Veterinary Bioscience: Cardiovascular System

Introduction to Veterinary Point of Care Ultrasound (V-POCUS)

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What is V-POCUS?

Veterinary Point of Care Ultrasound (V-POCUS) refers to an ultrasound examination that is goal directed and is answering a specific question[1]. For example, is there free fluid? Is there adequate cardiac contractility? Is there a pneumothorax? Is the bladder full of urine? It is commonly used at the cage side/stall side or in the consultation room.

With the increasing portability and affordability of handheld ultrasound devices there will be an increase in use in clinical practice. In fact, it is now being seen as an extension of the physical examination (but will never replace it!).

To obtain images of quality and accuracy you will be required to learn the physics behind ultrasound image production, how artifacts and image interference occurs, and the dexterity required to obtain the ultrasound image. At this stage in the DVM program it is important to become familiar with the ultrasound probe and understand some basic image acquirement skills. The detail will come as you progress through the program, and you will have ample opportunity to practice using the devices.

The Basics

Physics

The probe of the ultrasound is responsible for sending out and receiving sound waves. These sound waves are usually in the 3–14-megahertz (MHz) range, and therefore are not heard by the human ear. The sound waves that are received back are used to generate pixels at different shades of grey (echogenicity), which creates an image on your screen. This ranges from white, (hyperechoic), for bone or air, through a grey scale (hypoechoic; soft tissues) to black (anechoic) for fluid. This is visualised in the diagram below.

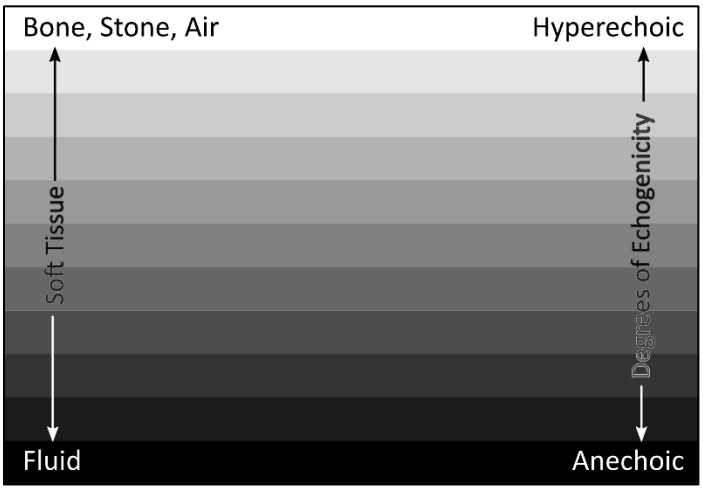

Image adapted from '*Point of care ultrasound techniques for the small animal practitioner*,' Chapter 1, by G. Lisciandro 2021.

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Apply these principles when performing an ultrasound on the models provided in the practical class. You will see different organic materials (fruit and vegetables) as different shapes and shades of grey, surrounded by anechoic material (the water and gelatine material).

Different modes

This ultrasound has B-mode (brightness mode or 2D mode - most common), M-mode (motion mode) and Doppler mode. We will focus on B-mode and experiment with colour Doppler.

Orientation

Each probe has a marker, indicated by the red arrow, which corresponds to a marker on the screen. This allows us to orientate ourselves with the image on the screen in relation to where the probe is. As standard, the marker should point to the head of the patient (cranially), when scanning. Therefore, the left of screen is cranial, and the right of the screen is caudal. As we are interpreting a 2D image of a 3D object, orientation is key.

Terms to be familiar with:

- Longitudinal (long axis) plane: longitudinal to the long axis of the structure
- Transverse (short axis) plane: at 90 degrees to the long axis

Image Optimization

- **Depth**: adjusting the area on your screen to optimize the area of interest. The scale on the right-hand side of the screen is used.
- **Gain**: refers to the brightness of the image.
- **Frequency**: refers to penetration of the ultrasound waves and resolution (detail) of the image. High MHz has poor penetration, but good detail and is used for smaller patients. Lower MHz has good penetration but poorer detail and is used for larger patients.

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How do I start?

There are many handheld devices on the market. At the University of Melbourne, we use the Butterfly iQ Vet+ Ultrasound. This ultrasound has been developed to include all settings within an app, which is stored on the university iPads. To start using the ultrasound please ensure the probe is plugged into the iPad, then open the Butterfly iQ app from the home screen.

iPad and Butterfly iQ Vet Ultrasound setup

iPad home screen

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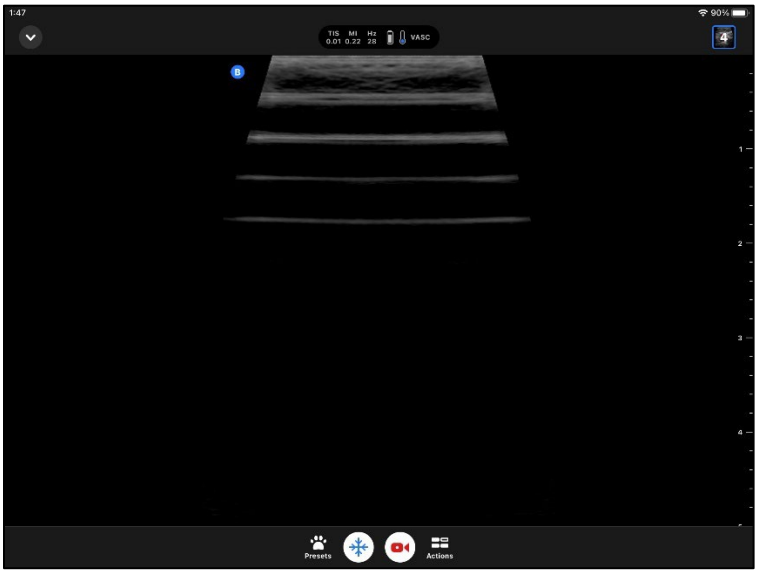
The home screen will appear when the probe is connected and should look like this:



Holding the probe

The probe should be held in your dominant hand. It can be held in your palm with your thumb located at the marker, or alternatievely it can be held in a pencil grip. These are both demonstrated below. Your grip will depend on what you are ultrasounding and can be changed at any time, however always be aware of where the marker is located to optimize image orientation on the screen.

The probe surface represents the 'footprint' that you are imaging.

A. Palm grip

B. Pencil grip

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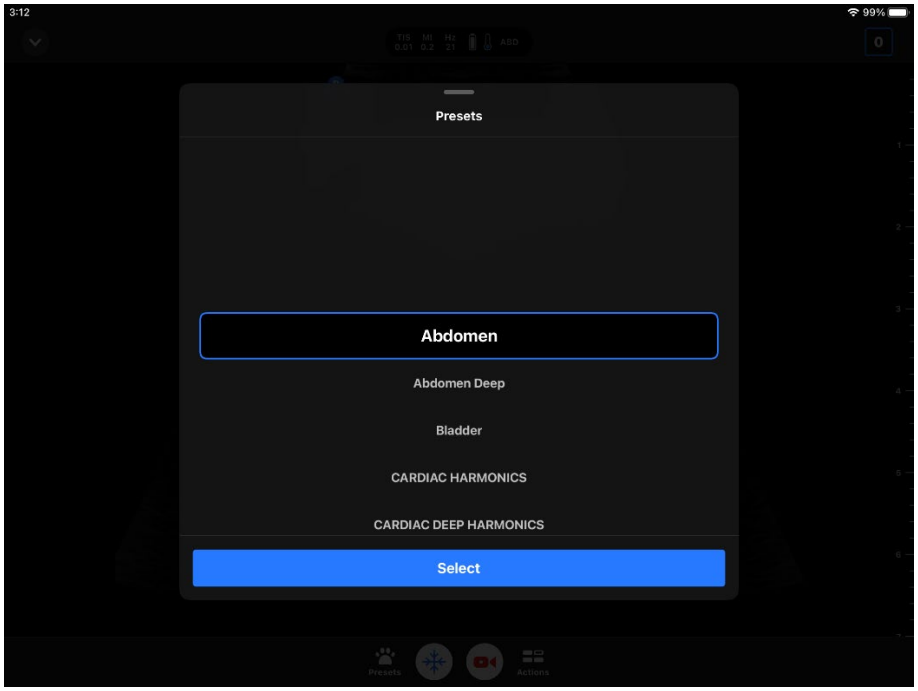
Application of acoustic couple gel

Ultrasound waves have difficulty traveling through air, therefore the application of gel to the ultrasound probe is to improve the 'bond' between the probe and the surface being imaged. This improves the image quality.

Try it out! See the difference of the image on the iPad before and after the application of gel. Even when we clip animals the small spikes of clipped hair trap air and can interfere with image acquisition.

Using the ultrasound models

Select the 'abdominal' preset by tapping on the paw at the bottom of the screen and selecting 'abdominal'. This is a B-Mode setting used in small to medium sized dogs, and our ultrasound models.



Remember, to optimize the image we can change the **depth.** How many centimetres deep do you think the model is? Adjust the depth on your screen by using one finger to swipe up and down slowly. You will see the scale change on the right side.

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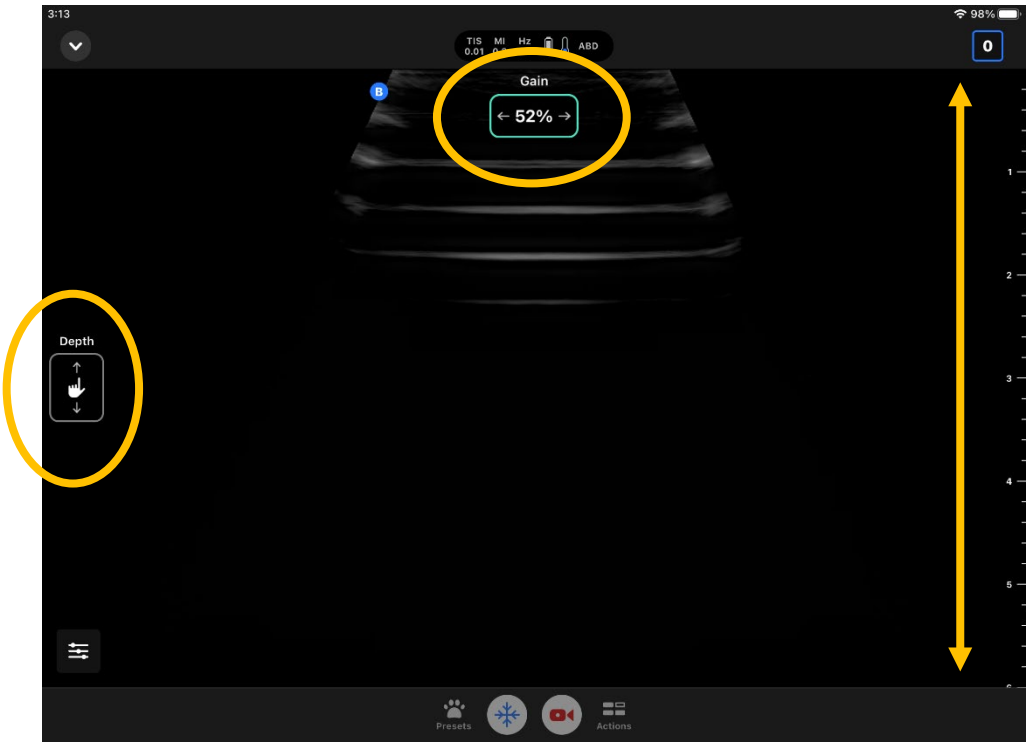
We can also adjust the gain, or brightness. If you swipe one finger to the right to increase gain (make the image look brighter) or to the left to decrease gain (to make the image darker).



Place the probe <u>gently</u> on the model. As you slide the probe over the surface of the model answer the following questions:

- What part of the model is being seen at the top of the screen?
- Can you see the table on your image?
- What happens when you change the gain and depth?

Find a hyperechoic object in the model and answer the following questions:

- Are the objects round, thin, thick?
- Is the structure a mixed echogenicity, hyperechoic, hypoechoic or anaechoic?
- What type of fruit or vegetable do you think it is?
- How many can you count?
- What happens to the object when you rotate the probe 90 degrees?
- Can you obtain a longitudinal and short axis view of the objects?
- Can you measure the size of the object?

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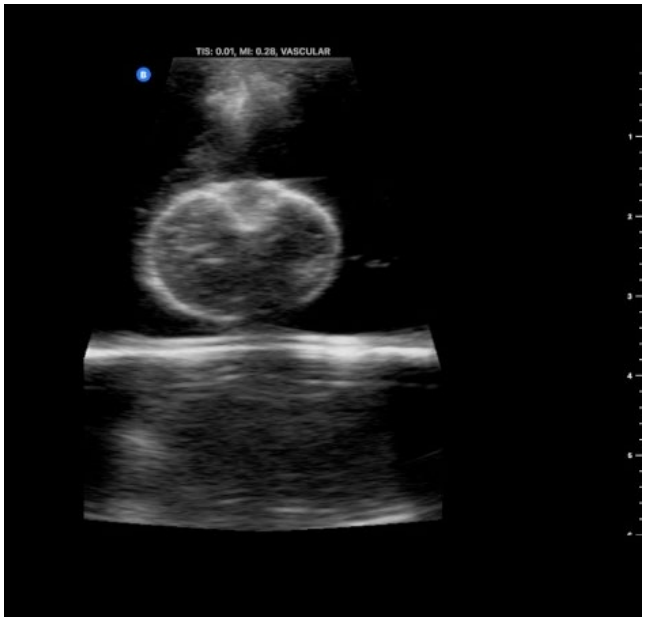
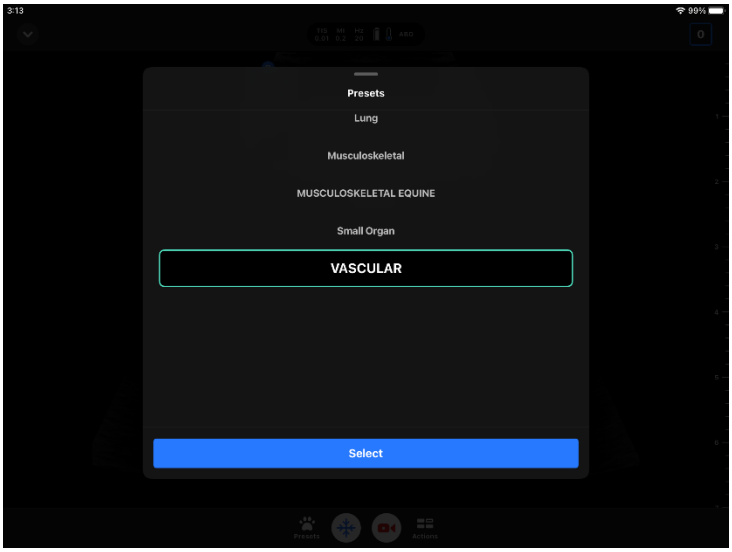


The above image is an example of a piece of fruit from one of the models in your class. Note the bright hyperechoic lining around a homogenous hypoechoic centre, and the anaechoic material surrounding it. It is approximately 1.5cm from the surface of the model, 1.5cm in height and 2.4cm wide. 'Fanning' through this peice of fruit allows assessment of it's overall structure.

Assessing vasculature

If you would like to you can now try and find a vessel in a longitudinal and cross section view on yourself or your partner. The radial artery (where you feel for a pulse on the wrist) or the carotid artery and jugular vein (in our jugular grooves) are the most accessible vessels to locate.

Tap the paw and switch to the 'vascular' presetting, which is a high frequency, linear setting.



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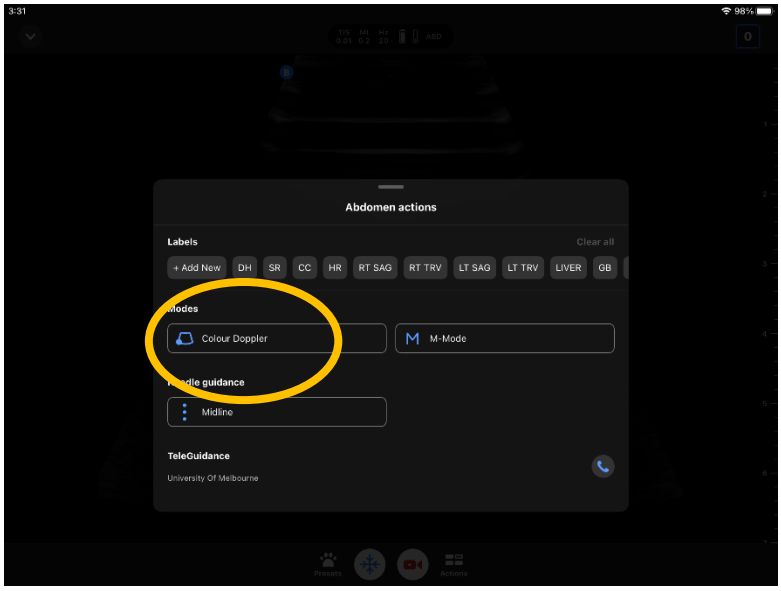
This introduces the importance of pressure on the probe. As veins are thin walled they are easily collapsed if too much pressure is used when obtaining an image. How might you tell if there is an artery in your field of view?

Placing the probe longitudinally along the radial artery. In which direction will the vessel appear on the screen?

Colour Flow Doppler

Colour flow Doppler allows us to see if there is blood flow within a vessel, and also which direction that flow is going. It is used with B-mode. To turn on colour flow Doppler tap on the small 'actions' button at the bottom of the screen, and select 'Colour Doppler'. Drag the box that appears over the area that you are looking for flow.



Can you see red or blue flow over the area?

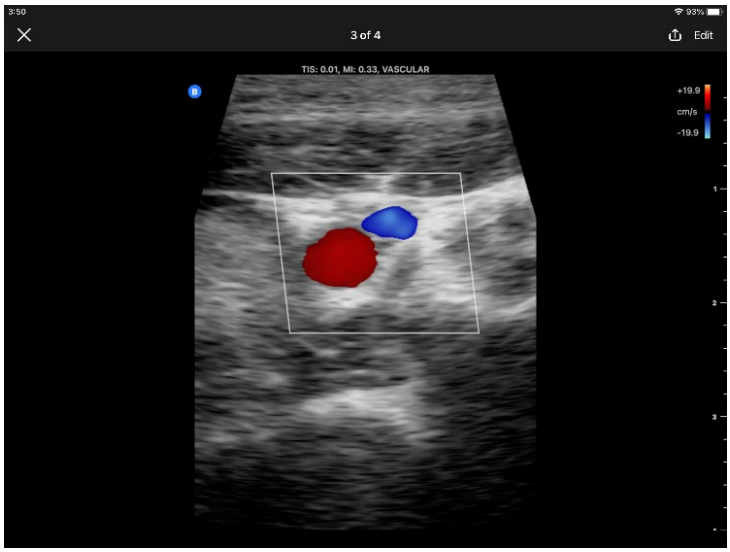
The colour will depend on whether the blood is flowing towards the probe or away from it.

A. longitudinal radial a.

B. Cross sectional radial a.

The above images are A. longitudinal and B. cross sectional views of the left radial artery. Below is a cross section of the carotid artery and jugular vein together. Note the surrounding soft tissue (muscle and connective tissue).

How does turning the probe 180 degrees affect the colour flow Doppler?



Cross section of jugular vein and carotid artery

As you go through the DVM program you will be exposed to more in-depth teaching of the theory behind ultrasound and across species. V-POCUS is an exciting and developing area of veterinary medicine. If you would like to know more, a textbook reference is below.

1. Lisciandro, G 2021, Point of care ultrasound techniques for the small animal practitioner, 2nd Ed, John Wiley & Sons, USA.

Please wipe down and clean the probes after each use