cm) is almost universally found in association with significant aortic stenosis.
• Aortic regurgitation is common as part of the valve degeneration.
• Post-stenotic dilatation of the aortic root is common with severe stenosis.
• Coarctation is associated with a bicuspid aortic valve.
• Aortic atheroma and mitral annular calcification are commonly seen with calcific disease.

TTE can easily identify aortic stenosis. The central feature of severe aortic stenosis is a failure of the leaflets to open during systole, which is identified using the PLAX view to observe the maximum aortic valve cusp separation (figure above).

There are three main types of aortic stenosis with roughly equal incidence: bicuspid valve stenosis, degenerative (calcific) aortic stenosis and rheumatic aortic stenosis.

A calcific valve appears as a trileaflet valve with progressive deposits of calcium in the leaflets. Rheumatic calcification occurs from the edges of the valve inwards, leading to a small, central opening

While features of the different types of stenosis are distinctive in early disease, by the time stenosis becomes severe, calcification is marked and the underlying aetiology very hard to determine. For the purposes FCU, the identification of the cause of the aortic stenosis is not relevant. The presence of a restricted and heavily calcified aortic valve indicates a significant haemodynamic change from normal and this is more important in the critical care or emergency environment.

Any stenosis that impedes valve opening enough to be moderate or severe will result in a positive examination, and the consequences of all three types of aortic stenosis are essentially identical for a given level of valve restriction.

Colour flow Doppler (CFD)

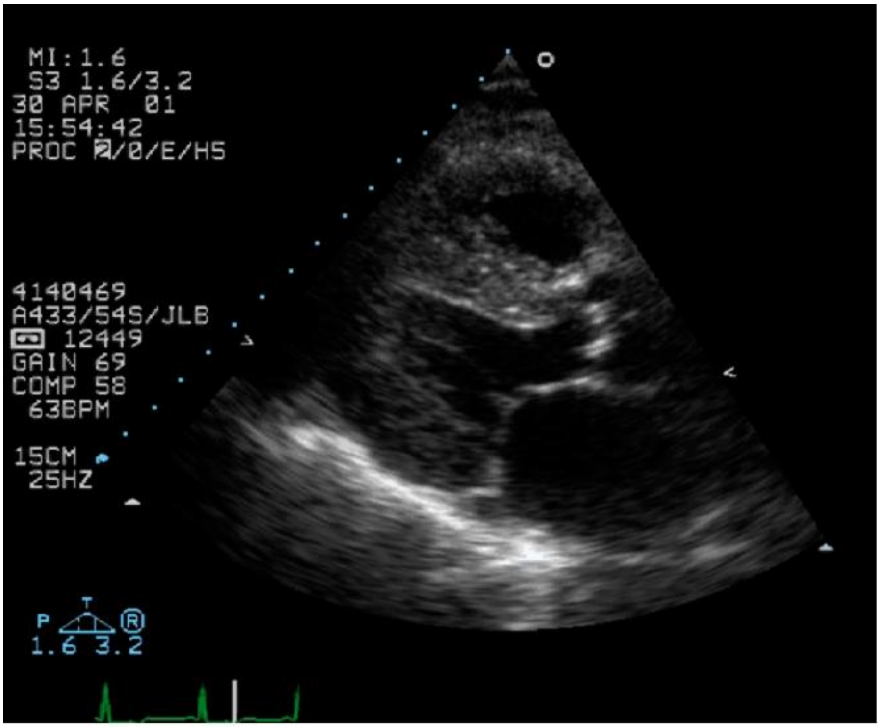
Colour flow Doppler is more useful for assessing aortic regurgitation, but any significant narrowing of the aortic valve will be associated with turbulence distal to the valve. This will be readily seen in a long axis window.

FCU criteria

These criteria are based solely on the 2D appearance of the valve. A positive scan is simply a valve that has a restricted opening similar to the reference views provided:

- An opening less than 15 mm in the parasternal long axis view
- Heavy calcification with an inability to see the valve opening

If the opening is clearly more than 15 mm then the FCU is negative for AS. If the opening is less than 15 mm or you cannot see the opening clearly, the FCU study is positive. An opening of at least 15 mm means that any aortic stenosis will be only mild.



In this image the aortic valve is calcified and not opening representing aortic stenosis

3. Lung Ultrasound

Ultrasound can be used to rapidly diagnose (and exclude) pneumothorax, consolidation, effusion, pulmonary oedema. Identification of pulmonary embolus is possible but to achieve a level of confidence to treat, usually requires a positive ultrasound for DVT and right heart strain on TTE.

In this workshop, you will learn how to diagnose pneumothorax and pleural effusion and consolidation.

Pneumothorax

Tension pneumothorax can be life threatening, and a pneumothorax may be life threatening if there is insufficient respiratory reserve and may develop into a tension pneumothorax.

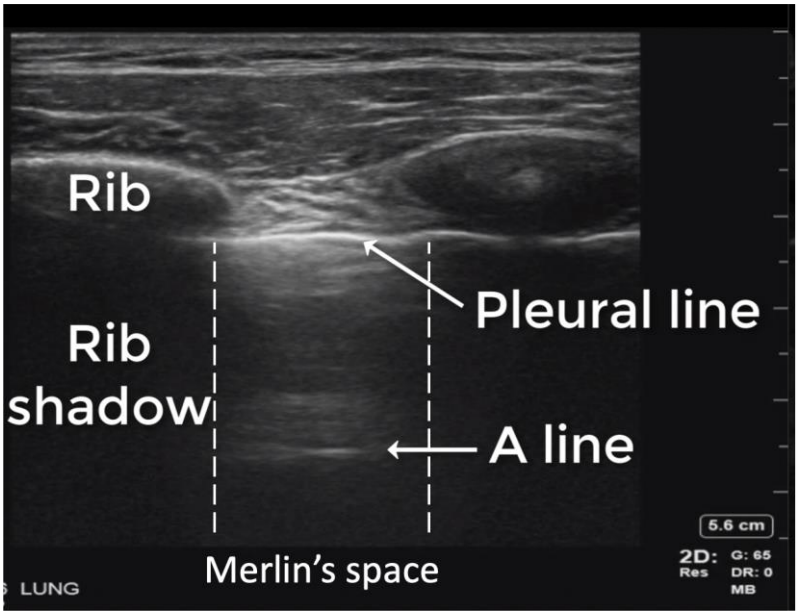
Probe

The curvilinear probe provides the best resolution and the largest foot-print (covers more intercostal spaces) than a phased-array transthoracic probe. A linear (vascular) probe has similar resolution to a curvilinear probe. However, a cardiac probe may be more convenient as it allows you to perform a cardiac and lung examination without the hassle of changing probes.

Patient position

In a supine patient, the air in a pneumothorax usually is best seen anterior, somewhere between (usually in the middle) the costal margin and the clavicle adjacent to the sternal edge.

Place the probe in a vertical orientation in this region, with the probe perpendicular to the chest wall. Look for the ribs (cast black shadows) and these will guide you to the pleural line, a bright white horizontal line just beneath the ribs and intercostal muscles. Adjust the depth so that the pleural line is in the middle of the screen.



During respiration, the two layers of pleura slide past one another resulting in subtle movement on the ultrasound display at the pleural line. This is termed the lung sliding sign and has been described as the appearance of 'crawling ants'.

The image deep to the pleural line in a normally aerated lung is all artefact and not an image of the lung parenchyma. In the normally aerated lung, the rest of the artefact appears as a grey speckled shadow and changes appearance during respiration similar to television 'white noise'. This is called Merlin's space. Lung sliding results in this grey pixelated appearance to speckle.

As the pleural line is highly reflective, it is usually duplicated below as reverberation artefacts, which are referred to as A-lines. These are caused by the ultrasound reverberating multiple times between the pleural line and the transducer face. The lines are equally spaced, at approximately the same distance between the skin and pleural line. Small degrees of probe manipulation (angling and heel-toe) so the ultrasound beam hits the pleura at right angles will enhance the appearance of A-lines. A normal appearance may include the occasional short vertical line seen to extend inferiorly from the pleural line, which moves and disappears with respiration. These are short comet-tail artefacts and are called Z-lines.

For lung ultrasound appearance to be regarded as normal, both A-lines and pleural lung sliding need to be present.

**Pneumothorax is suggested by the inability to see lung sliding. This is observed in two ways:
• The pleural line appears static and there is no movement
• The Merlin's space appears static and there is no movement

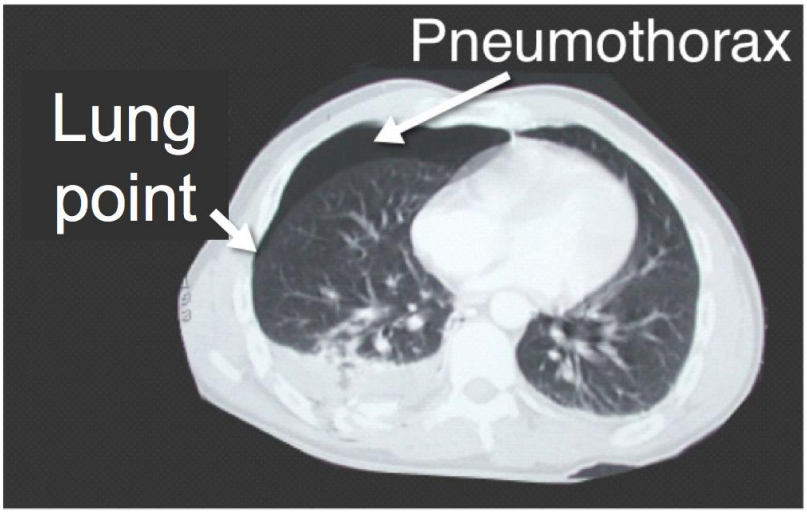
It is important to keep the probe still as each location is analysed as movements of the probe may be misinterpreted as lung sliding.

Identification of lung sliding excludes the presence of pneumothorax in the scanned region with a sensitivity close to 100%, depending mostly on operator experience.

Unfortunately, lack of lung sliding may be caused by other pleural or parenchymal pathology that prevents movement of the pleura and hence lung ultrasound is better at ruling pneumothorax out rather than ruling it in.

Conditions that also cause apparent lack of lung sliding include
• pleural adhesions/fibrosis/pleurodesis
• bullous disease
• severe atelectasis or consolidation,
• either bilateral or unilateral (such as bronchial positioning of a cuffed endotracheal tube) hypoventilation. For example, severe asthma/chronic obstructive pulmonary disease (COPD) or sputum obstruction can cause decreased or apparently absent lung sliding through global decreased ventilation.

**The method used to confirm pneumothorax (approaches 100% specificity depending on operator experience) is the identification of a lung point. The lung point is the point where the pleural air (that is separating the pleural layers) ends and the pleural layers become apposed. The lung point is the border (limit) of the pneumothorax air bubble. If the probe can be positioned over this lung point (edge) then the lung point can usually be seen to be moving with respiration.



Observe the following video of a lung point and pneumothorax:

https://youtu.be/7IZlR6aV8Io

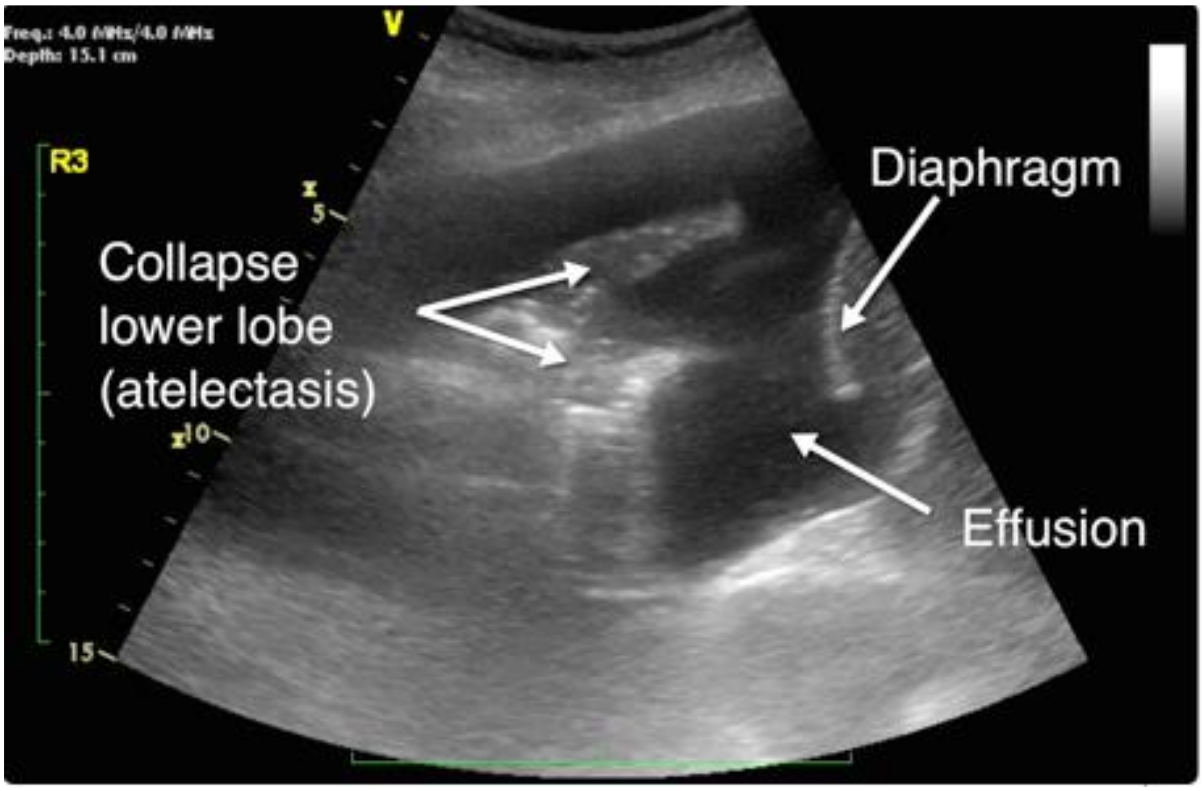
The lung point may not be found with a very large pneumothorax, especially when the patient is supine, as the collapsed lung may only contact the pleura at an extremely posterior location.

Pleural effusion/consolidation

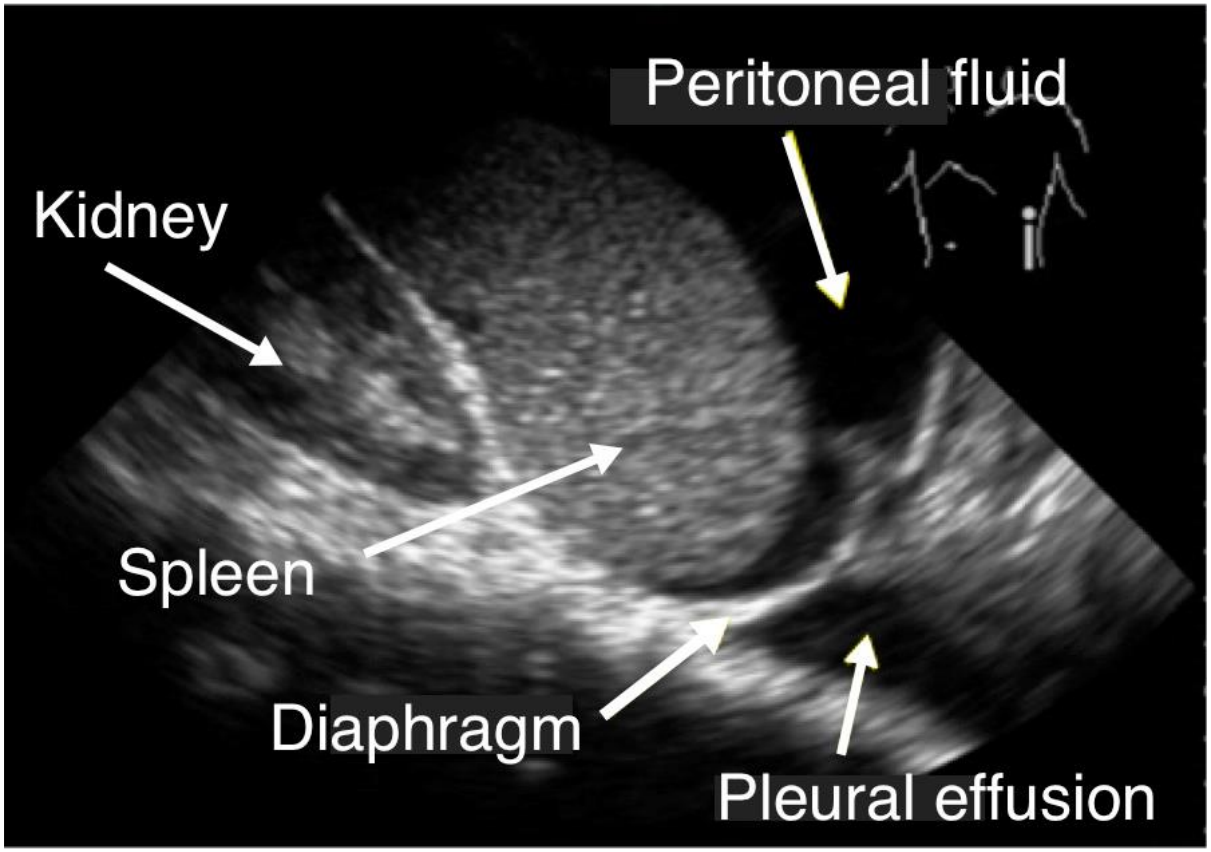
Pleural effusion

The typical sonographic appearance of pleural effusion is an anechoic (black) area between the parietal and visceral pleura, which usually changes size with respiratory movements. Because fluid is an effective transmitter of ultrasound, a pleural effusion can easily be detected with ultrasound, and the underlying lung pathology such as atelectasis and consolidation directly visualised. The heart and aorta may also be visualised through an effusion. Lung ultrasound is more accurate than supine chest X-ray and is as accurate as computed tomography for detecting effusion, LUS is more accurate than

chest X-ray in distinguishing between effusion and consolidation and is also able to detect much smaller effusions. Pleural effusions are commonly seen in patients with cardiac failure, malignancy and after cardiac or thoracic surgery.



Pleural effusion. A pleural effusion is seen here as a large hypo-echoic area beneath the chest wall



Peritoneal fluid The key landmarks are the diaphragm, kidney and spleen. Peritoneal fluid is seen here between the spleen and diaphragm.

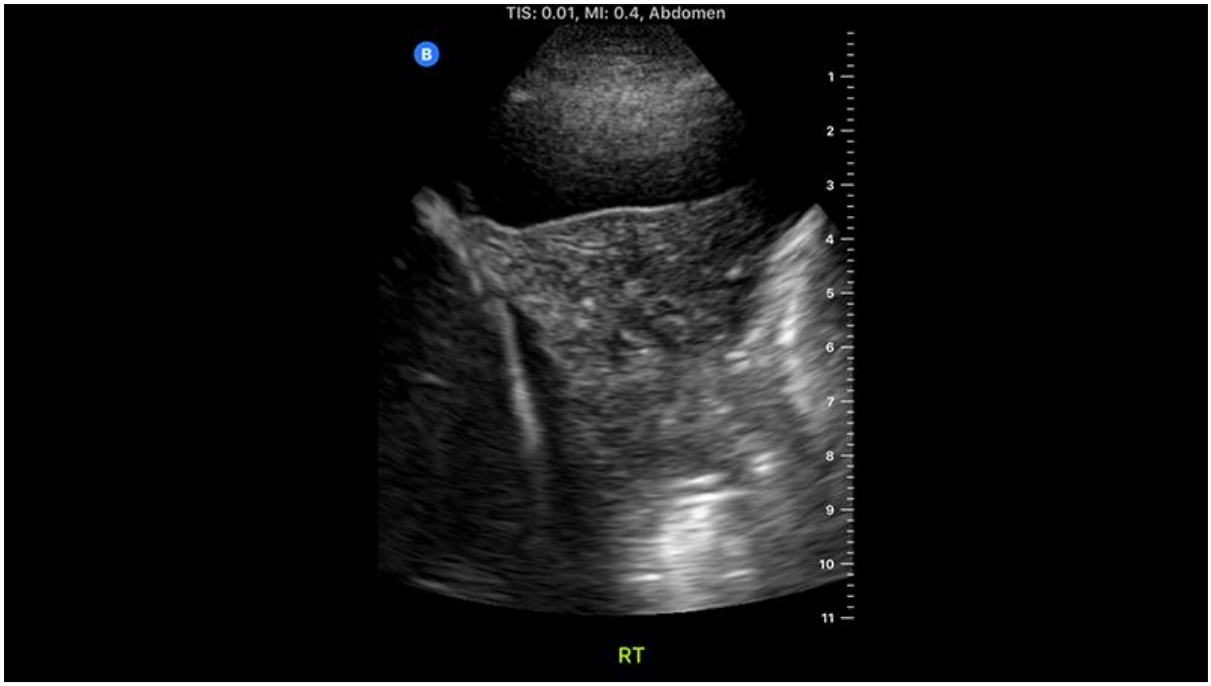
Consolidation

Lung consolidation is easily seen with ultrasound because the lung alveolar air spaces have become filled with fluid, which allows the transmission of ultrasound. Consolidation appears on ultrasound as grey and 'tissue-like', similar to liver tissue (hepatisation), as the homogenous patches of lung are separated by structures which resemble blood vessels. However, unlike liver, consolidated lung commonly still contains cartilage-walled and airfilled bronchi, seen as hyperechoic dots and branching streaks.

Consolidation can have a variety of causes including infection, cancer, contusion and pulmonary embolism. Differentiation of these pathologies with ultrasound may be aided by the quality of the deep margins of consolidation, and the presence of air, fluid and vascular patterns within the consolidation. Lung ultrasound is better than chest X-ray in diagnosis and distinguishing different causes of consolidation in mechanically ventilated patients and in patients presenting with pleuritic pain. It is superior to chest X-ray in diagnosing pneumonia in a variety of clinical settings.

Consolidation may show sharp edges adjacent to the normal lung ultrasound pattern (A lines with pleural sliding) with lobar involvement. More commonly, there is a transition zone of interstitial oedema (B-lines) between the consolidated area and adjacent normal lung, beside or deep to the consolidated area. This has been termed the 'shred' sign.

A low-frequency probe with a large footprint such as a curvilinear or phased array probe is usually required to sufficiently image the full extent of a pleural effusion. Effusions are usually not loculated and will collect in the dependent zone of the chest and will therefore mainly be detected in the lower/dependent areas, whether the patient is supine or upright.
It is important to routinely identify the diaphragm to avoid confusion of pleural fluid with peritoneal fluid. Failure to do this may result in intraperitoneal placement of the drain or needle. Very rarely, there may be confusion between a vascular structure and free fluid, and the use of colour flow or pulsed wave Doppler may identify the vessel.



Lower lobe lung consolidation with adjacent effusion and diaphragm

4. Gastric Ultrasound

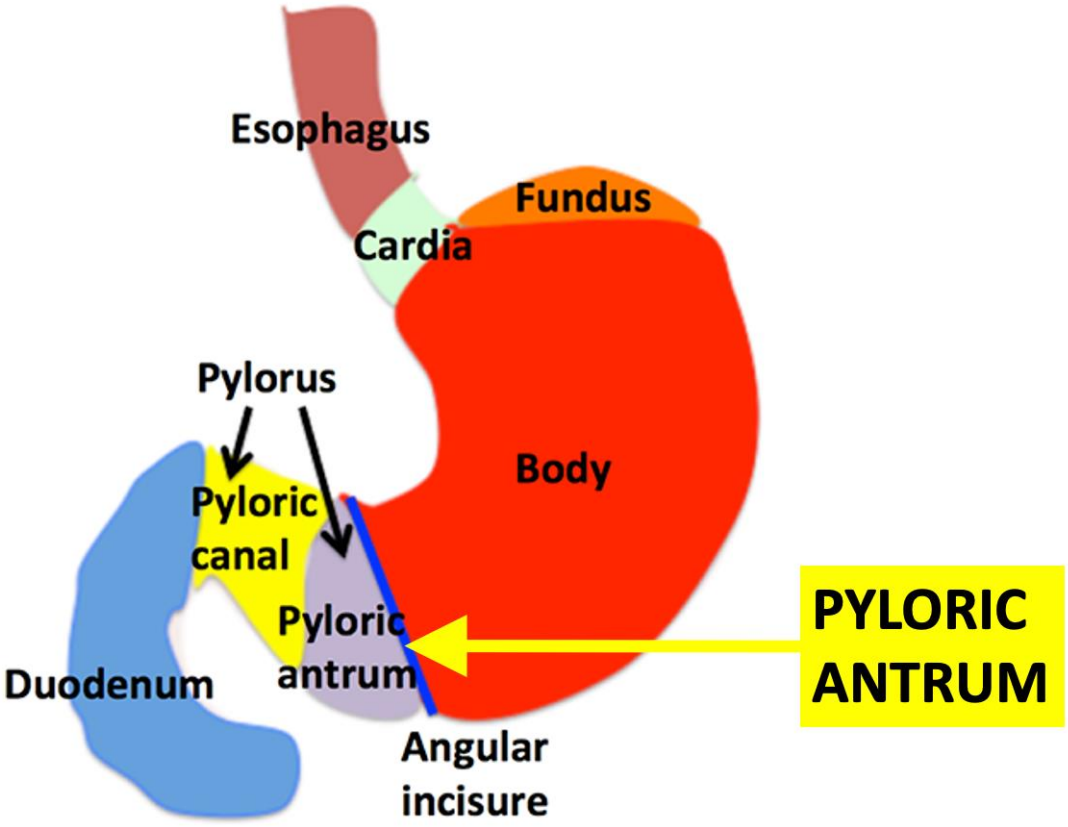
Pulmonary aspiration of gastric contents is a rare but potentially lethal and preventable complication of acute reduction in conscious state, such as from critical illness or induction of anaesthesia.

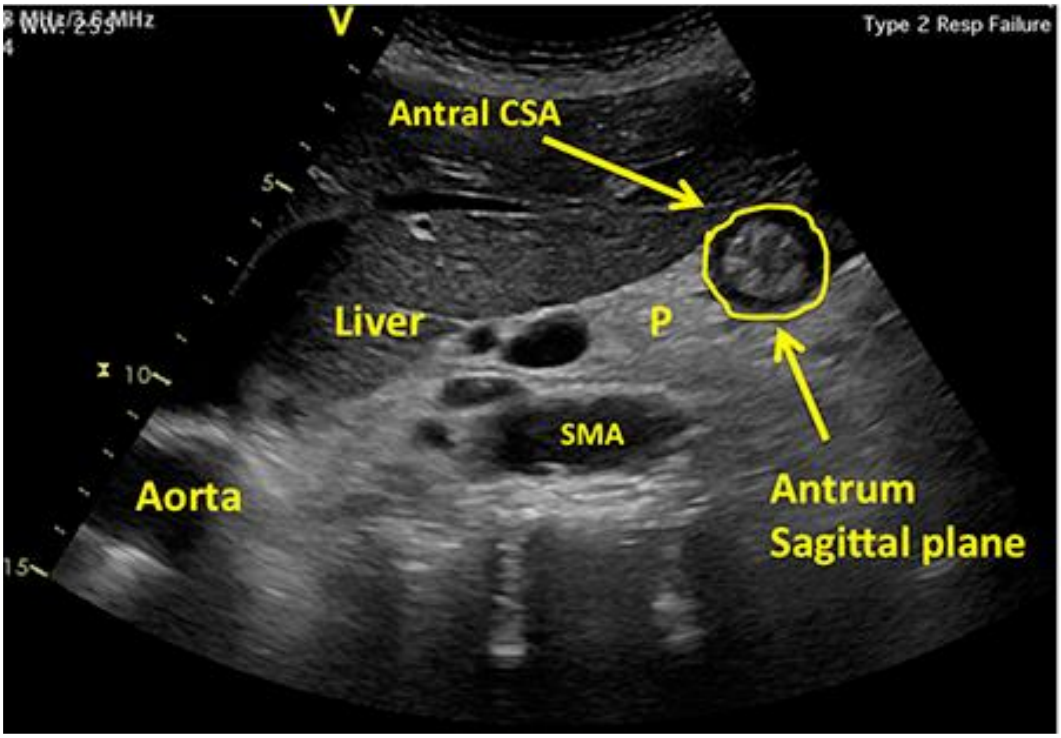
Gastric ultrasound may be used in real-time to assess whether the stomach is empty or contains fluid or solid matter. This may be useful of performed prior to airway intervention or anaesthesia. If a stomach is identified to be 'dangerous', that is containing a significant volume of fluid or solids, this warns the physician of this risk and provides an opportunity to empty the stomach prior to airway manipulation.

Sono-anatomy

For gastric ultrasound assessment, the pyloric antrum is the best-visualised and reproducible region of the stomach. It is the portion of the stomach where solids sit and are processed into particles of less than 1mm in size. For this reason, the antrum is the prime target of gastric ultrasound assessment of contents.

The probe is positioned to obtain a cross-sectional (short axis) view of the antrum, so this will appear as a circular structure.





Probe selection

A curvilinear abdominal probe (2-5MHz) probe provides optimal image acquisition with good depth penetration and resolution enabling identification of the key landmarks and assessment of stomach contents. A phased array (transthoracic echo probe) may surface in the absence of a curvilinear probe, and paediatric cases can be assessed using a linear probe.

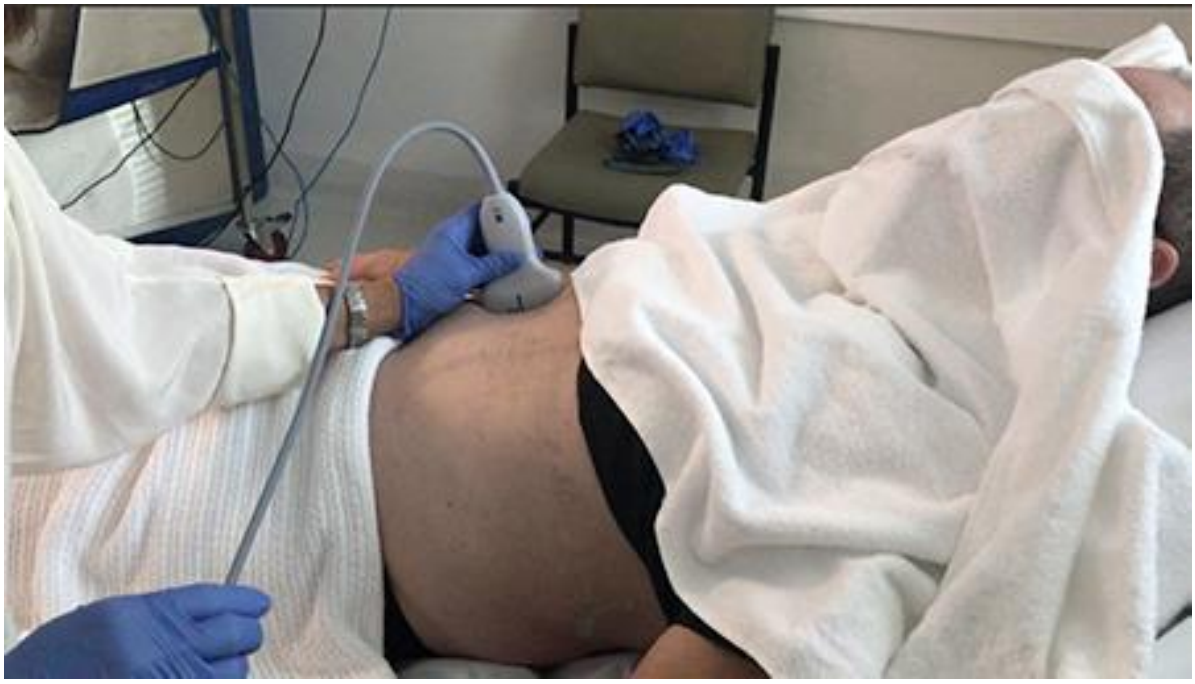
Patient position

The right lateral decubitus position should be used whenever possible as the gastric contents fall into the pyloric antrum and air is displaced into the upper stomach or oesophagus. This improves reliability and image quality. Where this position is contraindicated or impractical, he supine or recumbent position may be used (limited to 30 degrees).

Images may be improved by recording them at end-inspiration when the stomach is displaced inferiorly (and towards the probe).

Scanning technique

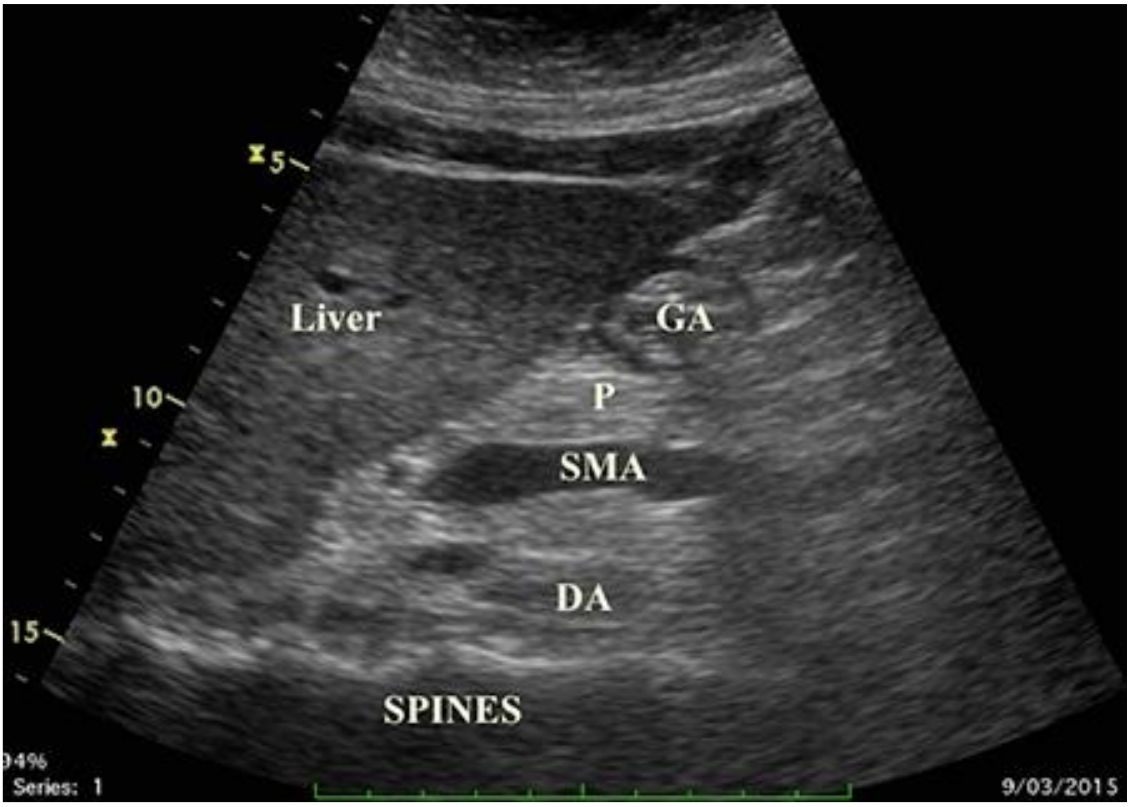
The probe is initially placed in the right epigastrium oriented in a para-sagittal plane (vertical), with the orientation marker positioned such that the head (superior) is to the right and the feet (inferior) is to the left.



Initial probe placement - epigastric, parasagittal plane to obtain the short axis view of the antrum.

First find the liver (figure below) by translating the probe to the left and right, maintaining a perpendicular and superoinfero/vertical/saggital alignment of the probe. The lower lobe of the liver should appear as a ‘tongue’. Beneath this tongue of liver will be gastric antrum, large vascular structures and the spine.

The objective is to obtain the short axis view of the gastric antrum.

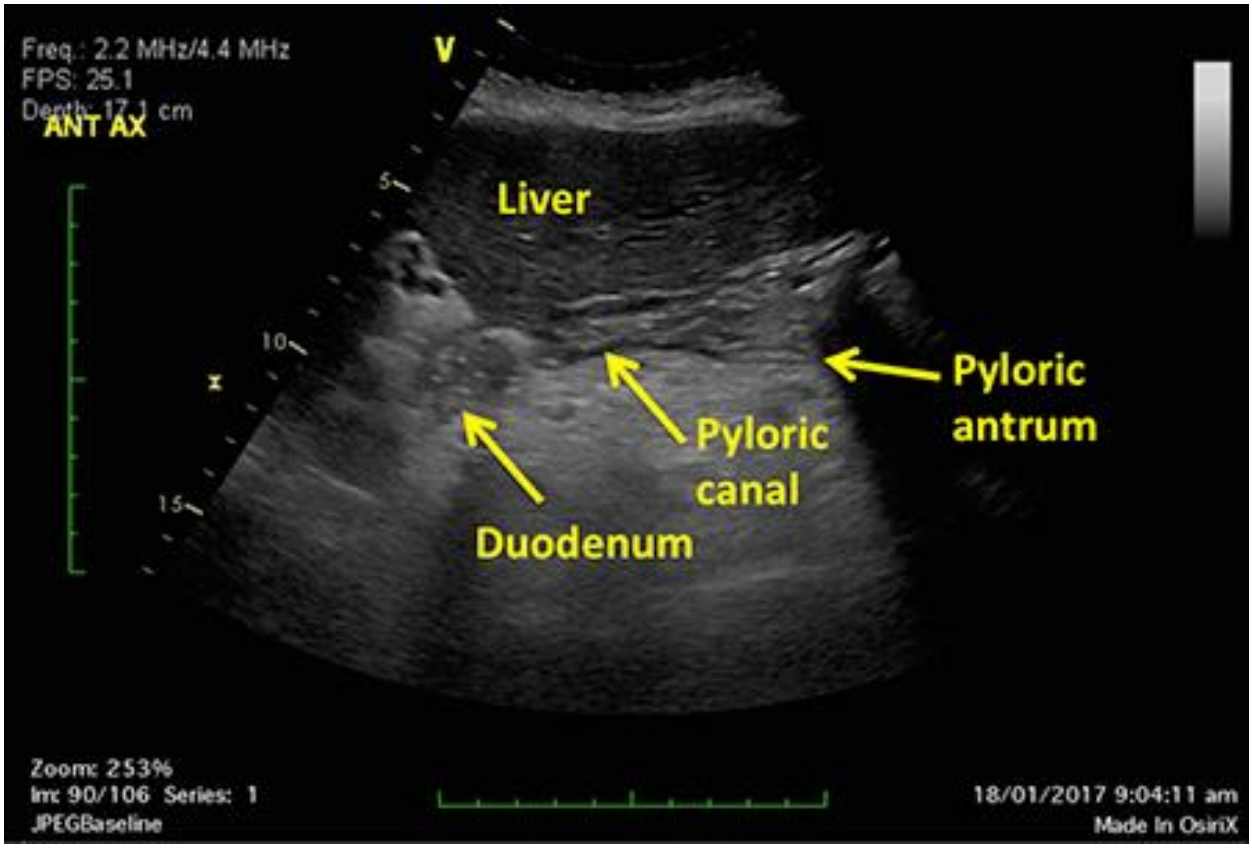


Short axis view of the antrum.

Adjust the depth setting such that the vascular structures below can be seen. This includes the abdominal aorta and inferior vena cava (IVC).

The aorta may be identified by its pulsatile nature, while the IVC may collapse on deep inspiration. To provide a consistent plane of assessment in gastric ultrasound the probe beam should be adjusted to visualise the leg lobe of the liver proximally and the superior mesenteric artery as the deep anchor.

Further confirmation of structures can be performed by rotating the probe into an axial plane to visualise the antrum, antro-pyloric junction and duodenum (third figure below). The pyloric canal may be distinguished from the pyloric antrum due to its thicker muscular layer.

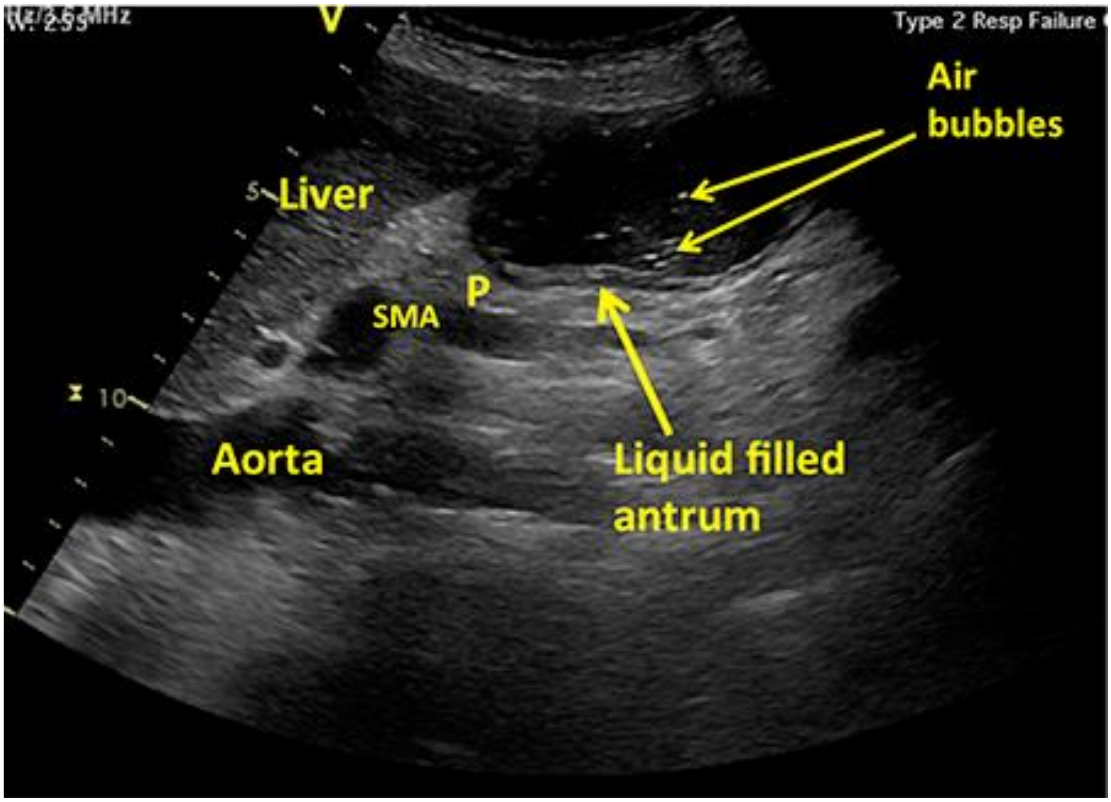


Ultrasound image of gastric antrum-axial plane.

Fluid in the Stomach

Clear fluid in the antrum appears distended, containing a hypoechoic (dark) or anechoic (black) lumen. The gastric wall appears distended and the walls have a thinner appearance by comparison to the contracted empty state.

Initially ingested gas bubbles give an initial 'starry night' appearance due to gas bubbles trapped within fluid. Over time bubbles coalesce forming larger hypoechoic regions that cast an acoustic shadow. This may have a similar appearance to nasogastric tubes – which appear as small hypoechoic area in the short axis, and two parallel thin white lines in the long axis (figure below).



How to Estimate the Volume of Gastric Contents

Estimation of the volume of gastric contents may be useful to help warn the clinician of the risk of pulmonary aspiration of gastric contents during airway manipulation under anaesthesia or sedation.

In the fasting state the gastric volume is usually small, containing only up to 1.6mL/kg. For an adult a fasting volume is typically 75 to 150mL. In a non-fasted state, the stomach can hold several litres of fluid and if this is aspirated it can quickly lead to severe respiratory failure and cardiac arrest.

The gastric volume can be estimated using either the cross-sectional area or using 2 linear dimensions made perpendicularly to each other using equations devised by Perlas et al.

Cross sectional area (planimetry):
GV (ml) = 27.0 + (14.6 x CSA (cm^2)) − 1.28 x age (yr)

Cranio-caudal and antero-posterior diameter:
SA= (anteroposterior diameter x craniocaudal diameter x π)/4

This formula is highly accurate with a mean difference of only 6ml between the predicted and measured volumes. However, it is applicable only to adult, non-pregnant subjects with body mass index up to 40 kg/m^2. It predicts volumes of up to 500 ml.

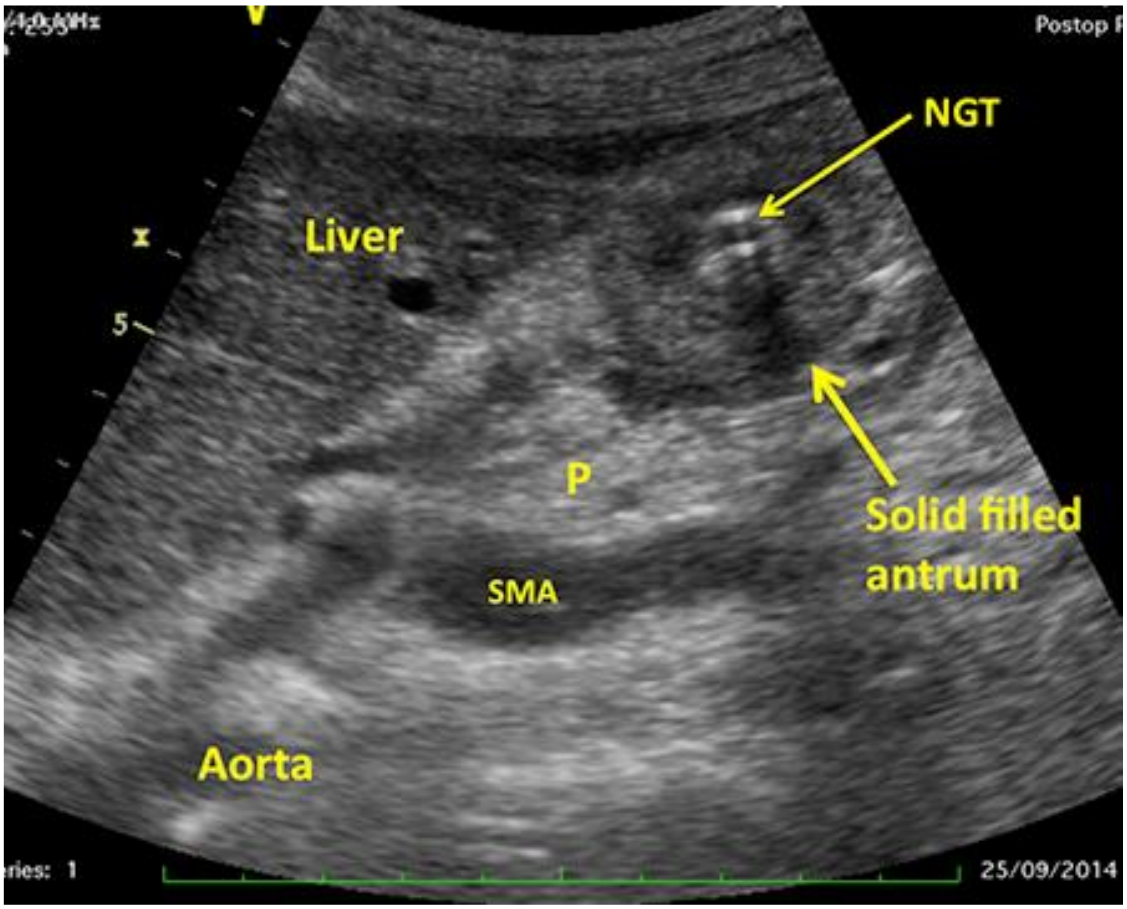
Alternatively, a table has been devised that can be used to estimate volume using the CSA without requiring a calculation using the Perlas formula.

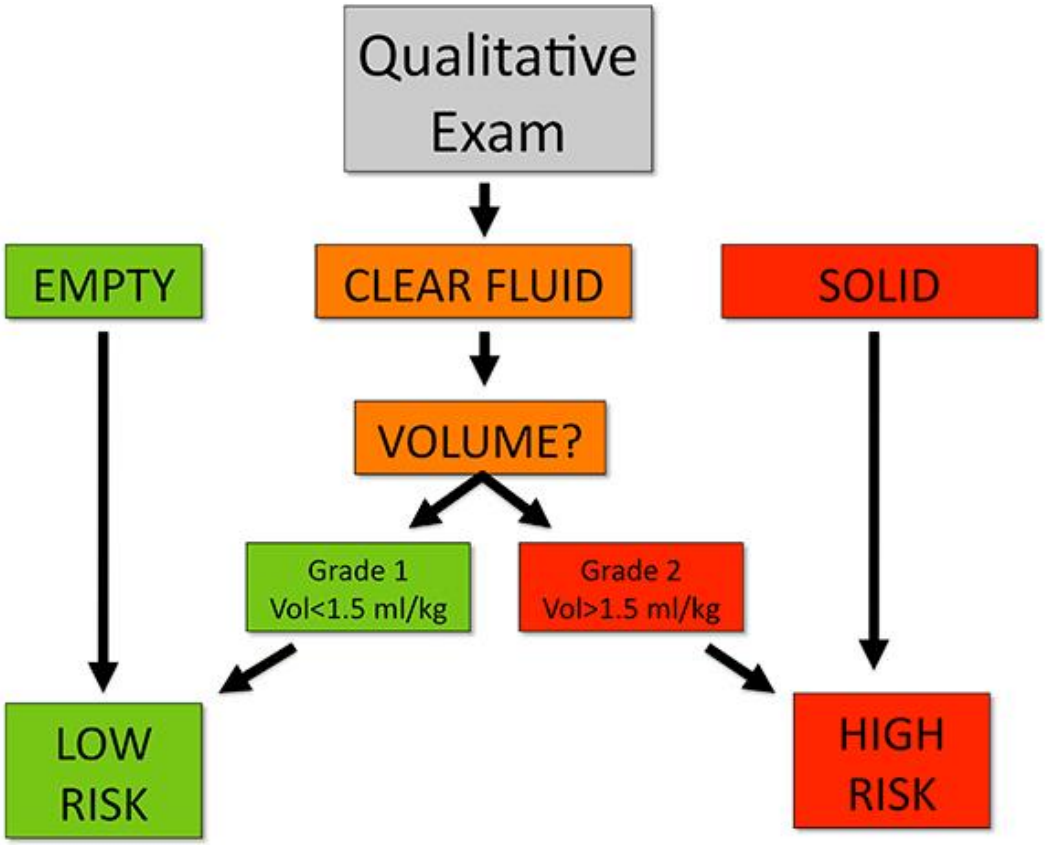
Food in the Stomach

After initial ingestion a food bolus consists of masticated food, fluid and air and hence usually appear quite complicated on ultrasound. The key is to identify the antral wall surrounding the matter. It is

especially important here to locate the familiar anatomical landmarks (liver, IVC and aorta) to be confident of identifying the antrum. The presence of air bubbles can produce hypoechoic regions that cast an acoustic shadow. Ring down arrtifacts can be seen that blur the posterior wall of the antrum. It can be difficult to determine the size of the stomach.

With ongoing digestion in the stomach and dissipation of the air bubbles, ingested food takes on a ‘frosted glass’ appearance, and as the artefacts disappear, making the antrum easier to appreciate (figures below).





Ultrasound of Other Stomach Regions

Ultrasound assessment of the gastric body and fundus may be useful for other indications (such as confirmation of gastric tube placement), however they are not reliable for assessment of gastric volume and contents.

5. DVT Ultrasound

Venous thromboembolism, which comprises deep venous thrombosis (DVT) and pulmonary embolus (PE), is the third most common vascular disorder in Caucasian populations. In Australia, DVT alone (without concomitant PE) affects 52 persons per 100 000 annually. It has been suggested that many cases of DVT are not diagnosed.

When there is clinical suspicion of a pulmonary embolus, identification of a lower limb DVT increases the confidence of this important diagnosis. The confidence of this important diagnosis can be further increased by identification of RV strain (dilation of the RV chamber on FCU).

Ultrasound has become the first imaging choice in the investigation of DVT. The examination is in most cases readily accessible, inexpensive and portable and can be performed in a short time. It does however depend upon operator expertise and can be limited by patient factors.

The inability to completely compress the vein with the ultrasound probe has an equivalent accuracy (false positive and negative predictive value) to formal venous “duplex” ultrasound, which is

visualisation of a thrombus within the vein lumen (on 2D imaging) with reduced or absent blood flow in the vein using colour flow and spectral Doppler.

Watch the two videos below.

The first video shows complete compression of the vein, indicating the absence of a DVT.
https://www.youtube.com/watch?v=F34VMzz21XE

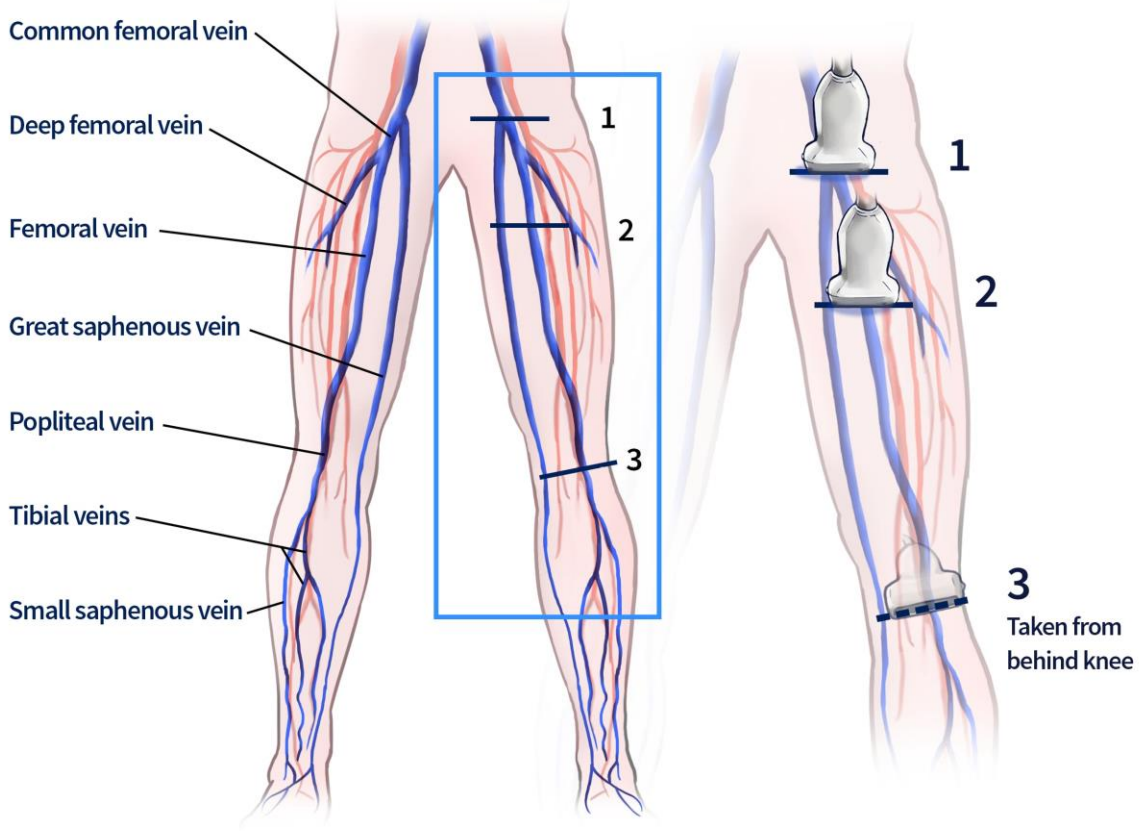
The second video shows the partial collapse of the vein, indicating the presence of a DVT.
https://www.youtube.com/watch?v=QRsZw_ZrH14

Compression ultrasound DVT technique can be easily taught to non-radiologists and nonsonographers, enabling point-of-care application, and therefore potentially saving considerable time and cost in referring patients to the medical imaging department. This technique is usually referred to as lower limb venous two- or three-point compression ultrasound, depending on the number and site of compression points, or point-of-care extended compression ultrasound.

Anatomy and overview of the sequence of DVT ultrasound

Knowledge of the venous anatomy of the lower limb is essential for the correct identification of vessels. There is some variation in the literature regarding the naming of the veins, which can cause confusion, and there has been the standardisation of nomenclature in an attempt to reduce this. Even describing the course of blood vessels and their branches or tributaries can cause confusion, as anatomical descriptions commonly follow the flow of venous blood from distal to proximal, whereas the clinician will usually scan with ultrasound from proximal to distal. The venous drainage of the lower limb is also subject to anatomical variation, and an awareness of common venous variants is helpful.

The following diagrams summarise the underlying anatomy, typical images, probe positions and sequence of proximal DVT ultrasound. It is reproduced from a review article on the subject (Canty, D., Mufti, K., Bridgford, L., & Denault, A. (2019). Point-of-care ultrasound for deep venous thrombosis of the lower limb. Australasian Journal Of Ultrasound In Medicine. doi: 10.1002/ajum)



Deep vein lower extremity anatomy and DVT sequence.

Lower Limb Proximal DVT Ultrasound Technique

The positioning and most important points on how to perform an above knee “3 point” compression proximal DVT ultrasound exam is covered in the following video.

The video demonstrates how to perform a DVT ultrasound exam, using the three main “points” of compression.

https://youtu.be/smt5sVU3yUI