POINT OF CARE ULTRASOUND FOR GENERAL PRACTITIONERS. YOU CAN DO IT TOO!

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Introduction:
Point-of-Care Ultrasound (POCUS) in veterinary medicine has expanded beyond its initial use in trauma assessment (FAST exam) to address a wider range of diagnostic queries. Unlike its predecessor, POCUS offers versatility across various clinical presentations.

Basic Machine Function and Probe Manipulations:
In POCUS exams, three primary functions on the ultrasound machine are crucial:
Master gain, depth, and frequency.

- Master gain regulates overall image brightness, typically controlled by a single knob. This adjustment enhances image clarity and highlights specific structures and fluids.
- Depth settings dictate the depth of ultrasound penetration and the displayed image. Both depth and gain settings are frequently adjusted during POCUS examinations at different anatomical sites.
- Understanding probe frequency is essential, as it influences image quality and depth perception. Higher frequencies yield superior image quality but are limited to superficial structures, while lower frequencies offer deeper penetration but with reduced resolution. Most probes allow frequency adjustments, particularly micro convex curvilinear probes. Tailoring frequency settings is essential; for instance, decreasing frequency may be beneficial for scanning larger dogs' abdomens, while increasing frequency aids in visualizing structures in smaller dogs and cats.

Abdominal POCUS:

Positioning and patient preparation:

Patients are examined in their most comfortable position, with minimal restraint necessary. Shaving is typically unnecessary unless the patient has a thick fur coat that impedes image resolution, such as Huskies and Northern breeds with dense undercoats.

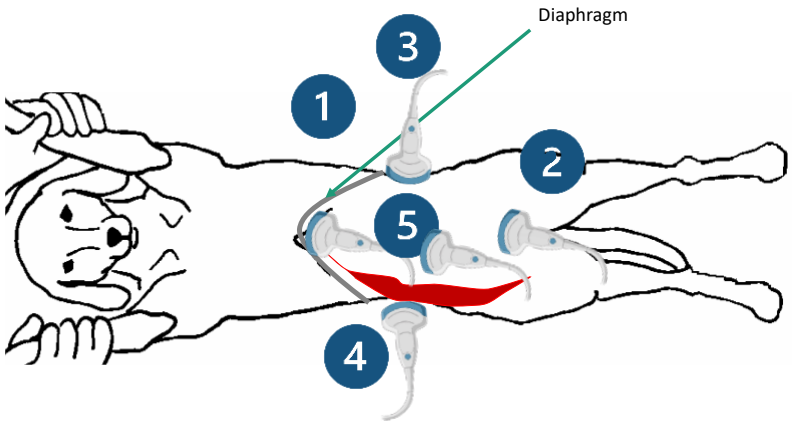
Alcohol is used for skin preparation, but it's important to part the fur before or after applying alcohol. Gel is optional but can be utilized with shaving for improved resolution or applied after parting the fur and applying alcohol. Hand sanitizers containing alcohol and gel can also be used.

Patients should not be placed in dorsal recumbency to avoid compromising their cardiovascular function, which can lead to increased work of breathing and decreased venous return.

Protocol:

During the examination, the ultrasound probe is systematically placed on five regions of the abdomen. At each site, the probe is fanned and rocked through a 45° angle in both long and short axis views. Moving the probe 1 inch in cranial, caudal, left, and right directions helps increase the area assessed at each site. This technique of fanning and rocking enhances the likelihood of detecting abdominal fluid.

The five sites for abdominal point-of-care ultrasound (APOCUS) includes:



1) <u>The subxiphoid site,</u> located just caudal to the xiphoid process. Scanning this site allows visualization of the diaphragm, liver, gallbladder, and caudal vena cava. To visualize this site effectively, palpate the "V" at the xiphoid region and place the probe in a long axis to the body. Then, rock the probe until the diaphragm is visible, adjusting the depth until the entire diaphragm encircling the liver is observed. Note that individual liver lobes cannot be detected in a normal patient.
    - One common pitfall in abdominal ultrasound is mistaking hepatic vessels for fluid. It's essential to recognize that ultrasound is dynamic, allowing us to differentiate between vessels and fluid by employing techniques such as fanning, rocking, sliding, and rotating the probe. By manipulating the probe, it becomes easier to discern whether the observed structures form vessels.
    - Another potential pitfall is edge shadowing, where ultrasound beams create dark shadows along the edges of an organ, resembling fluid. These shadows can be misleading, but careful probe manipulation can help clarify whether they represent actual fluid or artifact.
    - Additionally, intestinal walls may sometimes be mistaken for abnormal fluid or structures. Again, by moving the probe, it becomes easier to determine whether the observed structure is intestine or another anatomical feature, such as the stomach. Dynamic probe manipulation is crucial in avoiding misinterpretations and ensuring accurate ultrasound diagnosis.

2) <u>Urinary bladder site</u>: This site facilitates the visualization of the bladder and its apex. To begin, position the probe in a long axis to the body between the pelvic limbs. Upon locating the bladder, it is crucial to adjust the depth to visualize both the

dorsal and ventral walls of the bladder. Subsequently, slide the probe to locate the apex of the bladder. Once positioned at the apex, employing techniques such as fanning, rocking, and rotating the probe to a short axis, followed by fanning and rocking in the short axis, will enable the visualization of abnormal effusion. Furthermore, the probe can be shifted to either side of the bladder and fanned to detect fluid in deeper gravity-dependent sites at the body wall

3) Right paralumbar site: This site enables the visualization of the liver, right kidney, body wall, and intestines. Obtaining this view can be challenging as it often requires maneuvering between ribs to visualize the normal structures. In some cases, it may be necessary to begin in the short axis to the body so that the probe can be positioned between ribs. In smaller dogs and cats, the probe can be placed in the long axis to the body caudal to the 13th and final rib. Once the liver is visualized, the probe can be moved caudally to locate the kidney. It's important to position the probe quite laterally from midline to locate these organs.

4) Left paralumbar site: This site allows visualization of the spleen and left kidney. The probe must be placed quite laterally to midline to visualize both organs. Initially, the probe is positioned in the long axis to the body, often mid-abdomen and lateral to start. It is usually easier to locate the spleen first and then slide the probe caudally until the left kidney is found. Utilizing fanning and rocking techniques with the probe aids in locating the organs of interest.

5) The umbilical site : is also suggested to confirm the localization of gravity-dependent abdominal effusion by positioning the probe at the umbilicus. The probe is angled at approximately 45 degrees, with the head of the probe oriented toward the tabletop. Subsequently, the probe should be gently rocked and fanned to optimize visualization.

Pleural and lung ultrasound:

Patient Positioning:

Scan the patient in the position where it is most comfortable, typically standing or sternal in cases of respiratory distress. Avoid placing the patient in a dorsal position for the POCUS exam to prevent potential decompensation.

Normal Findings:

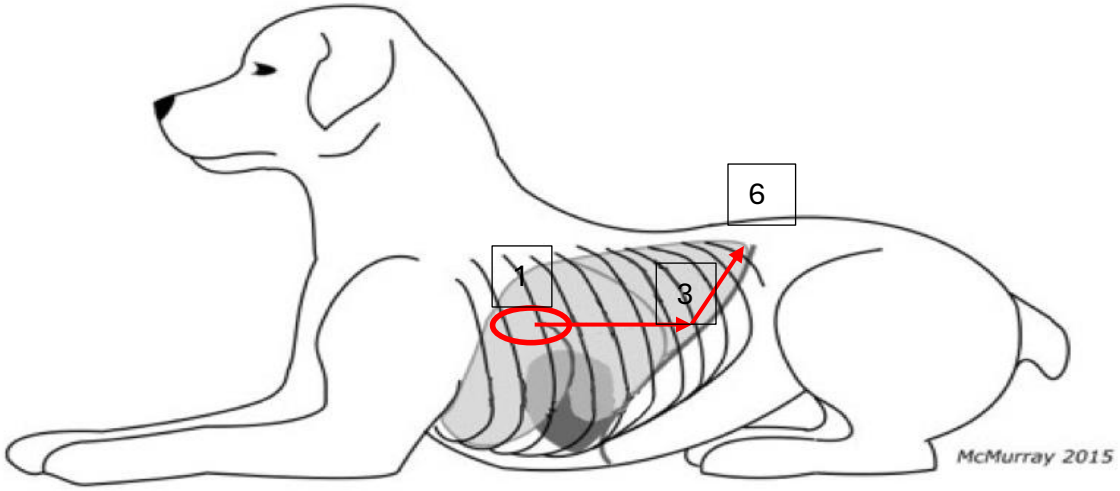
- Bat Sign/Gator Sign: This occurs when the probe is perpendicular to the ribs, allowing visualization of the rib heads, rib shadowing, and the pleural line. The resulting image resembles the wings and body of a bat or the eyes of a gator peaking above the water line. The Bat Sign aids novice sonographers in identifying the pleural line, which is the first white line below the rib heads.

- Glide Sign/ lung sliding: This is observed as a shimmering effect along the pulmonary-pleural interface (pleural line) during respiration, indicating the normal to-and-fro motion of the lung sliding along the chest wall.

- B-lines, are characterized by bright white dancing hyperechoic streaks that originate from the pulmonary-pleural interface. These streaks extend through the far field without fading and swing to-and-fro in rhythm with the lung's motion during respiration.

Protocol to scan the thorax for pneumothorax:

1. Identification of Bat or Gator Sign: Begin by identifying the "bat" or "gator sign" by placing the ultrasound probe perpendicular to two ribs Patient Positioning: Position the patient in sternal or standing position.



2. Locating Lung: Once you confirm that you are over the lung (bat sign visible), slide the probe caudally to locate the curtain sign, which denotes the transition zone between the thorax and abdomen at the diaphragm.
3. Identifying Caudal Border of Thorax: The caudal border of the thorax can be identified by locating the curtain sign, which is the transition between the thorax and abdomen, easily visible with sonography.
4. After identifying the curtain sign, the probe is moved caudall dorsally, one rib at a time, while observing for the curtain sign to appear when the patient takes a breath.
5. Continue moving the probe caudally until the curtain sign is consistently identified.

Occasionally, if the probe is initially placed over the abdomen, it may need to be moved cranially until the curtain sign is observed.

6. Next, the dorsal border of the thorax is determined by sliding the probe dorsally until the pleural line is no longer visible (replaced by epaxial muscles), then sliding the probe ventrally until the pleural line reappears.

N.B: If the patient is scanned in lateral recumbency, air will tend to accumulate at the widest part of the chest. Consequently, the probe's location should be adjusted to reflect this accumulation. It's crucial not to move the probe while assessing the presence of a pneumothorax, as moving the probe can generate a false "glide sign."

A pneumothorax is identified by one of more of the following findings:

- Absence of lung sliding
- Abnormal curtain sign (either a double curtain sign or an asynchronous curtain sign)
- Identification of a lung point

Lung Point:
If the glide sign or a normal curtain sign is confidently identified at the most dorsal caudal border of the lungs, it rules out pneumothorax. However, it's not always easy to identify a glide sign with certainty. In such cases, a pneumothorax can be confirmed by identifying the lung point.

The lung point is found by placing the ultrasound probe at the caudodorsal location (as described earlier for pneumothorax identification) and then sliding the probe ventrally (remembering that the diaphragm curves inwards, so the probe must be moved ventrally and cranially). Look for a point where the lung reconnects with the thorax wall OR where a glide sign is observed again. It's crucial to allow the patient to breathe as the probe is moved ventrally because the lung point/glide sign is only visible during the respiratory cycle.

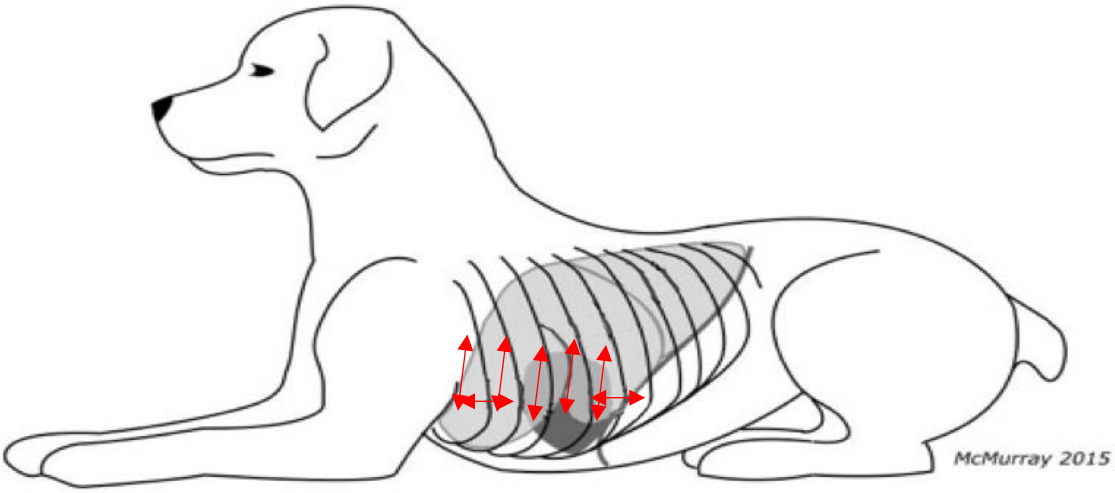
Protocol to scan the thorax for pleural effusion:

The presence of a glide sign excludes pleural effusion at the probe placement site.
Pleural effusion appears as the absence of a glide sign with anechoic fluid between the chest wall and the hypoechoic lung, or as anechoic triangles adjacent to the heart and outlining the diaphragm (outside the pericardial sac).

<u>Sonographic Technique to Identify Pleural Effusion:</u>

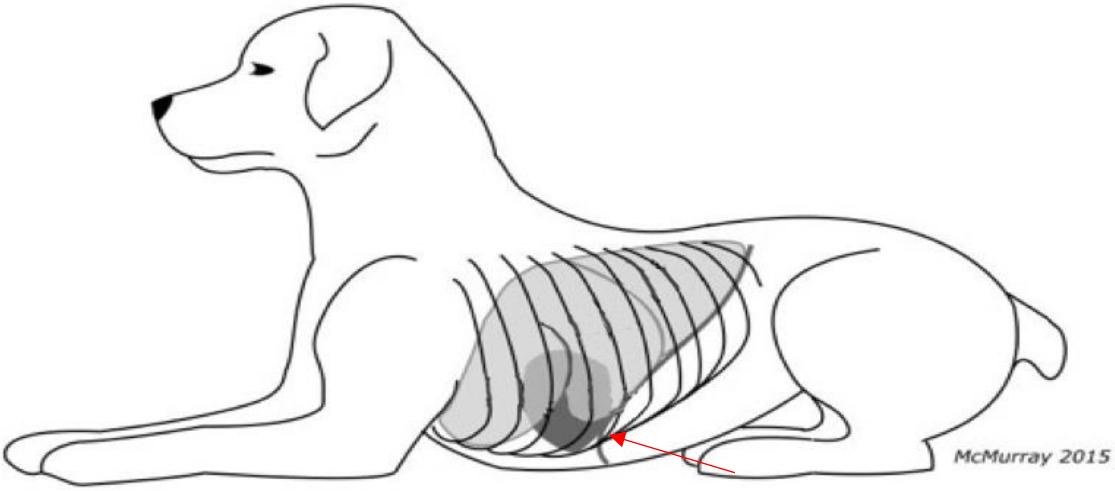
1. Parasternal Ventral Scanning:

Scan ventrally and caudally between the diaphragm and the heart.
Scan ventrally and cranial to the heart.
Turn the probe parallel to the ribs in ventral thoracic areas.
Rock and fan the probe widely and ventrally at the subxiphoid site.

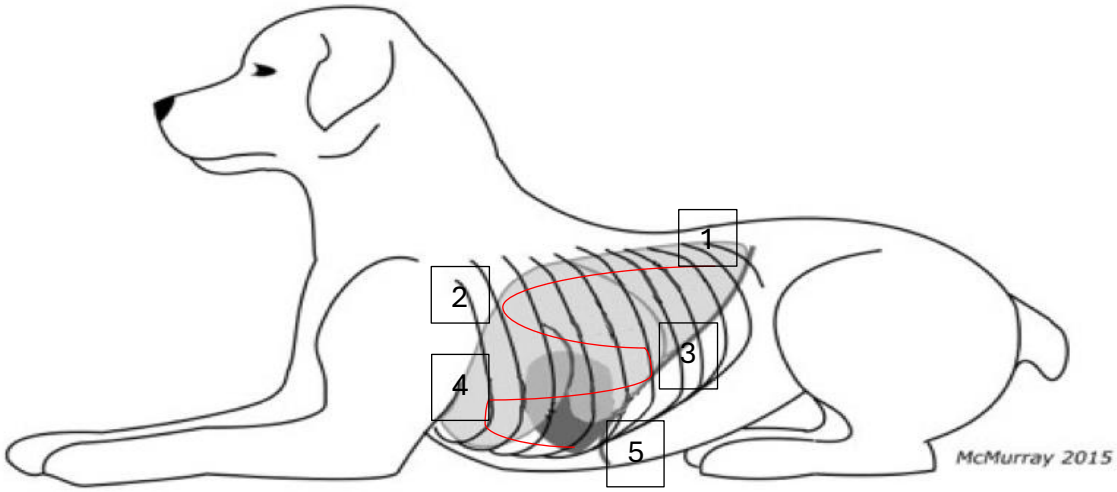


2. Subxiphoid Scanning:

Adjust the probe orientation to be more parallel relative to the spine.
Adjust the depth setting deeper compared to abdominal VPOCUS.
Rock and fan the probe widely and ventrally at the subxiphoid site.



Protocol to scan to identify lung parenchymal disease (Alveolar Interstitial Syndrome (AIS):



1. Start scanning the dorsal third of the thorax from the caudodorsal location.
2. Slide the probe cranially between intercostal spaces until the cranial lung border (front limb) is encountered.
3. Slide the probe ventrally just behind the front limb until the middle third of the thorax is reached.
4. Slide the probe caudally until the curtain sign is encountered.
5. Slide the probe ventrally to evaluate the lung regions cranial and caudal to the heart as described for pleural effusion.

Identification of more than 3 b-lines at a probe location is indicative of an alveolar interstitial syndrome. Differentials diagnosis for AIS are similar than that of intertitial and alveolar pattern on thoracic radiographs.

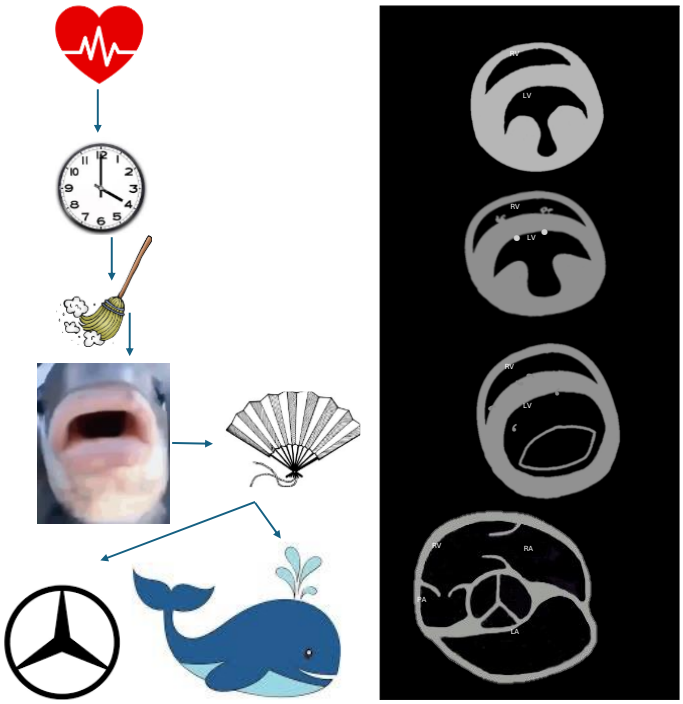
Artifacts to Note that can be easily confused as B lines:

- *Z-lines:* Arising from the parietal pleura, not the lung surface. They do not move with the glide sign and do not erase A-lines. They are ill-defined and disappear after 2-5 cm.

Cardiac POCUS:

Assessing the LA:Ao.

Technique:
The patient can be in a standing or sternal position, and the probe is placed just behind the right forelimb.
Alternatively, the patient can be placed on an L-shaped table, with the right parasternal region positioned over the opening of the table, eliminating the need for a cardiac table.



1. Palpate the precordial beat on the R side of the chest.
2. Place the probe over the precordial beat with initially the probe perpendicular to the ribs.
3. Rotate the probe so that marker is located at 4’oclock on a face clock.
4. You should a short axis view of the heart at the level of the papillary muscles, known as the "mushroom" view.
5. The probe is then slowly moved dorsally keeping the same angle for the marker at 4’oclock, and as the left ventricle and mitral valves become more apparent, it leads to the "fish mouth view." Sometimes it may be necessary to switch rib spaces cranially to achieve this view and rock the probe caudally (so that the beam of the probe is aimed towards the dogs’s pelvis, keeping the marker at a 4 o’clock position).
6. Once the "fish mouth view" is obtained, the probe is fanned slowly upwards to achieve the view needed for LA:Ao measurement, known as the "Mercedes and whale view." To fan the probe, you need to maintain the exact position of the probe on the chest, with the marker at a 4 o’clock mark and “drop” your wrist towards the table. The beam of the US should be aiming towards the spine.

<u>Calculation of the LA:Ao ratio:</u>

1. Obtain the "Mercedes and whale" view of the heart (right parasternal short axis view).
2. Freeze the image on the ultrasound machine and use the cine loop function to return to the most ideal image.

3. Imagine a diagonal line through the aorta towards the left atrium, from wall to wall, to determine the aorta width.
4. Then, imagine a diagonal line through the left atrium in the same axis as the aorta.
5. Compare both lines; a normal LA:Ao ratio is less than 1.3 in cats and 1.5 in dogs. Values above 2 may indicate significant cardiac disease, while an enlargement of the left atrium can be assessed subjectively by considering how many aortas can fit within it. If it is 4 or more, significant enlargement is likely, as seen in Figure 4e, depicting an enlarged LA:Ao in a congestive heart failure dog.