

Critical Care Ultrasound Course

**Dr Justin Bowra
CCUS Manual 4:
Basic cardiac echo**

- a. The questions to ask**
- b. How to scan**
- c. Cardiac anatomy on US**

Terminology note

1. Acronyms

- A4C: apical 4 chamber
- A5C: apical 5 chamber
- ACEM: Australasian College for Emergency Medicine
- ASUM: Australasian Society for Ultrasound in Medicine
- IVC: inferior vena cava
- LA: left atrium
- LV: left ventricle
- LVEF: LV ejection fraction
- LVIDd: LV internal diameter in diastole
- PE: pulmonary embolus
- PLAX: parasternal long axis
- PSAX: parasternal short axis
- PTX: pneumothorax
- RA: right atrium
- RV: right ventricle
- RVOT: RV outflow tract

2. Levels of cardiac echo (Just what is ‘basic cardiac echo’ anyway?)

There are a lot of different names & types of cardiac echo out there, which can be confusing. Basically, imagine three levels of cardiac echo, each one more complex. The differences between each are outlined below.

	Basic cardiac echo	Focused cardiac ultrasound (WINFOCUS consensus term)	Formal transthoracic echocardiogram
Also known as	Echo in life support	Rapid cardiac assessment	TTE
Duration	2 minutes (‘quick and dirty’)	5-10 minutes	≥30 minutes
Probe	Sector or curved	Sector	Sector
Preset	Cardiac or abdominal	Cardiac	Cardiac
Scanning mode	B-mode only	B-mode ± M mode	B mode, M mode & Doppler
Windows	1 or 2 will suffice (usually subcostal or PLAX)	4 are recommended (subcostal, PLAX, PSAX, A4C)	At least 5 (subcostal, PLAX, PSAX, A4C, A5C); sometimes more are required
Clinical role	Initial resuscitation of the critically ill patient	Further investigation of the acutely unwell	Delineating more subtle pathology

		patient	
Example of clinical questions	<ol style="list-style-type: none"> 1. Is the heart beating? 2. Is there a tamponade? 3. Is the IVC / LV/ RV large/small/grossly normal? 4. Is LV/RV contraction grossly normal? 	<ol style="list-style-type: none"> 1. What is the LVEF (quantitative)? 2. Is there a segmental wall motion abnormality? 3. Is there a regurgitant jet? 	<ol style="list-style-type: none"> 1. Is there valve disease? 2. Is there an ASD/VSD? 3. Is there LV diastolic dysfunction?
Formal level of training required in Australia	ACEM Echo In Life Support (ELS) module	ASUM Rapid Cardiac Assessment module	DMU/ DDU echocardiography

Credentialing

This course satisfies the ‘echocardiography in life support’ module for ACEM (and for ASUM when that module is finalised).

Principles of basic cardiac echo

- **Opportunistic:** you often can’t achieve all views in the critically ill but you can usually obtain at least one useful view of the heart
- **Qualitative:** ‘gross visual’ assessment (no measurements)
- **Simple:** limited to 2D ‘B’ mode scanning
- **Caricatural:** as Lichtenstein pointed out, life threatening abnormalities are usually bloody obvious on US. For example:
 - If a PTX is causing life threatening respiratory distress, it won’t be a small one.
 - If a PE is causing shock, it will be large enough to distend the IVC and stretch the RV.

The focused questions

In the shocked, dyspnoeic, or arrested patient we ask the following questions:

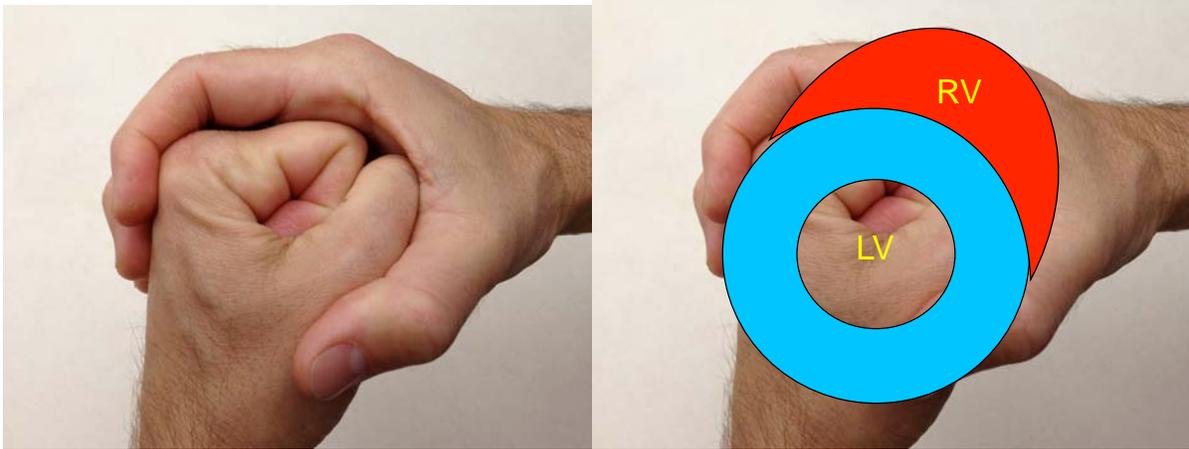
- **Is the heart beating?**
 - In the arrested patient, cardiac standstill carries a significantly worse prognosis and many clinicians would cease resuscitation at this point.
- **Is there a tamponade?**
 - This is a clinical question: IE the single most important features is that the patient is critically shocked.
 - One needs to ID a pericardial effusion (NB this can occasionally be subtle / localised, but will usually surround the heart & be present throughout the cardiac cycle)
 - The easiest, most reliable US feature of tamponade [versus simple effusion] is the presence

of distended veins (IVC and elsewhere). Other features such as RV diastolic collapse can be subtle.

- **Is the IVC / LV/ RV large/small/grossly normal?** See the relevant sections of this manual.
- **Is LV/RV contraction grossly normal?** See the relevant sections of this manual.

Before you start

- **Anatomy:**
 - The right side of the heart lies in front of the left. That means it's closer to the probe on all views except the apical.
 - The heart is a complex structure: like a hand (RV) wrapped around a fist (LV).



- **Patient position:** obviously this depends on how sick is your patient! If you can move them at all, then it's worth knowing that:
 - **Supine** is best for the subcostal windows
 - But for the parasternal and apical windows, **left lateral** is best (pillow wedged under right shoulder) to get the heart out from under the sternum, and left hand behind head to open up the rib spaces

Probe and scanner settings:

- As mentioned above, you can get away with the curvilinear 'FAST' probe on abdo/ FAST settings.
- However, the cardiac (sector array) probe and cardiac preset will provide better images of fast moving structures (eg the valves) and its smaller 'footprint' of the probe allows scanning between the ribs.

A word of warning:

*The cardiac preset flips the image in a left-right direction, giving you a **mirror image** of what you would see with the abdominal preset. This is why the recommended probe marker positions are 'opposite' for each preset & window.*

Where to scan – the cardiac windows

- Subcostal/subxyphoid long axis
- Parasternal long (PLAX) and short (PSAX)
- Apical 4 chamber (A4C) and 2 chamber (A2C)

Remember:

For the focused questions above, usually just one or two windows will suffice.

Subcostal Long Axis View

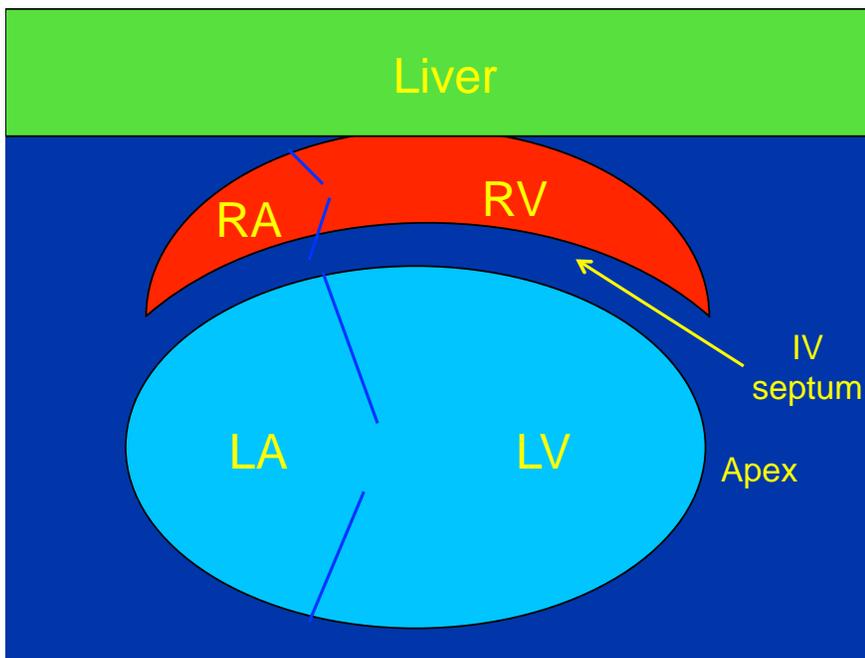
- The subcostal/subxyphoid window is familiar to those who perform EFAST scans and is often the most reliable view because it uses the liver as a window.
- Sometimes it's the only possible window (e.g. during CPR)
- Patient position:
 - Supine is best
 - A deep breath improves the image (pushes liver under the probe and bowel gas away)
 - Knees bent also helps (relaxes the abdominal wall muscles)
- Probe just under the xiphisternum, angled up under the ribs (= towards the heart)
- Probe marker:
 - On abdominal preset: to patient's right = 9 o'clock
 - On cardiac preset: to patient's left = 3 o'clock

Remember:

*The cardiac preset flips the image in a left-right direction, giving you a **mirror image** of what you would see with the abdominal preset. This is why the recommended probe marker positions are 'opposite' for each preset & window.*



Figure. Probe position for subcostal window



*Figure. Schematic: subcostal long axis window.
Nearest the probe, the liver is at the top of the screen.
Below that, the RV 'wraps around' the LV.
The LV shares the IV septum with the RV.
The atria are on the left.
The ventricles are on the right.*

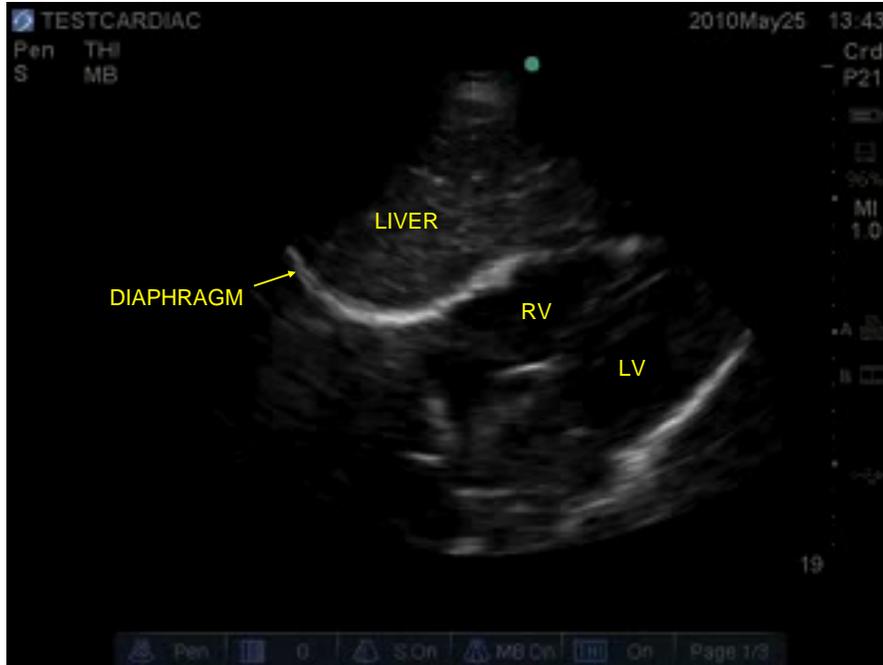


Figure. Normal heart, subcostal window

- Anatomy: the RV is **above** the LV and the liver is at the top of the screen. The cardiac apex should point to the **right** of the screen.

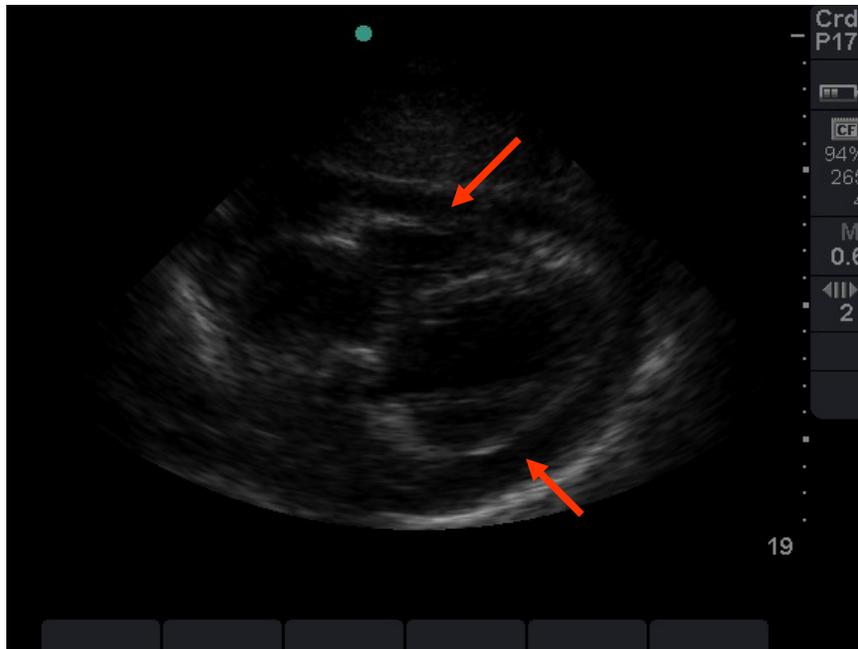


Figure. Pericardial effusion (arrowed), subcostal window

Parasternal Long Axis View (PLAX)

- The right ventricle (RV) ‘hides’ behind the sternum in this view, so don’t base RV assessment on this window!
- Probe to the left of the sternum, angled straight down (= towards the heart)
- Probe marker:
 - On abdominal preset: to patient’s left elbow = 5 o’clock
 - On cardiac preset: to patient’s right shoulder = 11 o’clock
 - I.E. angled along the long axis of the **heart**, not the patient
- Rotate the probe until the heart comes into view
- Sometimes you need to move up / down to the next intercostal space, and/or slide the probe laterally.
- Try and angle the probe so that you can see the following simultaneously:
 - The aortic and mitral valves (AV & MV)
 - The left atrium, left ventricle (NOT including the apex), the aortic root (Ao) and the RV outflow tract (RVOT).



Figure. Probe position for PLAX window. (a) curved probe (b) sector probe

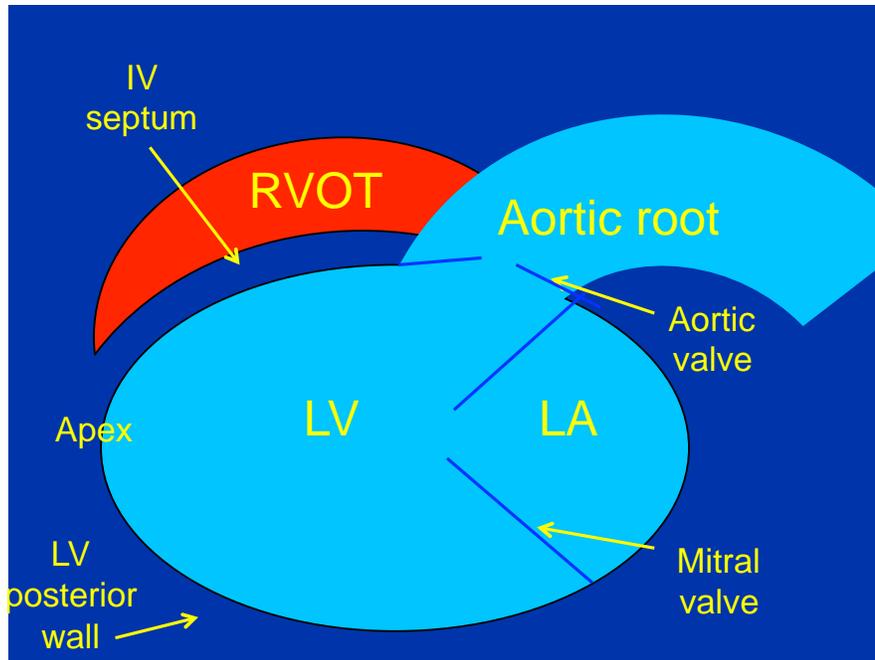


Figure. Schematic: PLAX window.

Nearest the probe, the RV outflow tract (RVOT) 'wraps around' the LV.

The LV shares the IV septum with the RV.

Furthest from the probe is the LV posterior wall.

To the right, the LA empties into the LV via the mitral valve.

Above the LA is the aortic root.

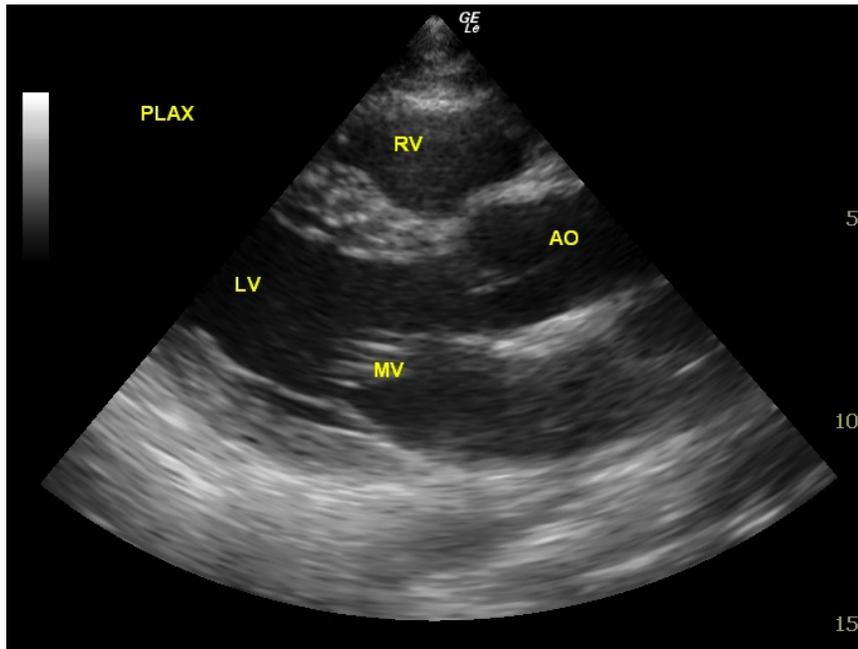


Figure. Normal heart, PLAX window

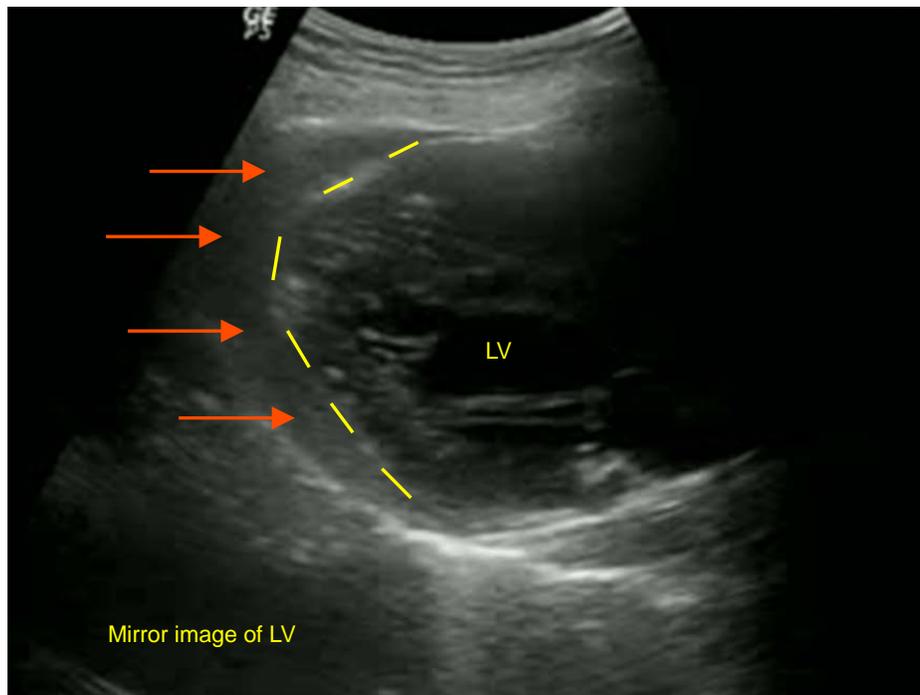


Figure. PLAX window: Clotted pericardial blood (red arrows) similar echogenicity to the myocardium (separated from pericardium by dashed line). NB note also the mirror image of the LV at bottom left of image.

Parasternal Short Axis View (PSAX)

- Probe in same position as for PLAX
- Probe is now rotated **clockwise** so that:
 - On abdominal preset: to patient's right elbow = 8 o'clock
 - On cardiac preset: to patient's left shoulder = 2 o'clock
 - I.E. angled along the short axis of the heart
 - In this view, the heart appears in **transverse** section
 - Then tilt the probe from apex to base of the heart. This allows a number of different 'slices' to be obtained:
 - PSAX- AV [level of aortic valve]
 - PSAX-MV [level of mitral valve = base of LV]
 - PSAX-PAP [level of papillary muscles]
 - PSAX-APICAL [level of apex]
- In basic cardiac echo, we can't usually see the RV very well because it's lurking in the near field, under the sternum. So all we are really looking at is the LV:
 - Its size
 - Its global function (leave the regional wall motion abnormalities to the fancier scans)
 - Most importantly, its shape: is it an 'O' or a 'D'?
 - 'O' sign = normal state of affairs = LV is higher pressure than RV
 - 'D' sign = cor pulmonale = RV is higher pressure than the RV
 - And it's best to look at the level of the papillary muscles if at all possible.

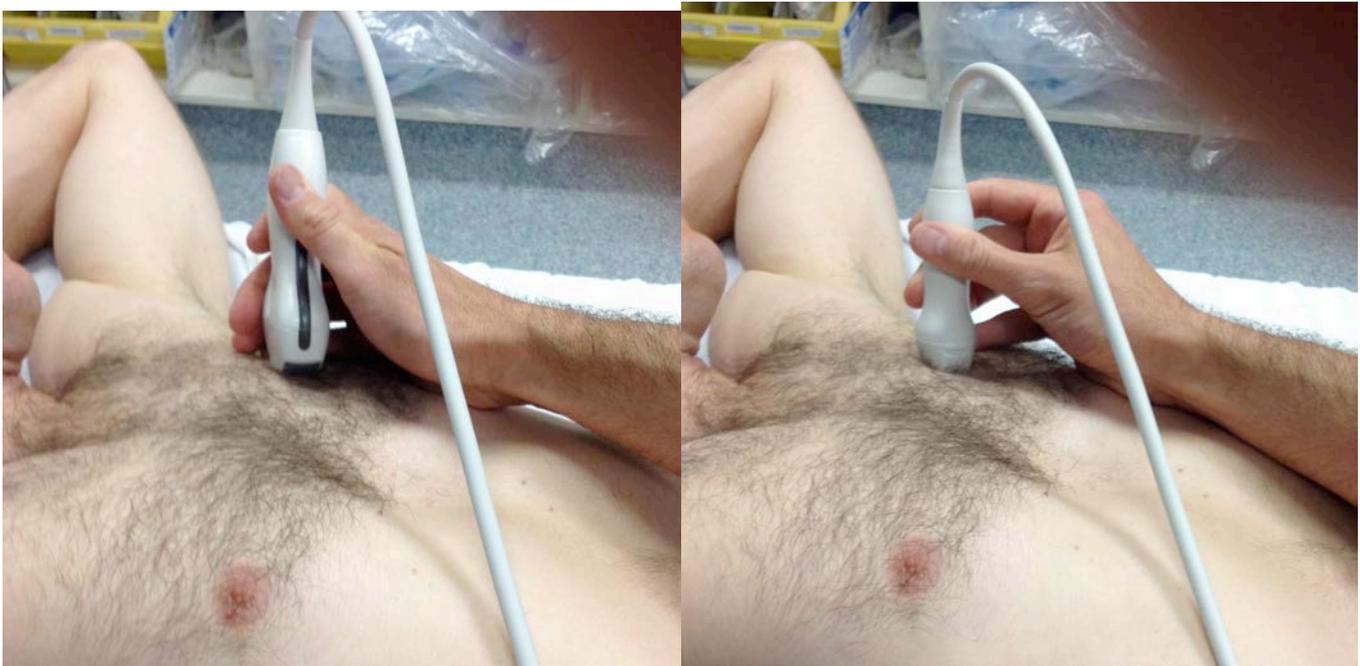


Figure. Probe position for PSAX window: (a) curved probe (b) sector probe

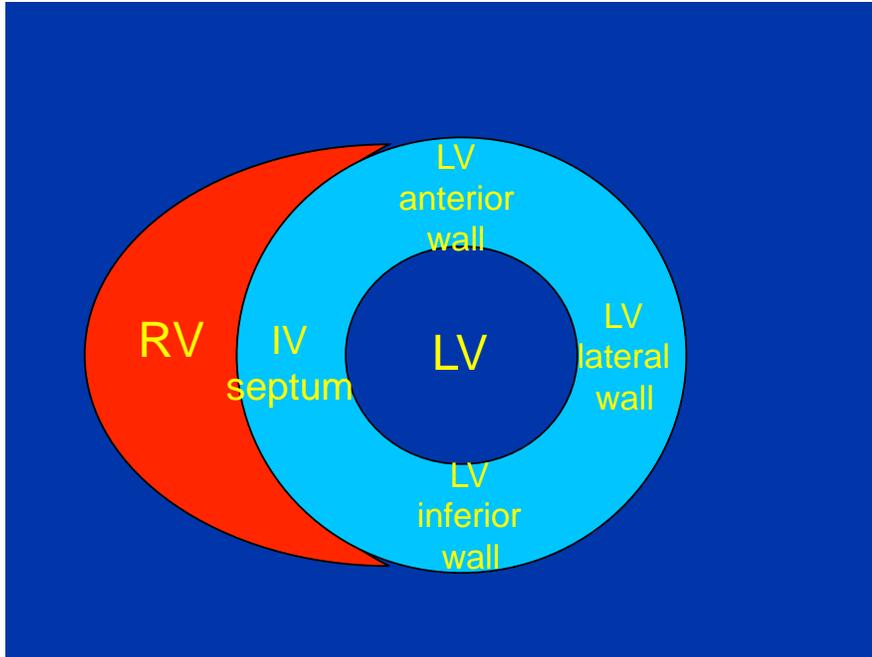


Figure. Schematic: PSAX window.

The RV 'wraps around' the LV.

The LV shares the IV septum with the RV.

Across from this is the LV lateral wall.

Nearest the probe is the LV anterior wall.

Furthest from the probe is the LV inferior wall.

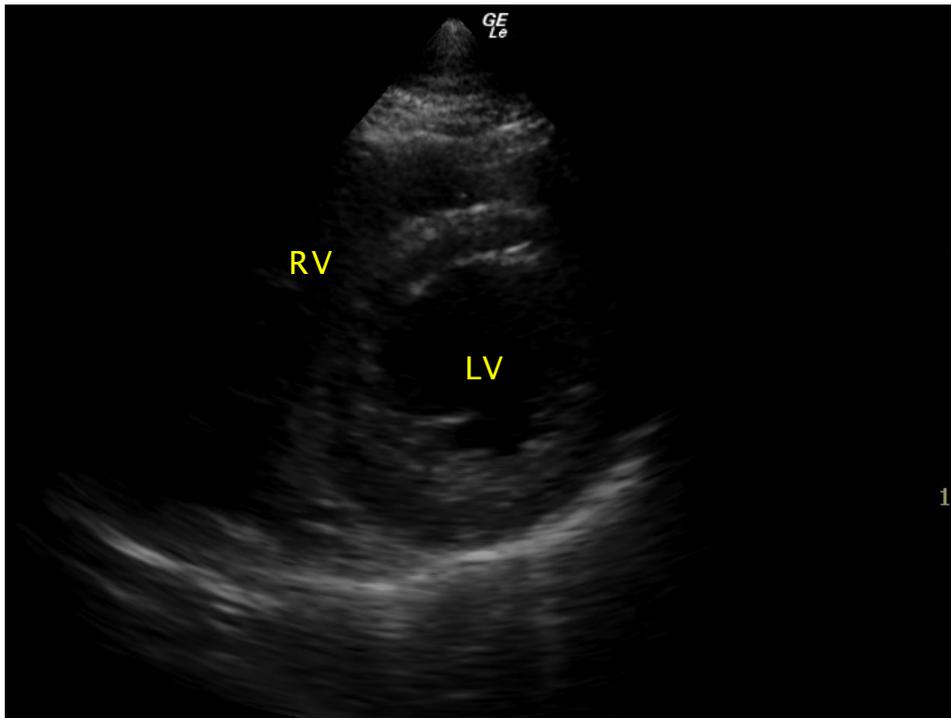


Figure. Normal heart, PSAX window. The 'O sign'.

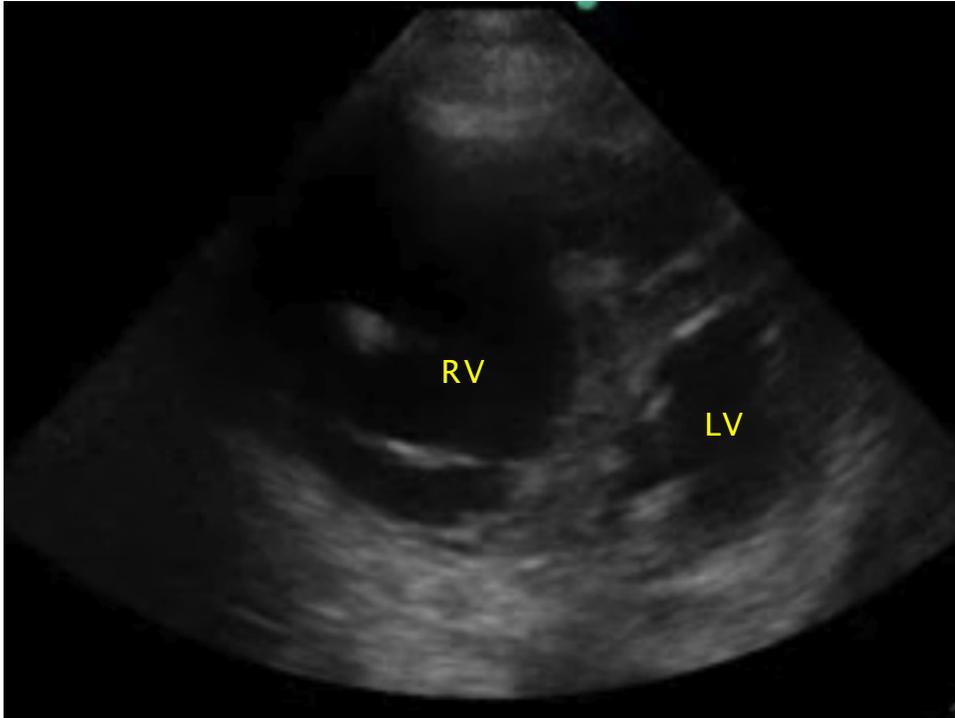


Figure. Cor pulmonale, PSAX window. The 'D sign'.

Apical Four Chamber View (A4C)

Top tip:

Once you get to the apical views, the curved probe is not very useful.

- Either slide the probe down the heart to the apex, or place the probe at the point of apex beat (usually 5th intercostal space, near anterior axillary line)
- Probe angled up along the axis of the heart, more or less towards the patient's head
- Probe marker:
 - On abdominal preset: to patient's right elbow = 8-9 o'clock
 - On cardiac preset: 2-3 o'clock
 - I.E. angled **along** the heart's long axis
 - In this view, the heart appears in **transverse** section
- In basic cardiac echo, this view helps identify right sided pathology (eg dilated RV) and also pericardial effusions



Figure. Probe position for A4C window: (a) curved probe (b) sector probe

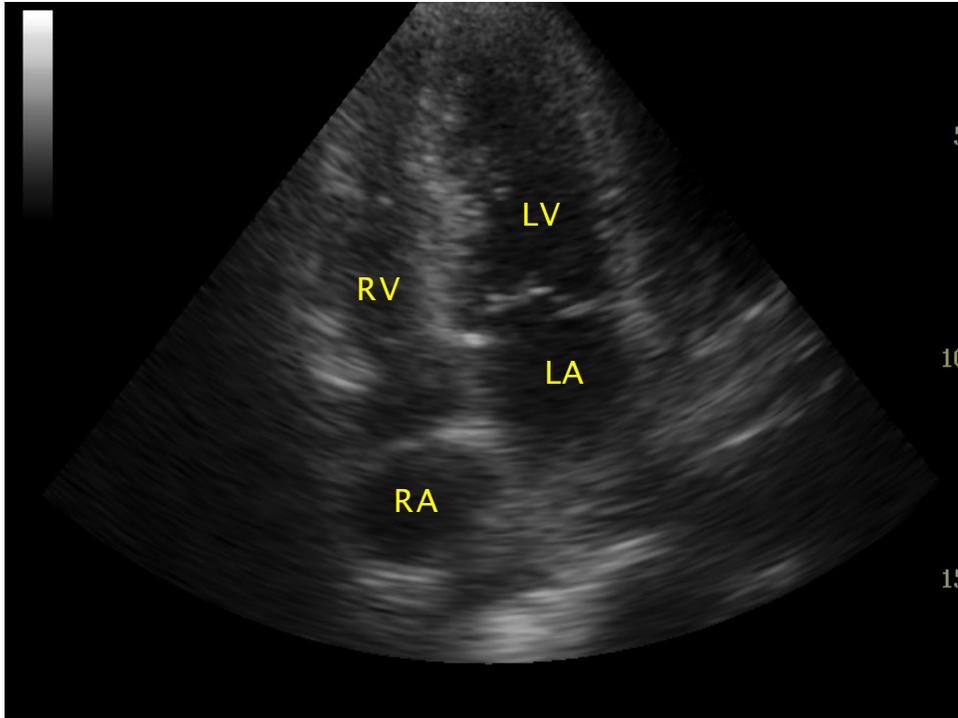


Figure. Normal heart, A4C window.

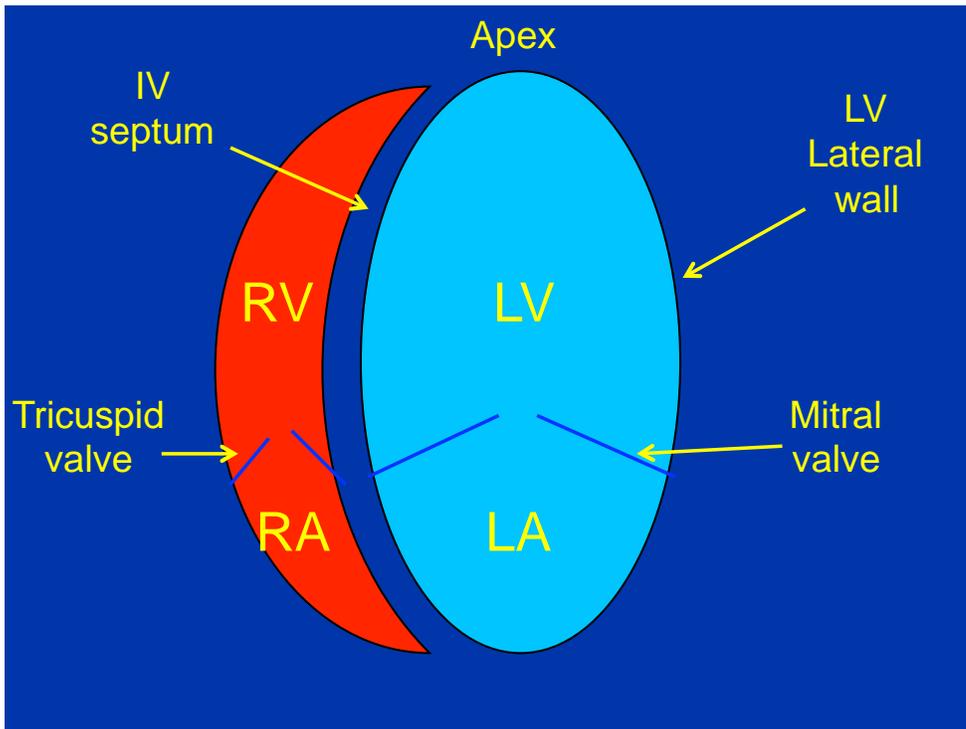


Figure. Schematic: A4C window.
The RV 'wraps around' the LV.
The LV shares the IV septum with the RV.
Across from this is the LV lateral wall.
Nearest the probe is the LV apex.

Furthest from the probe are the RA and LA.

Apical Two Chamber View (A2C)

Top tips:

- 1. Once you get to the apical views, the curved probe is not very useful.***
 - 2. The A2C view doesn't add much for basic cardiac echo.***
- Probe in same position as for A4C but rotated **anticlockwise** so that marker is at 11 o'clock on cardiac preset.
 - In basic cardiac echo, this window is rarely helpful! That's because it's really just looking at the anterior and inferior walls of the LV, for regional wall motion abnormalities.

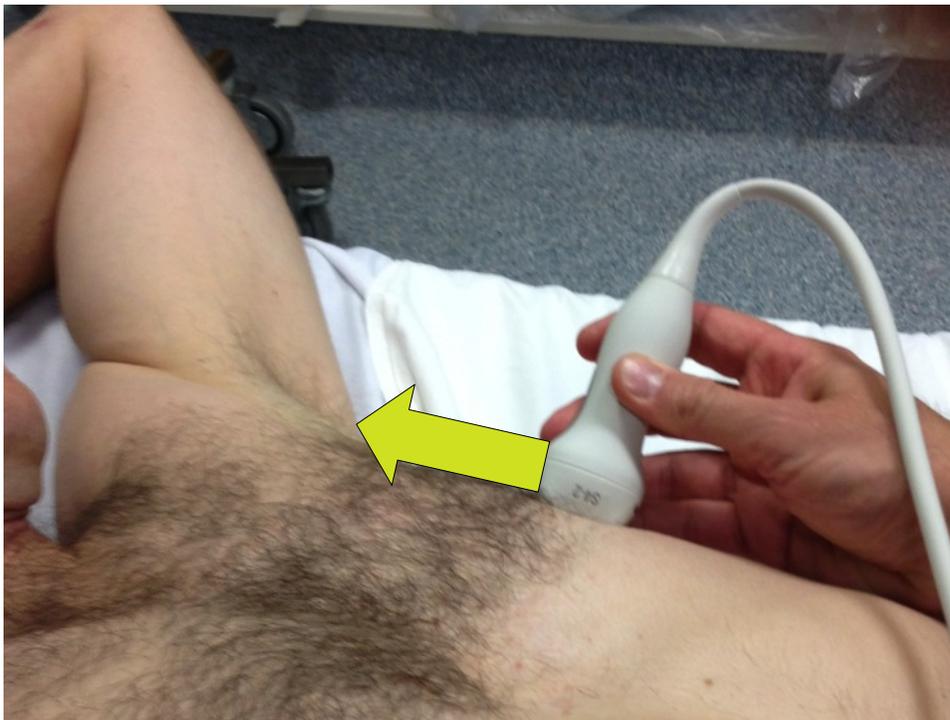


Figure. Probe position for A2C window. Probe marker to 11 o'clock.

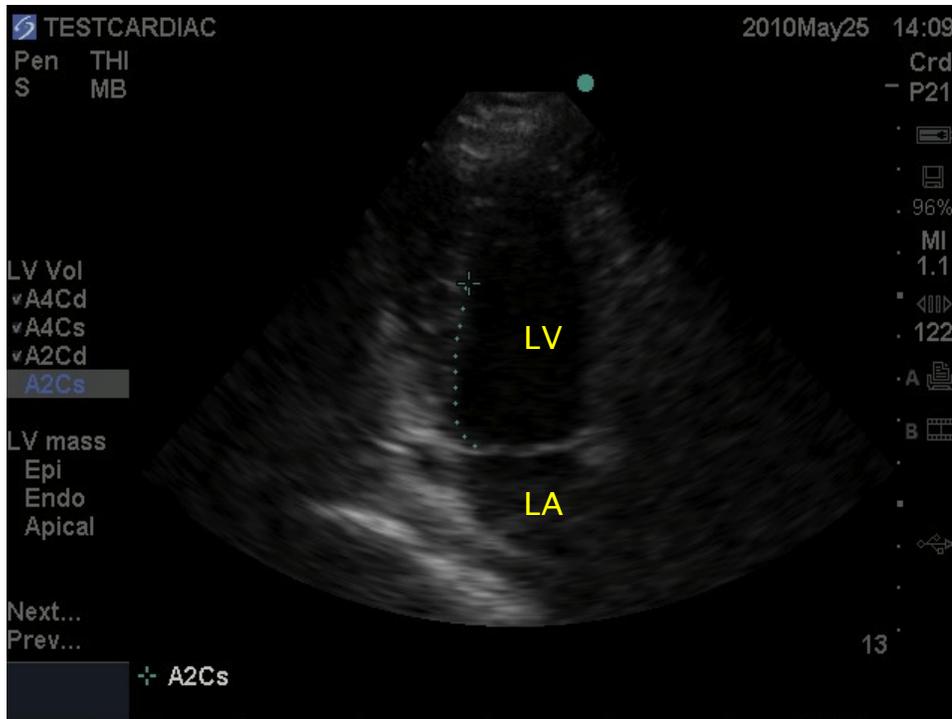


Figure. Normal heart, A2C window.