Basics in Echocardiography

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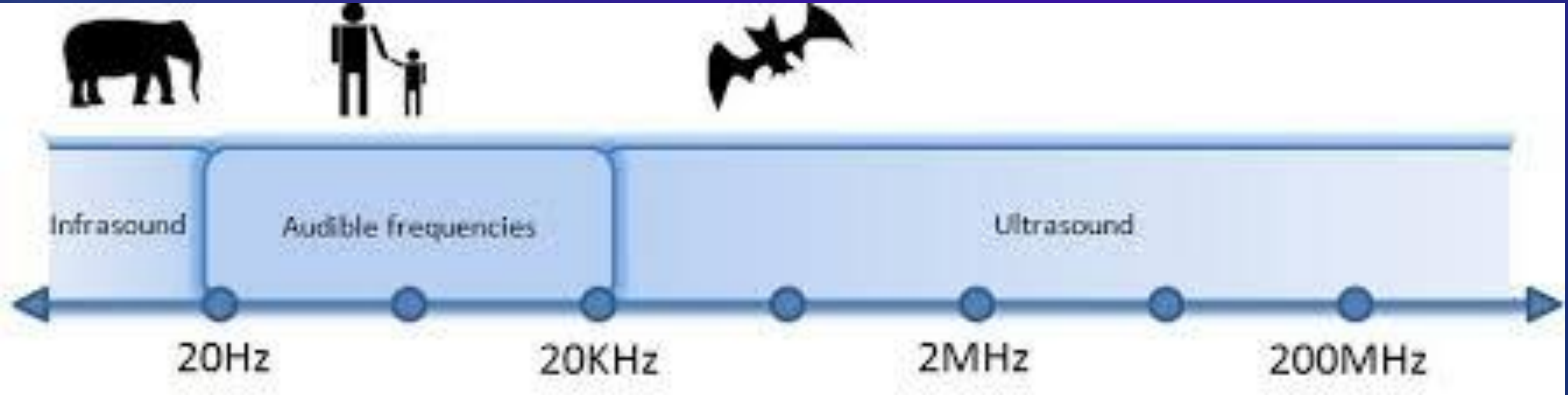
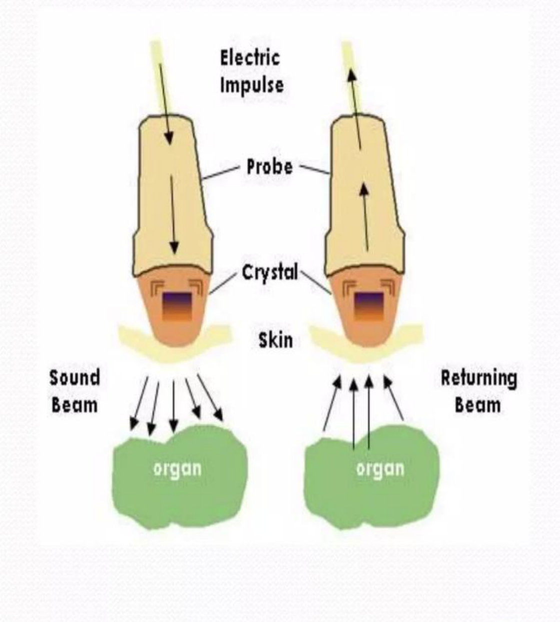
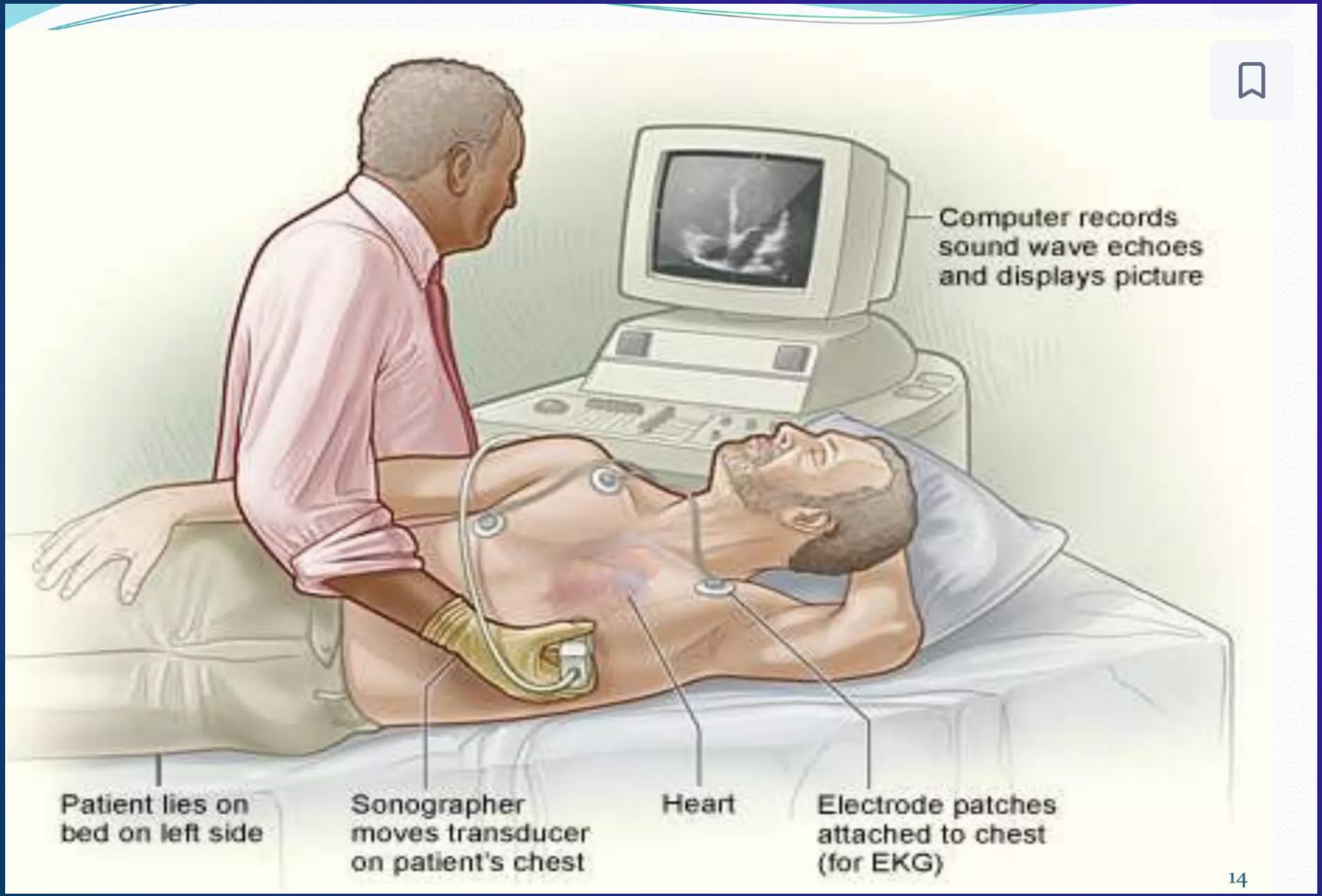
Introduction to Echocardiography

- type of ultrasound
- uses high-pitched sound waves to produce an image of the heart.
- **Ultrasound waves above 20 kHz frequency, which cant be perceived by the human ear.**
- Sound waves sent through the transducer which are reflected off various heart structures.
- Echoes are converted into images of the heart, that can be visualized on a monitor.
- The conversion of sound to electrical energy is called **piezoelectric effect.**



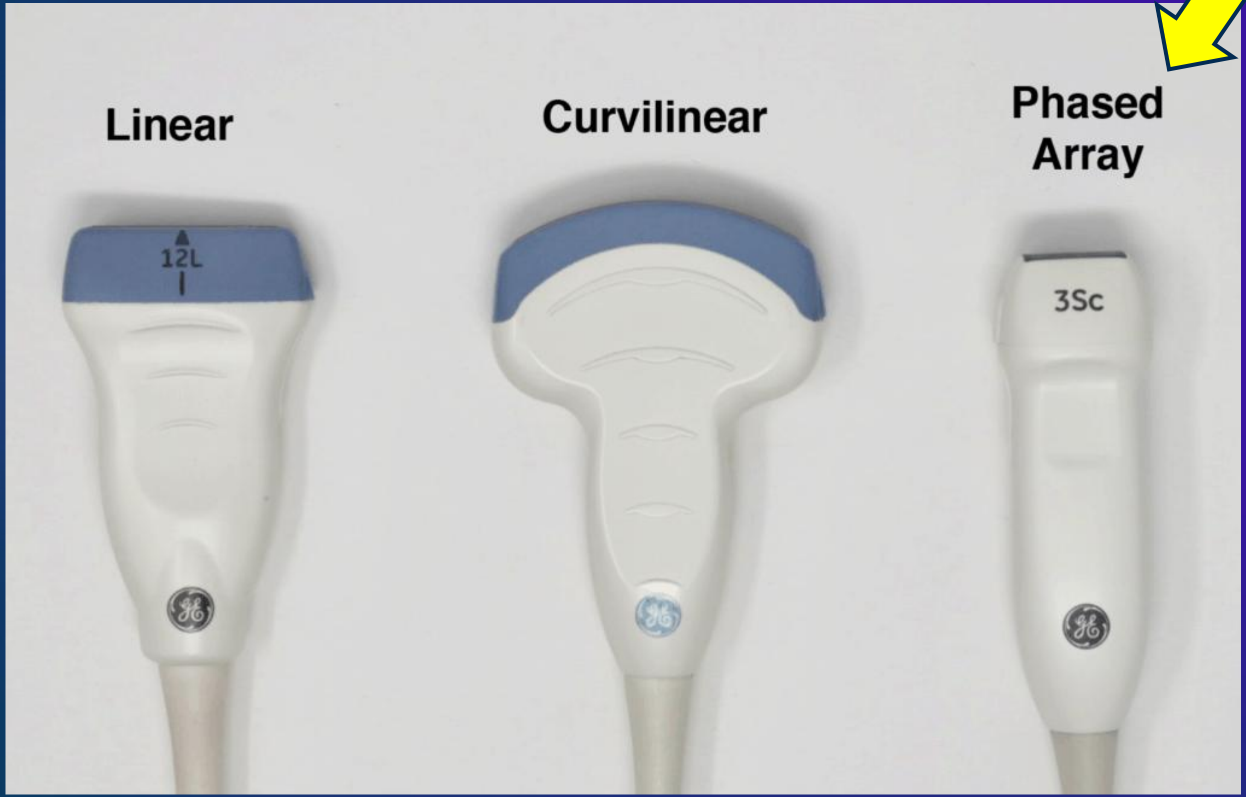


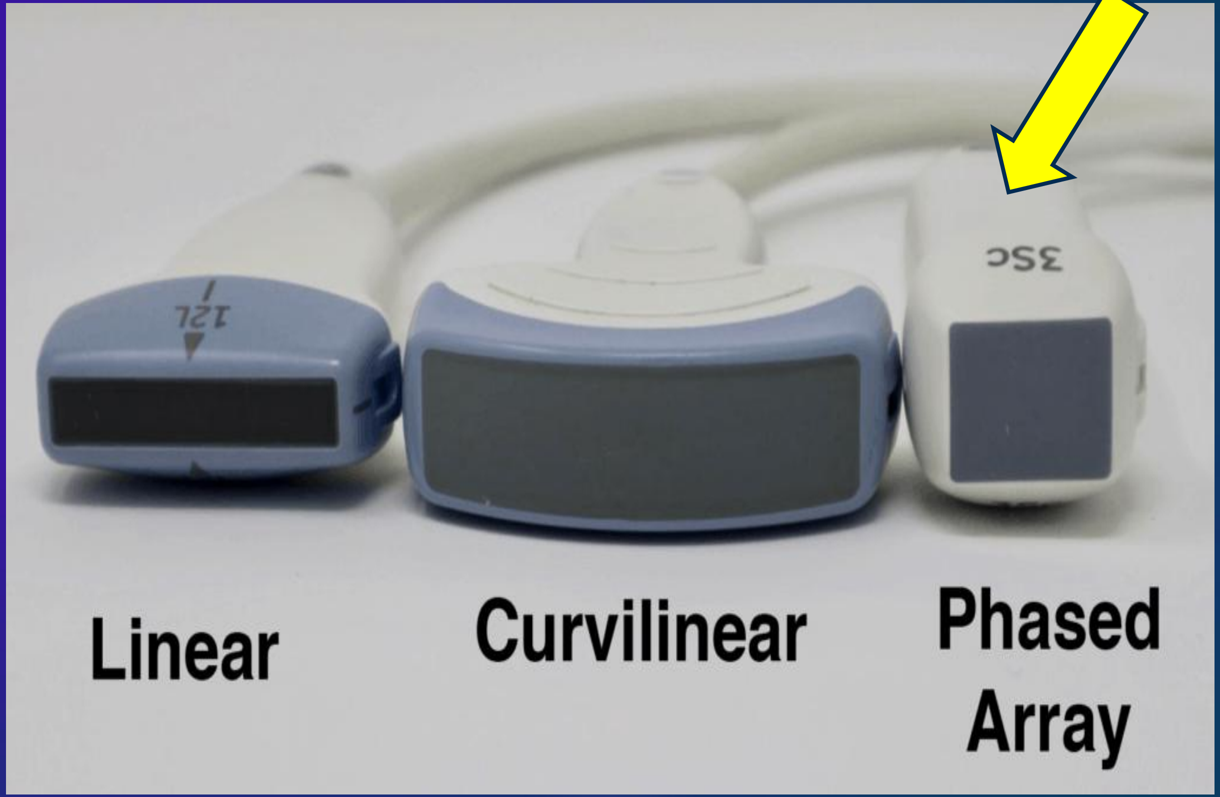
5 basic components of an ultrasound scanner



- Pulse generator - -> Applies high amplitude voltage to energize the crystals.
- Transducer- converts electrical energy to mechanical
- Receiver – detects and amplifies weak signals.
- Monitor– displays and amplifies weak signals
- Memory stores the video display

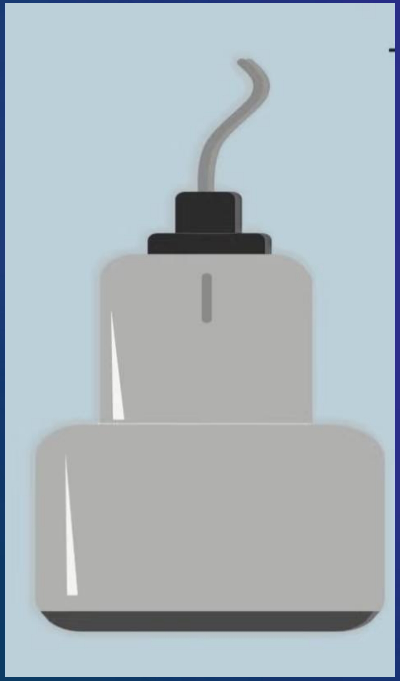
Types of Probe

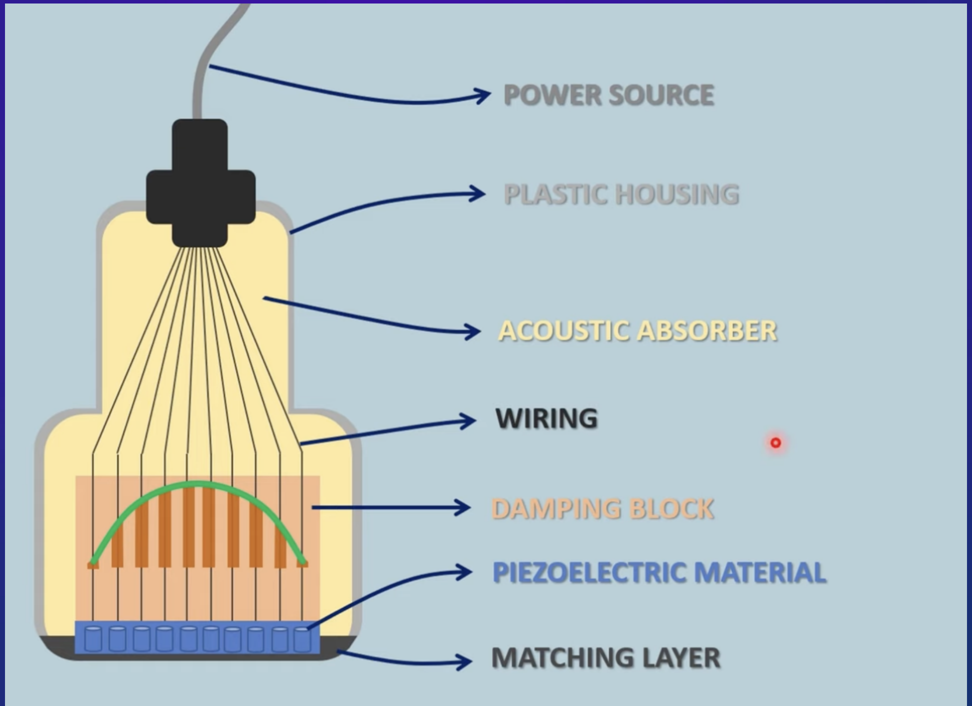


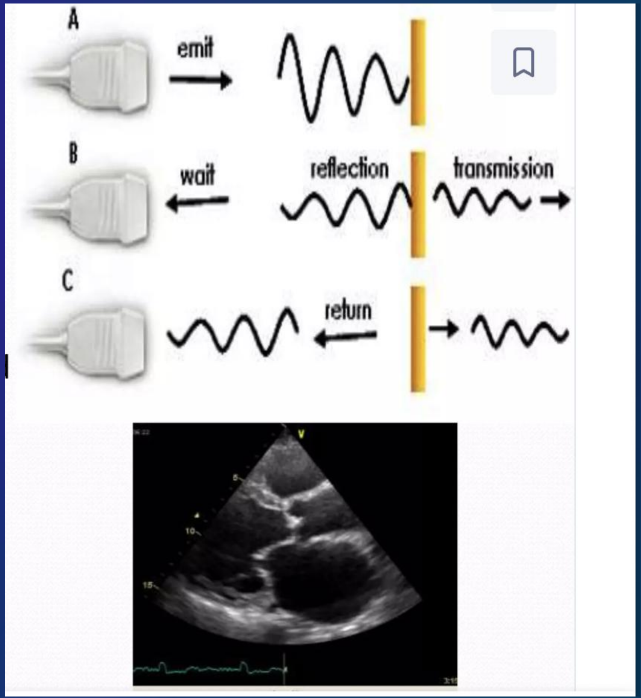


Components of the Transducer/ Probe

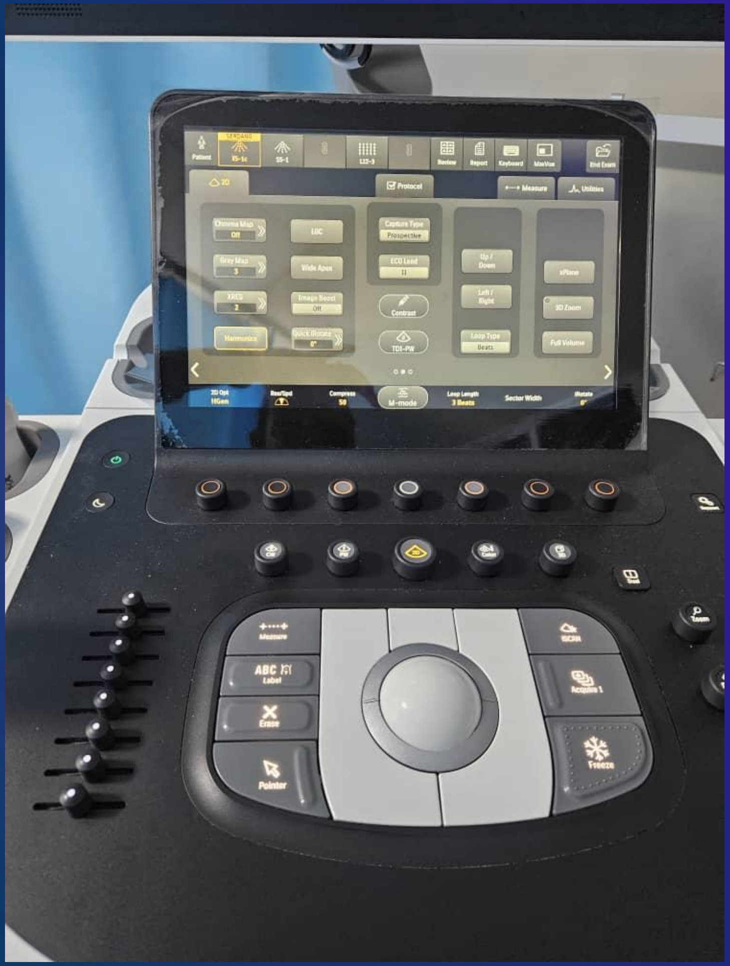
- Generate, transmit, and receive reflected ultrasound waves from the heart.
- It contains a piezoelectric material that converts electrical energy into ultrasound waves and reconverts reflected waves back into electrical signals

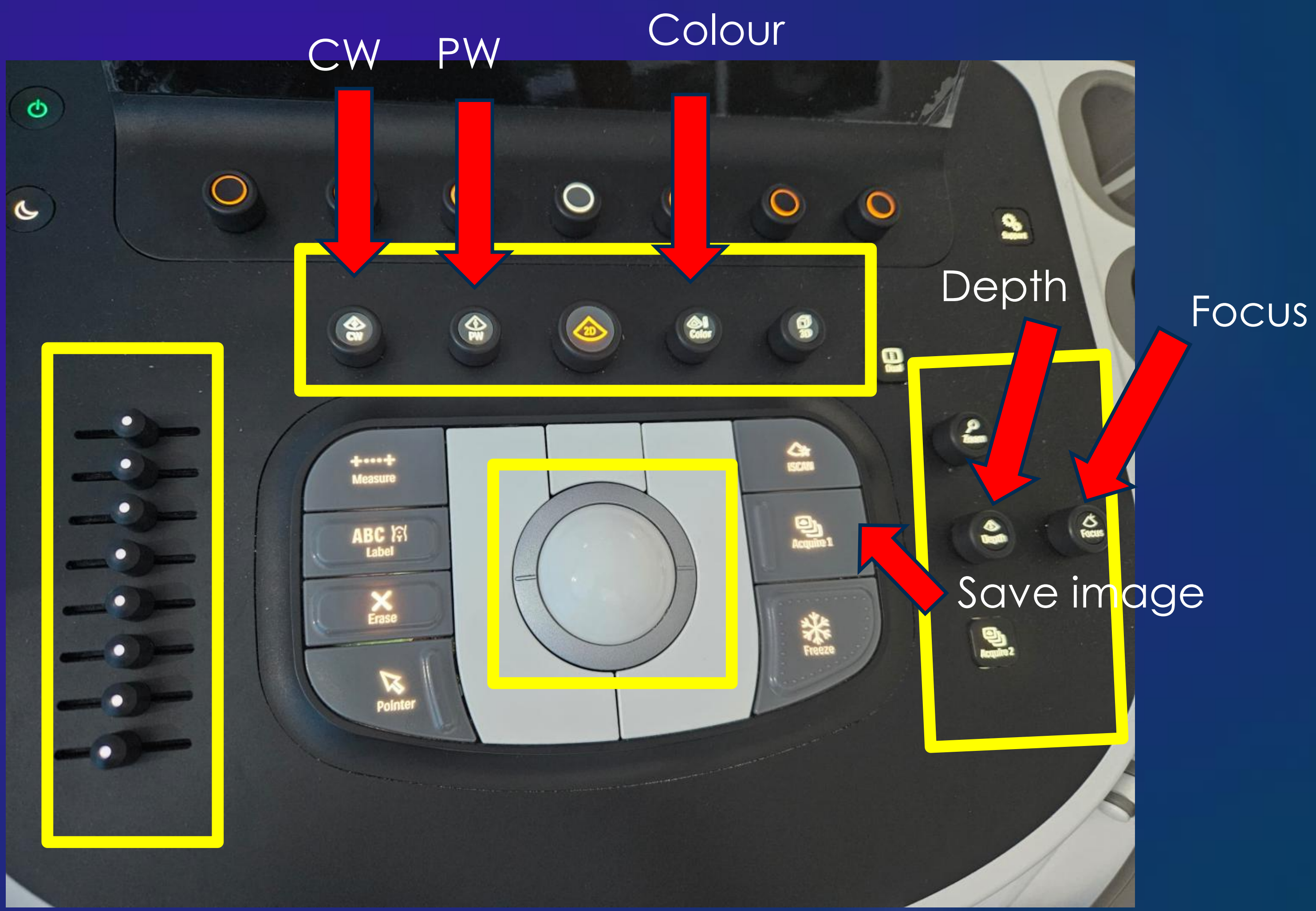






Knobology




CW
PW
Colour
Depth
Focus
Save image
Measure
ABC
Label
Erase
Pointer
iSCAN
Acquire 1
Freeze
Acquire 2

GAIN

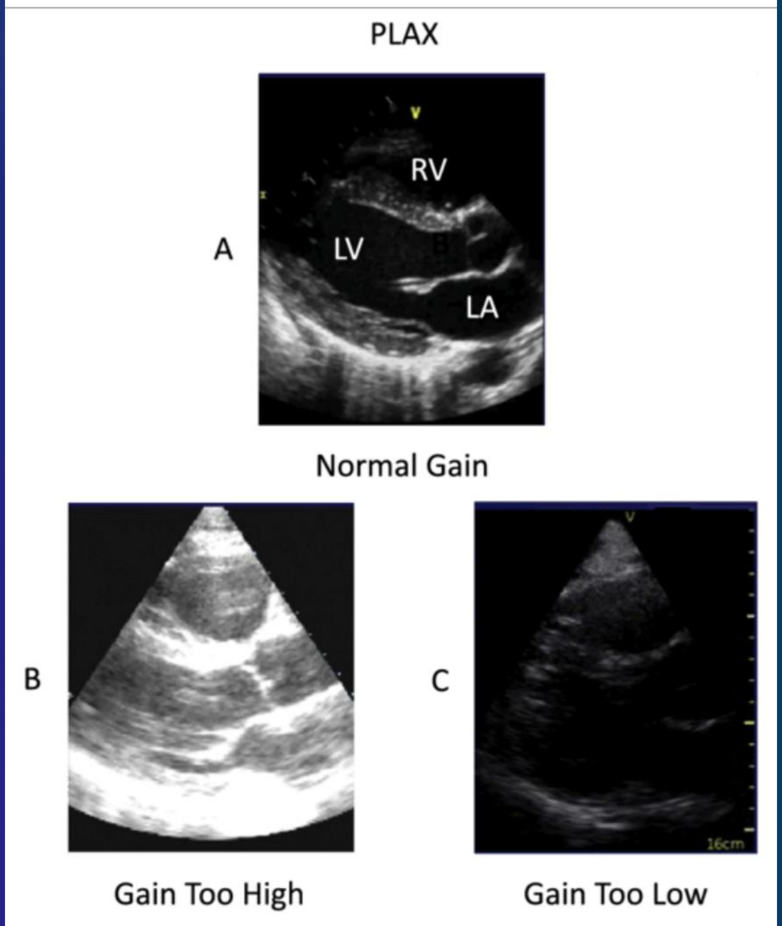
- **controls brightness of the image.**
- If the gain is **too low**: The image will be too **dark**
- If the gain is **too high**: The image will be too **bright**

- **Types of Gain Controls**

1. **Overall Gain** – Adjusts the entire screen equally.
2. **Time Gain Compensation (TGC)** –

Adjusts brightness at specific depths (near field vs far field).

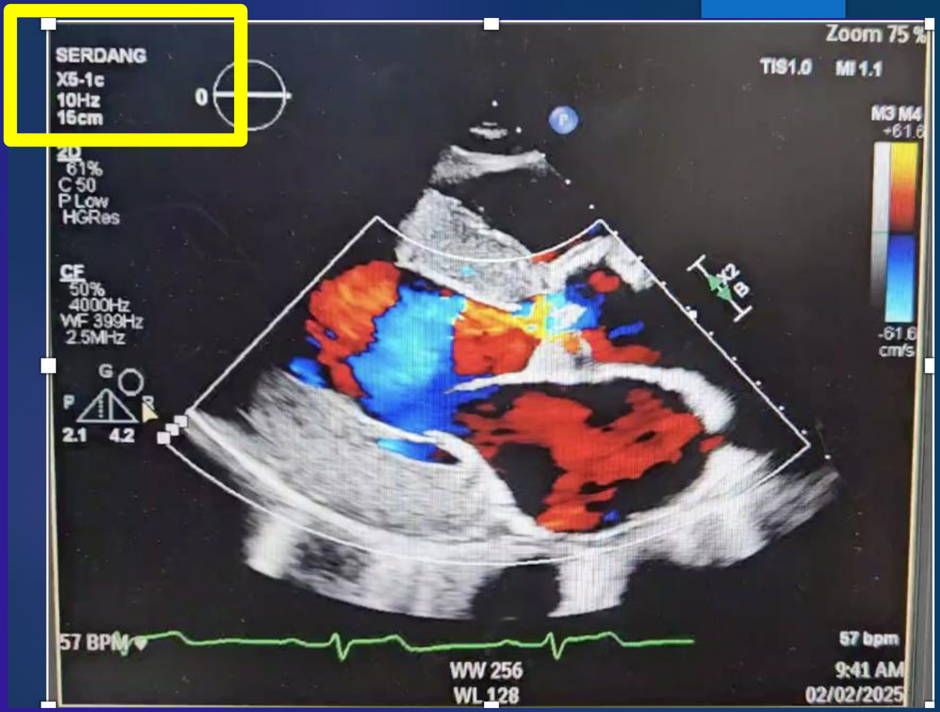
- **Lateral Gain Compensation** – Less common, adjusts brightness side to side.



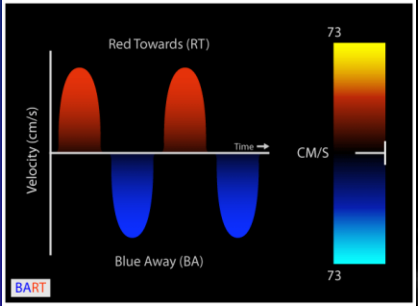
Depth

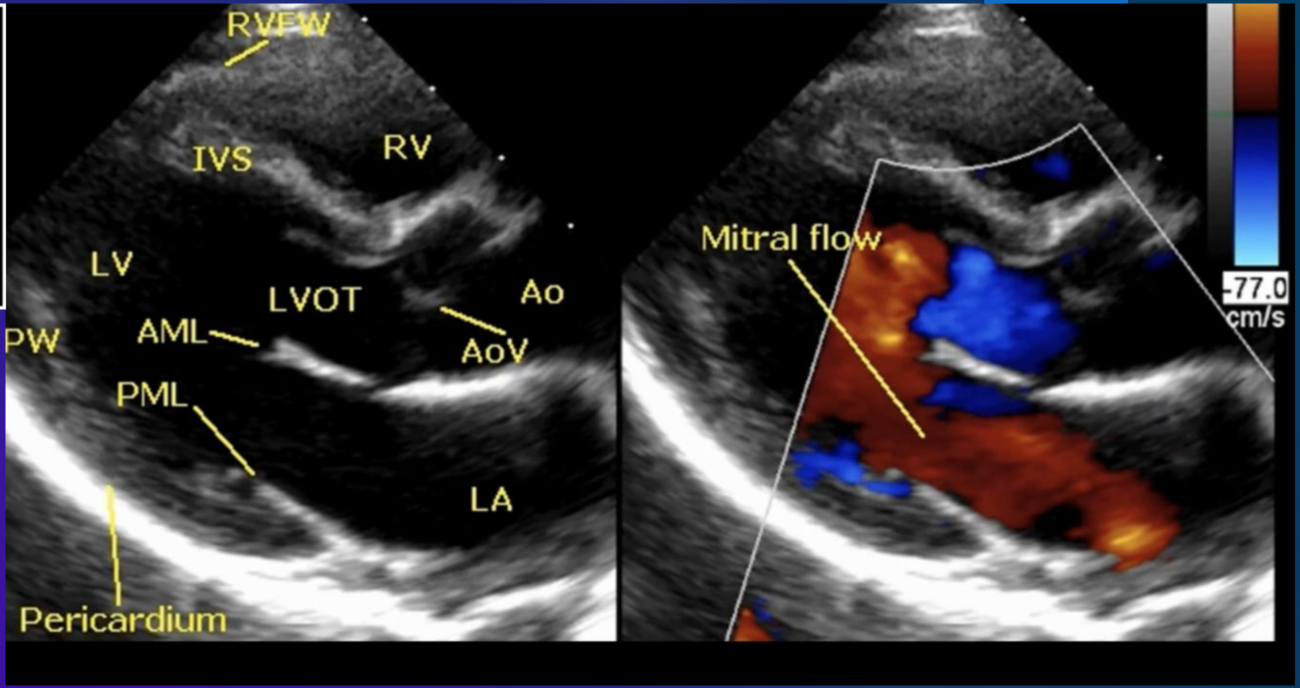
- Zooming in or out
- Increase depth → see **deeper structures**, but things look **smaller**
- Decrease depth → **zoom in** on superficial structures, but you might **miss deeper anatomy**

Less depth = higher **frame rate** and **better resolution**
More depth = can see **pericardial effusion**, deep structures like **descending aorta**

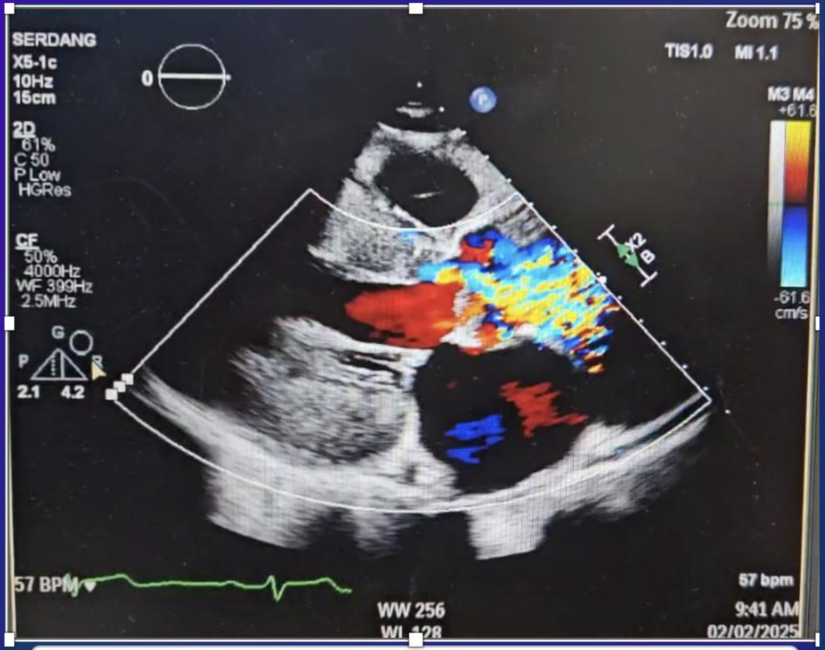


Colour maps



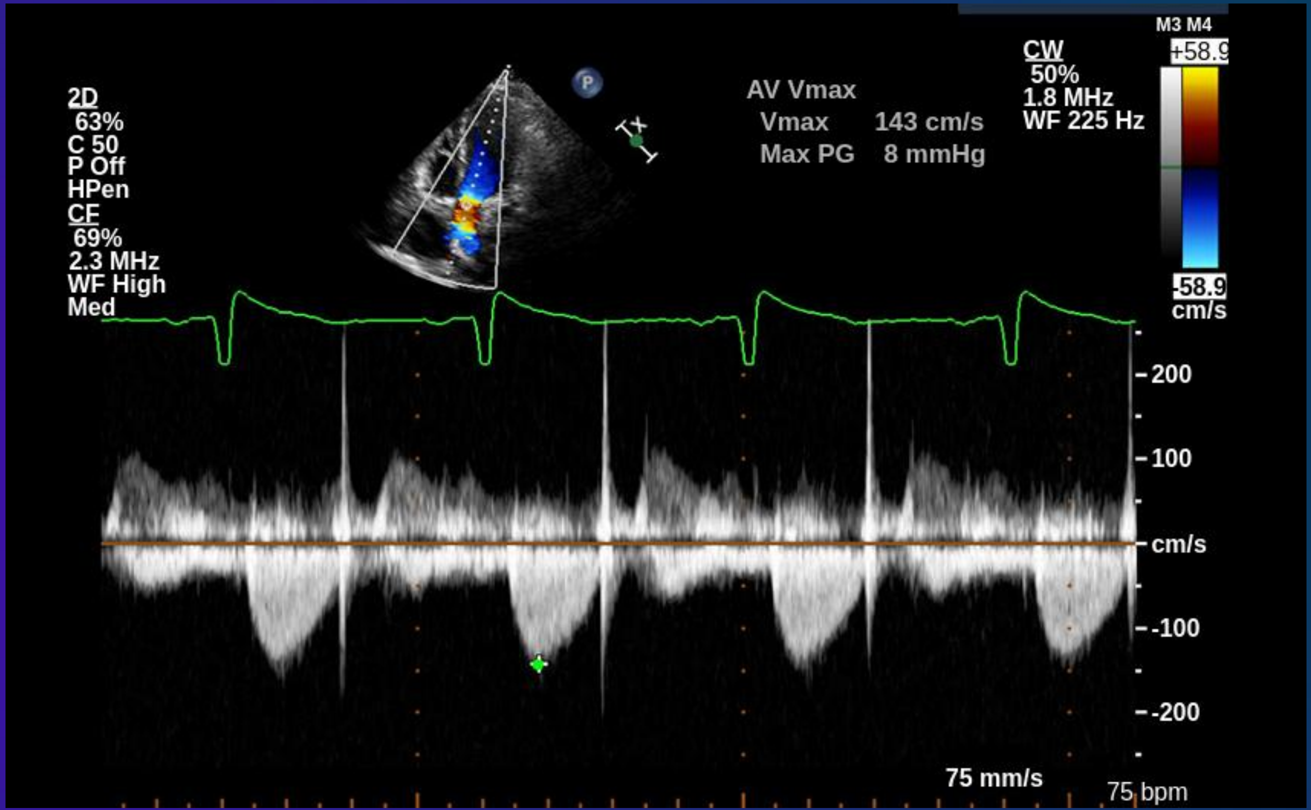


Color	Direction of Flow	Interpretation
Red	Toward the probe	Normal mitral inflow, aortic regurgitation
Blue	Away from the probe	Aortic outflow, tricuspid regurgitation
Green or Mosaic	Turbulent flow	High-velocity jets, stenosis, shunts



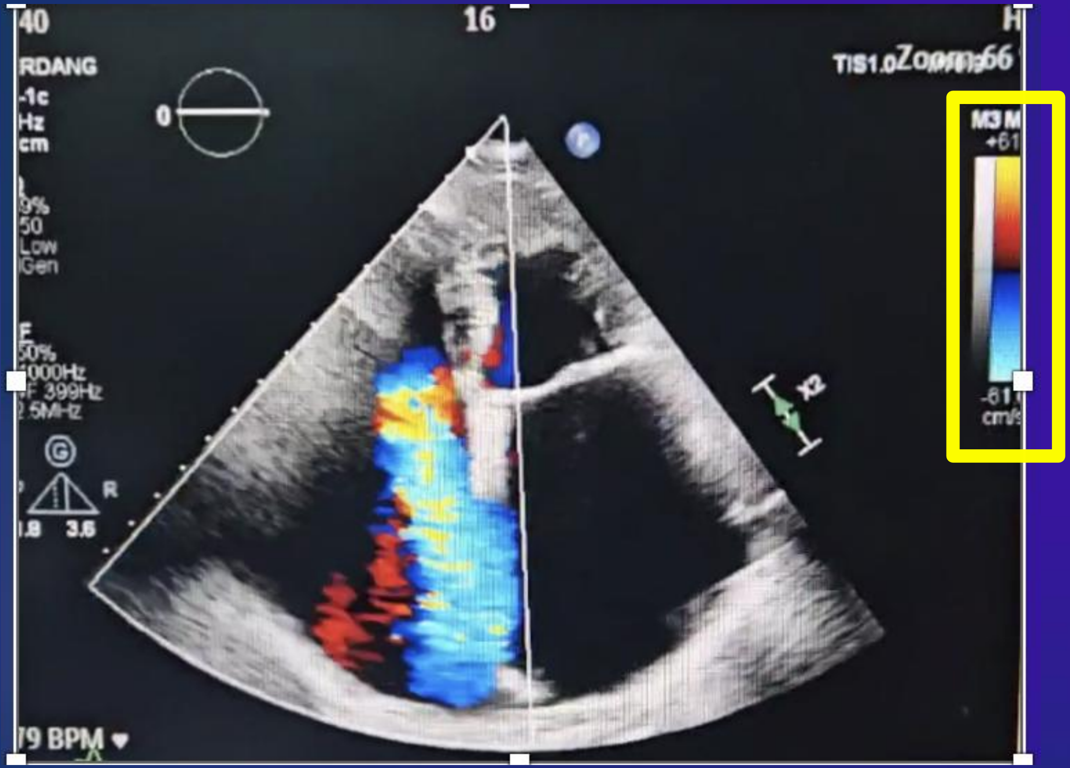
Baseline

- **horizontal line** on the spectral display that separates:
- **Above the baseline** → blood flow **toward** the transducer (positive velocity)
- **Below the baseline** → blood flow **away** from the transducer (negative velocity)
- So, the baseline represents **0 m/s** velocity — no movement relative to the probe.
- **Y-axis**: Velocity (cm/s or m/s)
- **X-axis**: Time
- **Waveform**: Shows blood flow over time



Nyquist limit

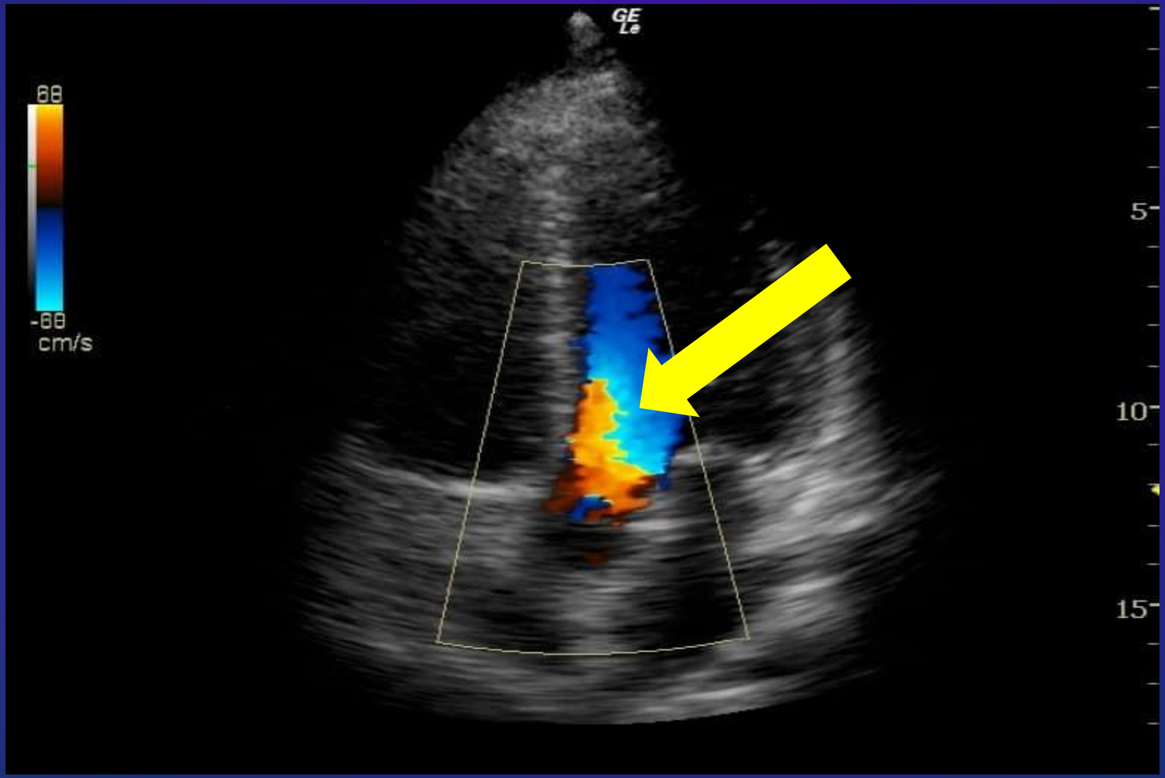
- It's all about how **fast** we can measure blood flow **before aliasing**.



Normally set 50-70cm/s

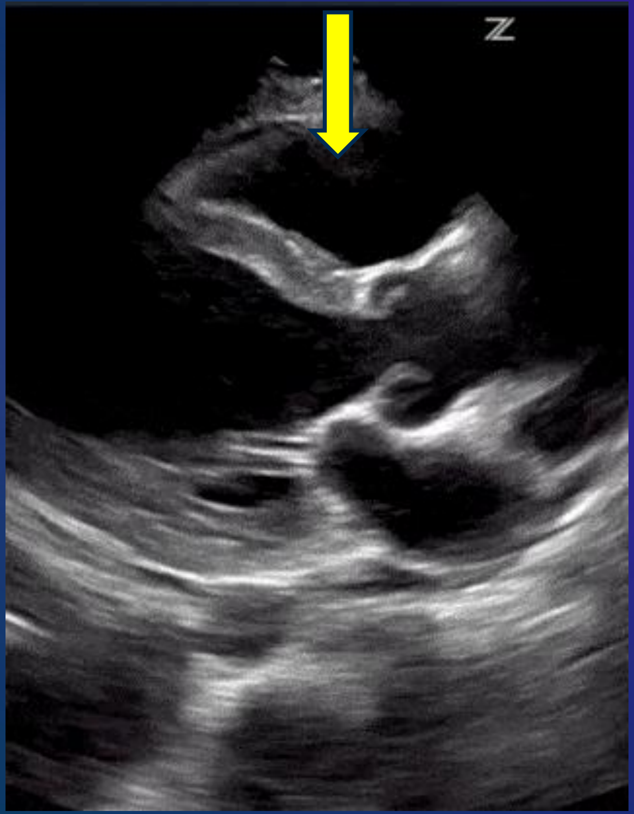
Aliasing

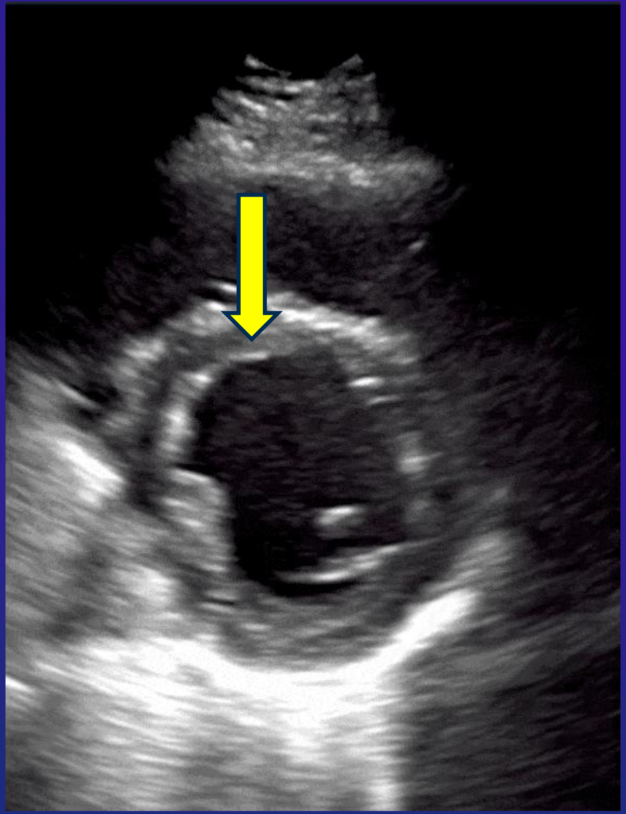
- **Aliasing** is an artifact that occurs when the **velocity of blood flow** exceeds the **Nyquist limit**, causing the Doppler signal to be displayed **incorrectly**, often as a **reversed direction** or **distorted flow pattern**.

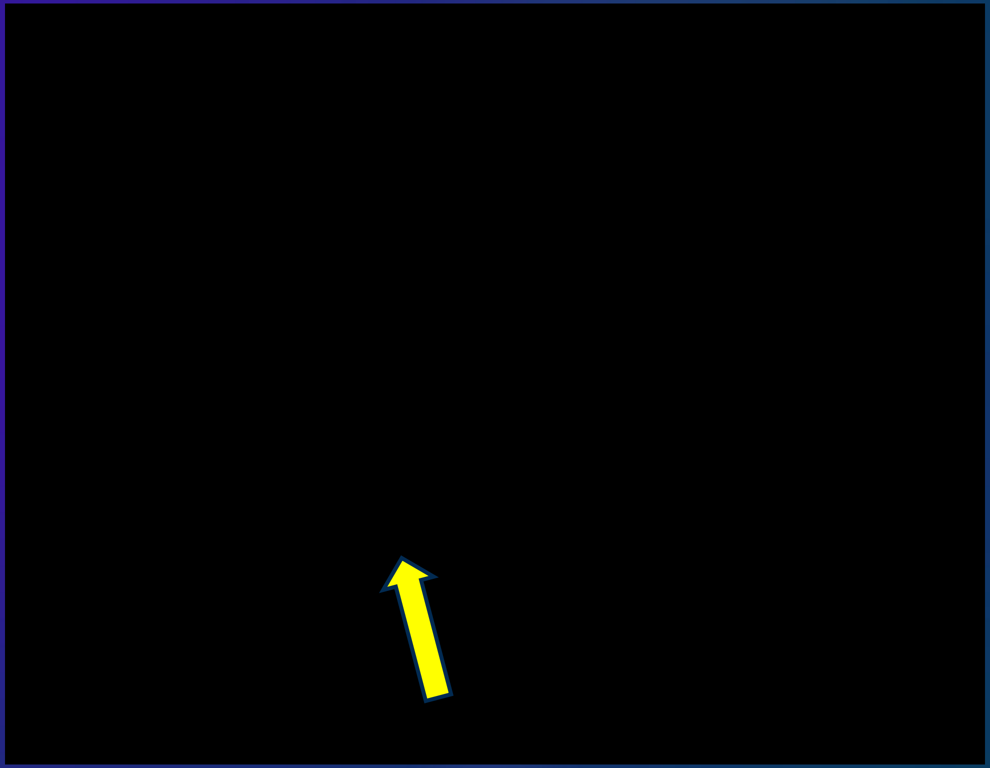


Grayscale image is generated based on intensity of reflected echo

Black	Fluid or blood
Grey	Myocardium
White	Calcification/ pericardium/ prosthetic valves

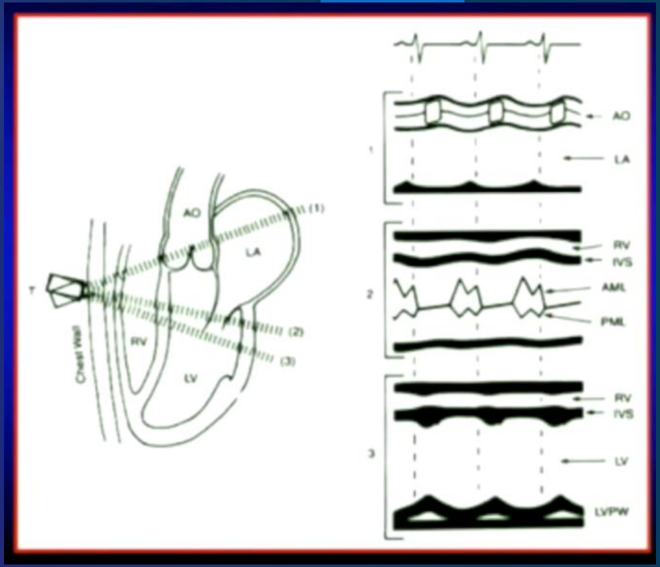


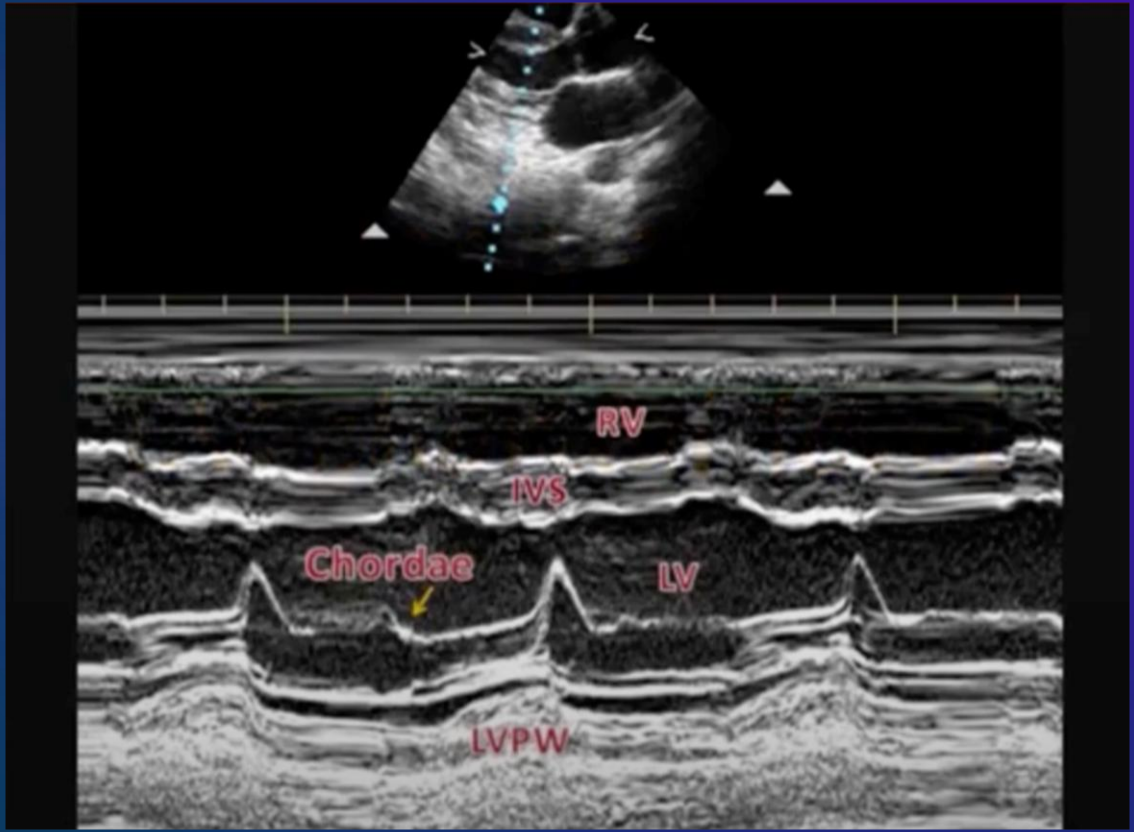


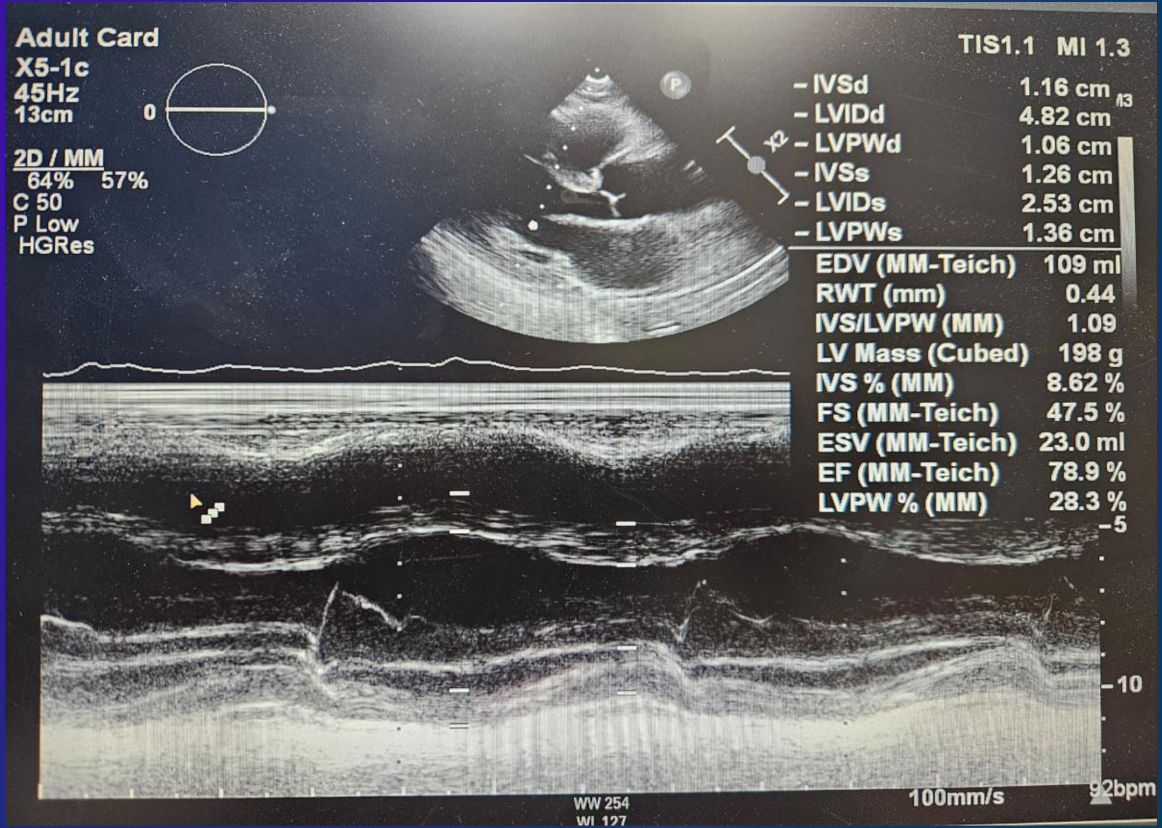


M-mode

Showing structures move over time — like a time-lapse of the heart in a **single straight line**.

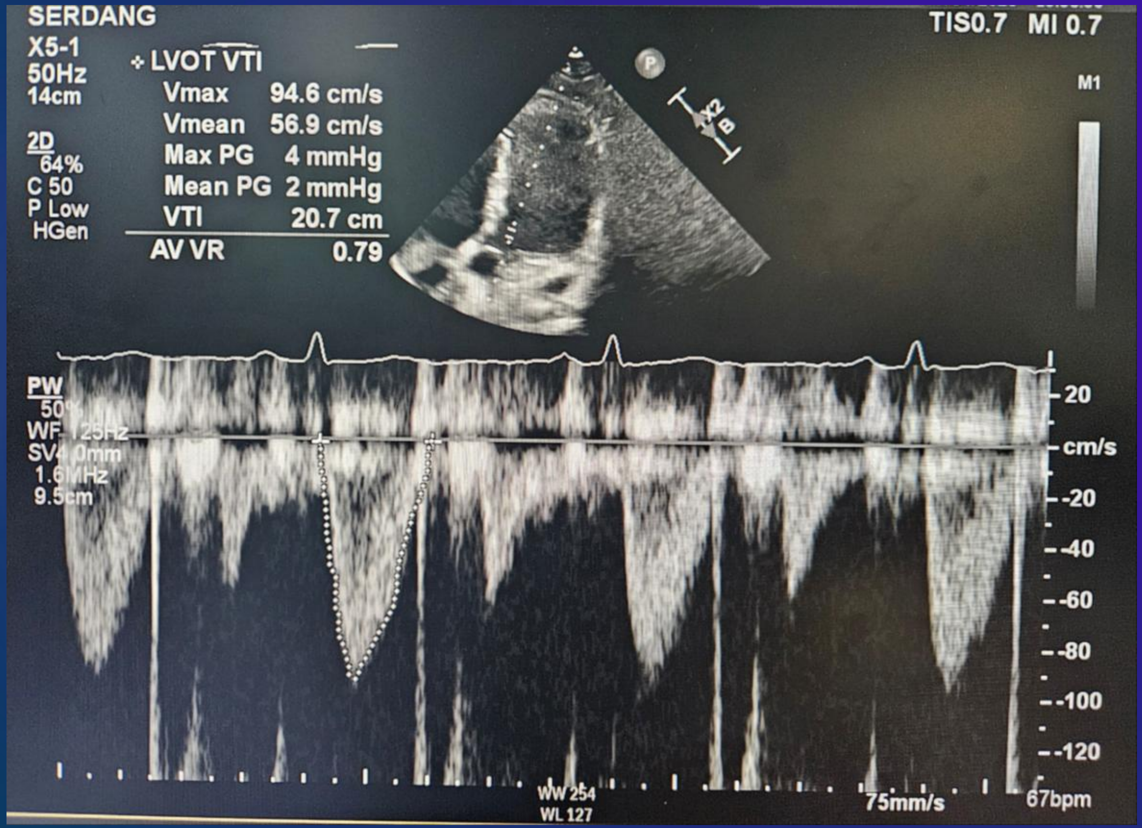


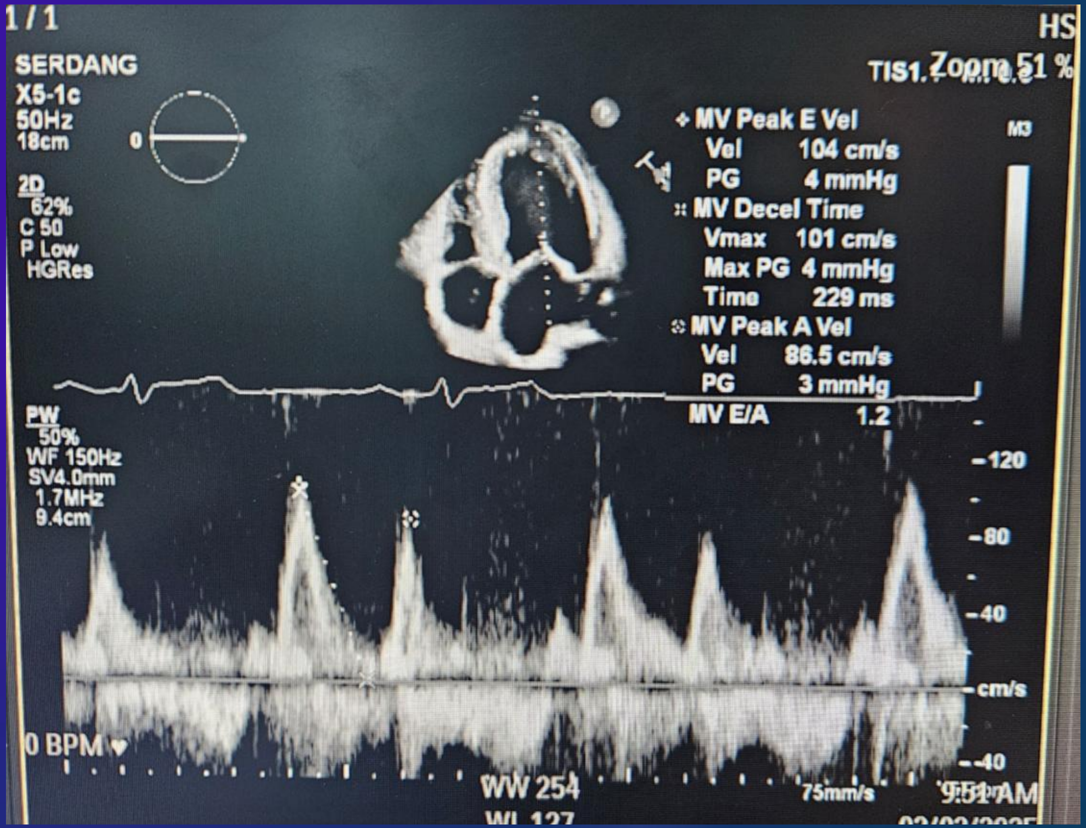




Pulse Wave Doppler (PW Doppler)

How It Works: A short ultrasound pulse is used to measure how fast blood is flowing.
Key Feature: Measures blood flow at a specific spot—useful for checking flow through heart valves or arteries.
Limitations: Not reliable for fast blood flow (over 2 m/sec) due to aliasing.
Uses: Checking blood flow through a heart valve, like the mitral valve.

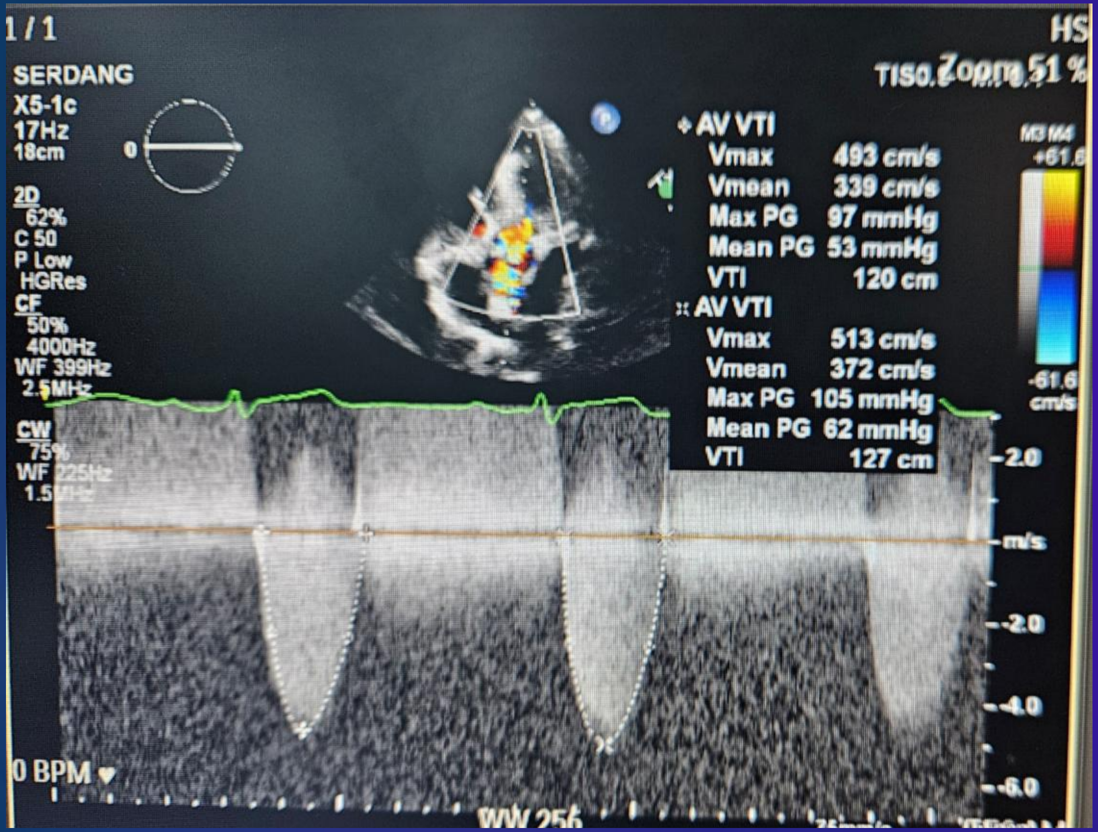




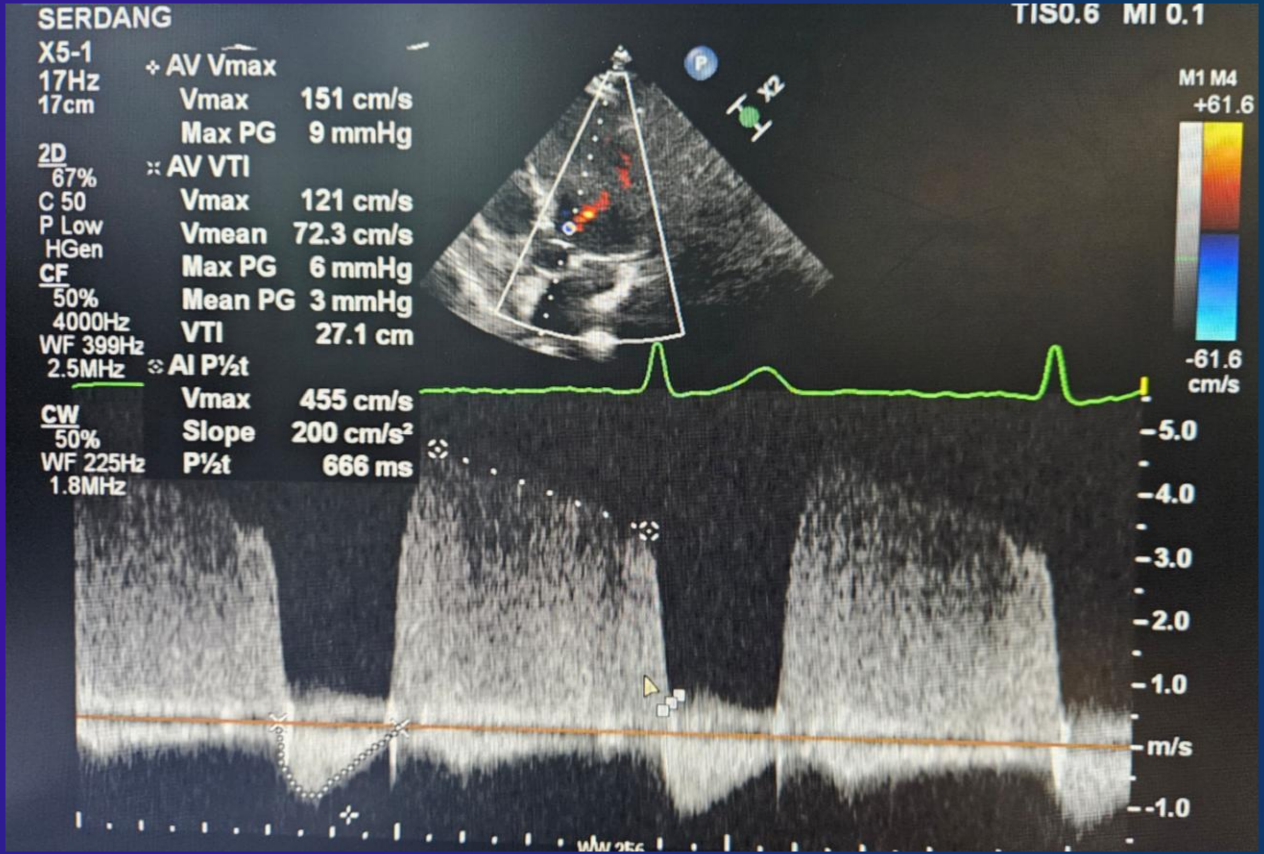
Continuous Wave Doppler (CW Doppler)

- **Definition:** Continuously sends and receives ultrasound waves from moving blood.
- **Key Feature:** Detects very fast flow, useful in conditions like severe valve disease.
- **Limitation:** Can't pinpoint the exact location of the flow.
- **Compared to PW Doppler:** Not limited by depth, so it can measure high speeds anywhere in the heart.

CW of Aortic Valve

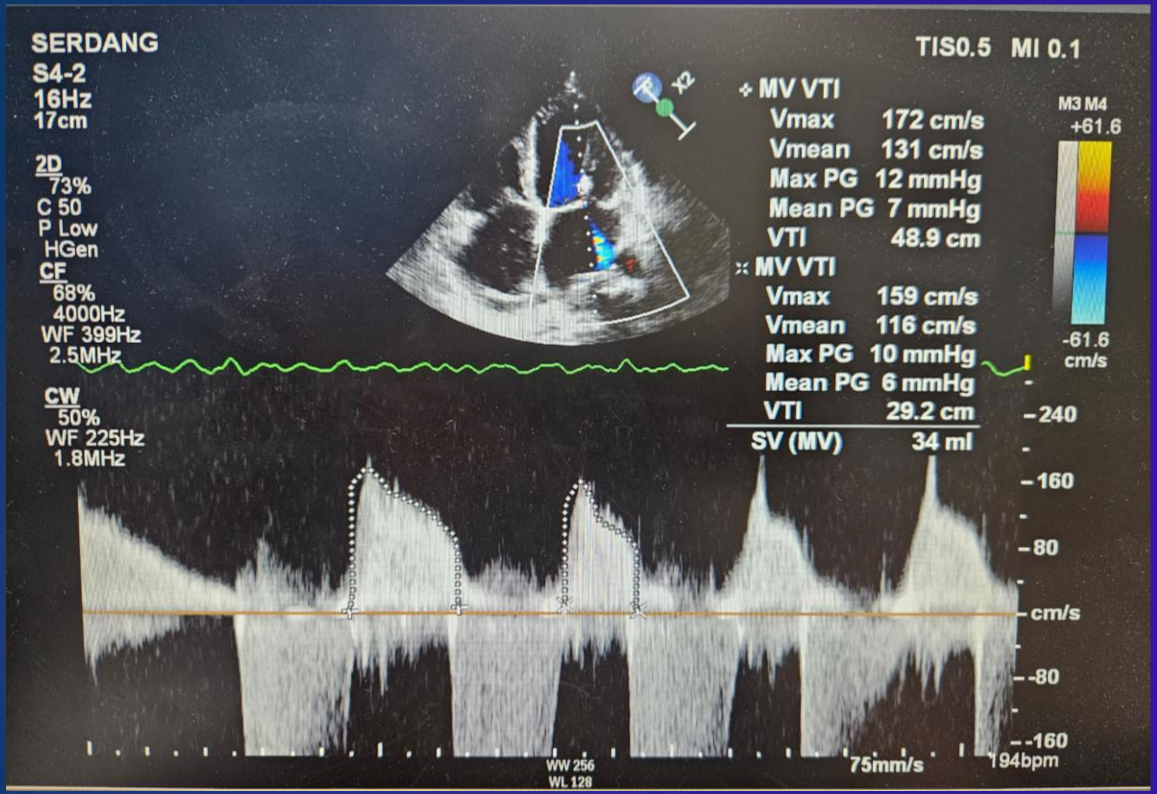


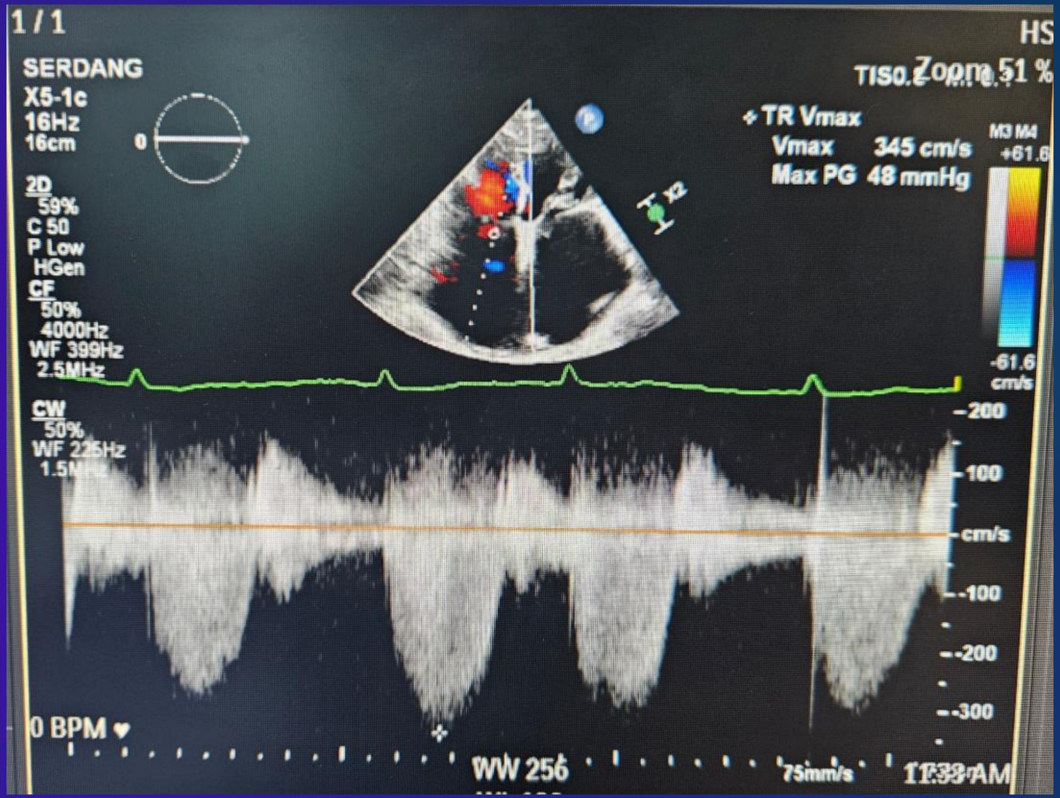
Severe AS doppler



Mild Aortic regurgitation

CW of Mitral Valve and Tricuspid Valve





Moderate Mitral Stenosis

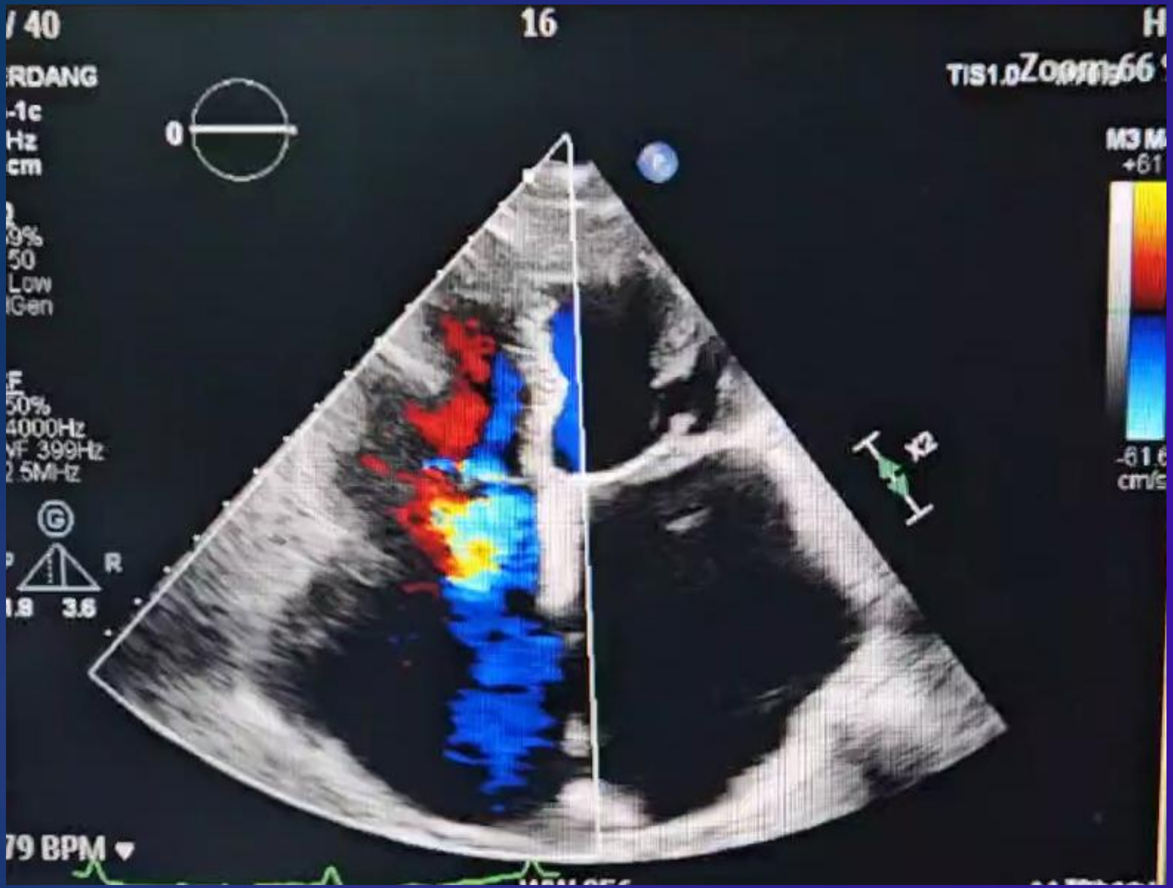
Severe Tricuspid regurgitation

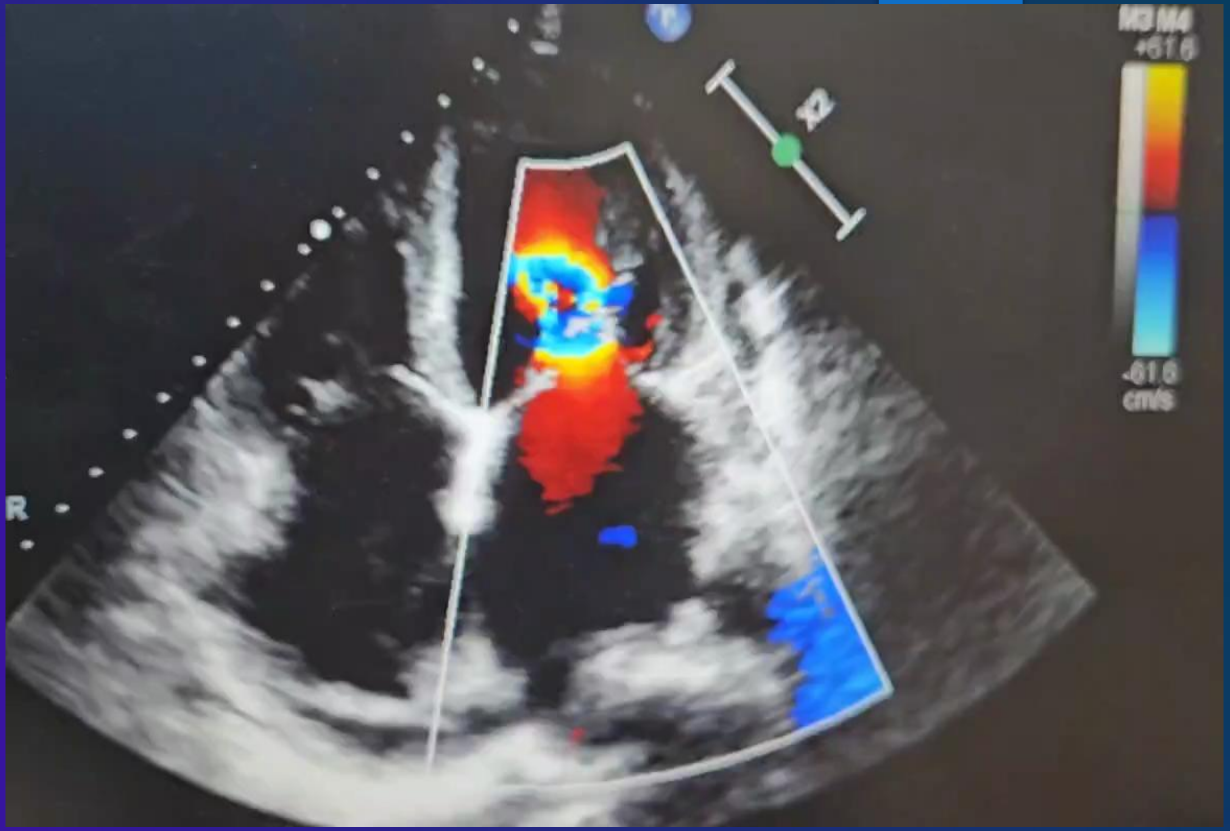
Color Doppler

- **The direction and velocity of blood flow are colour coded based on the BART CONVENTION (blue away, red towards)**
- Useful in determining the velocity and direction of blood flow through cardiac valves and or congenital shunt defect (ASD,VSD)
- It can also detect the presence and severity of regurgitation across cardiac valves.

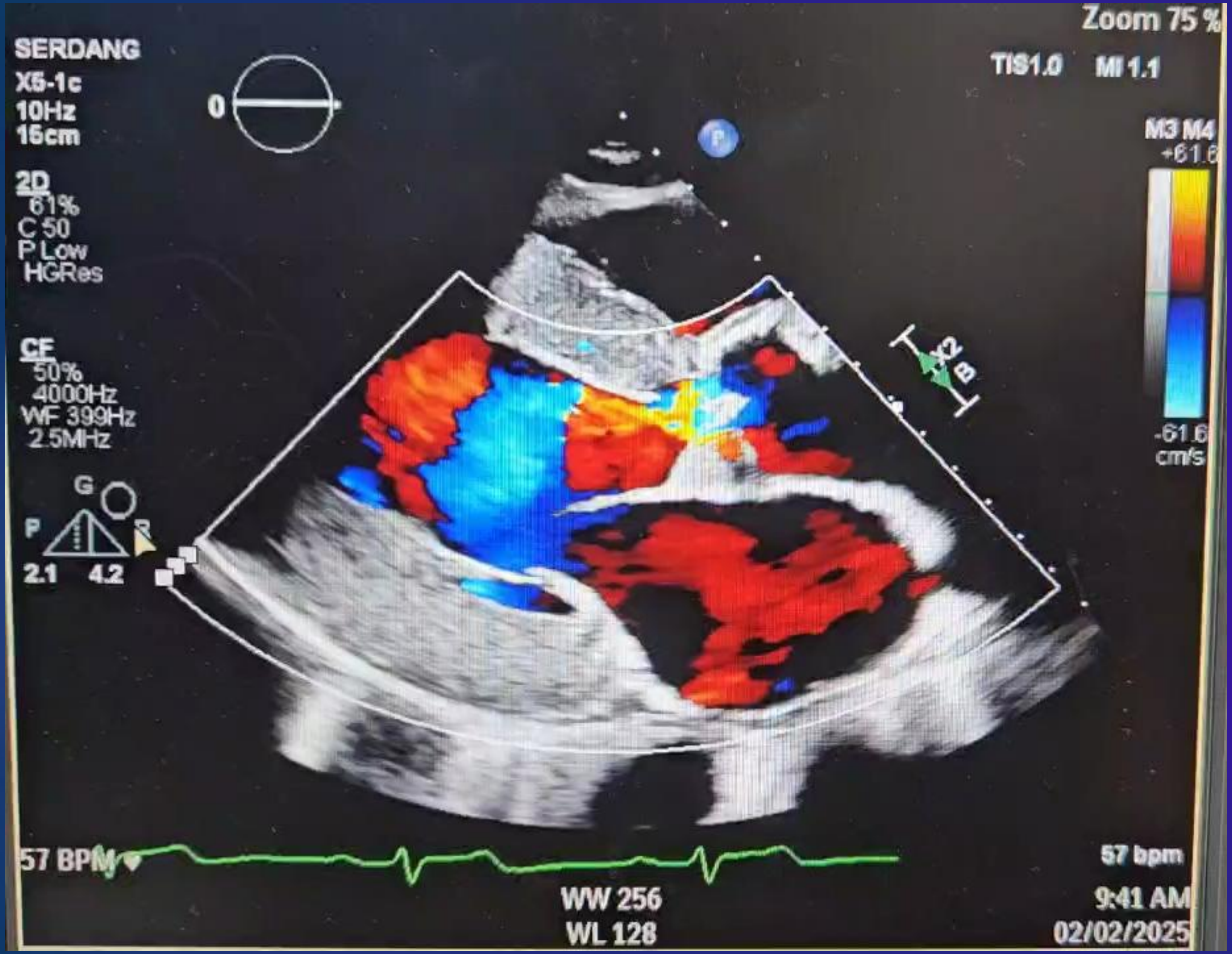
- **Clinical use:**
  - Visualizing blood flow across heart valves (e.g., mitral regurgitation or aortic stenosis).
  - Assessing shunts in congenital heart defects (e.g., atrial septal defect).

Colour doppler of Severe Tricuspid regurgitation



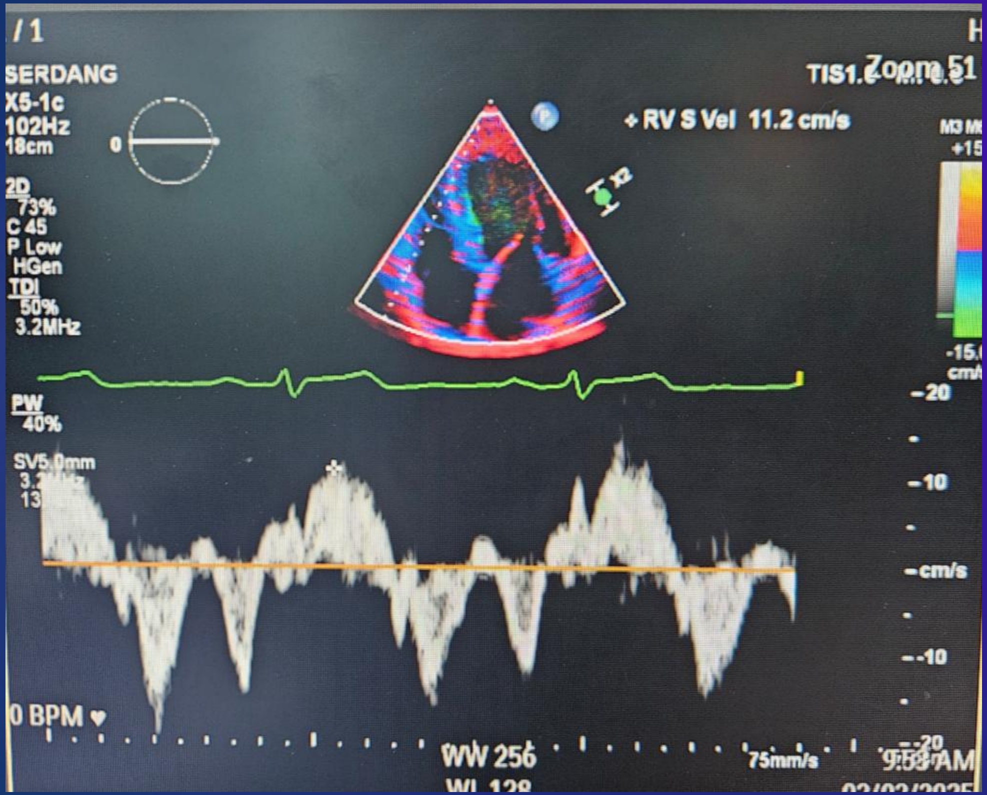


Severe AS with mild AR

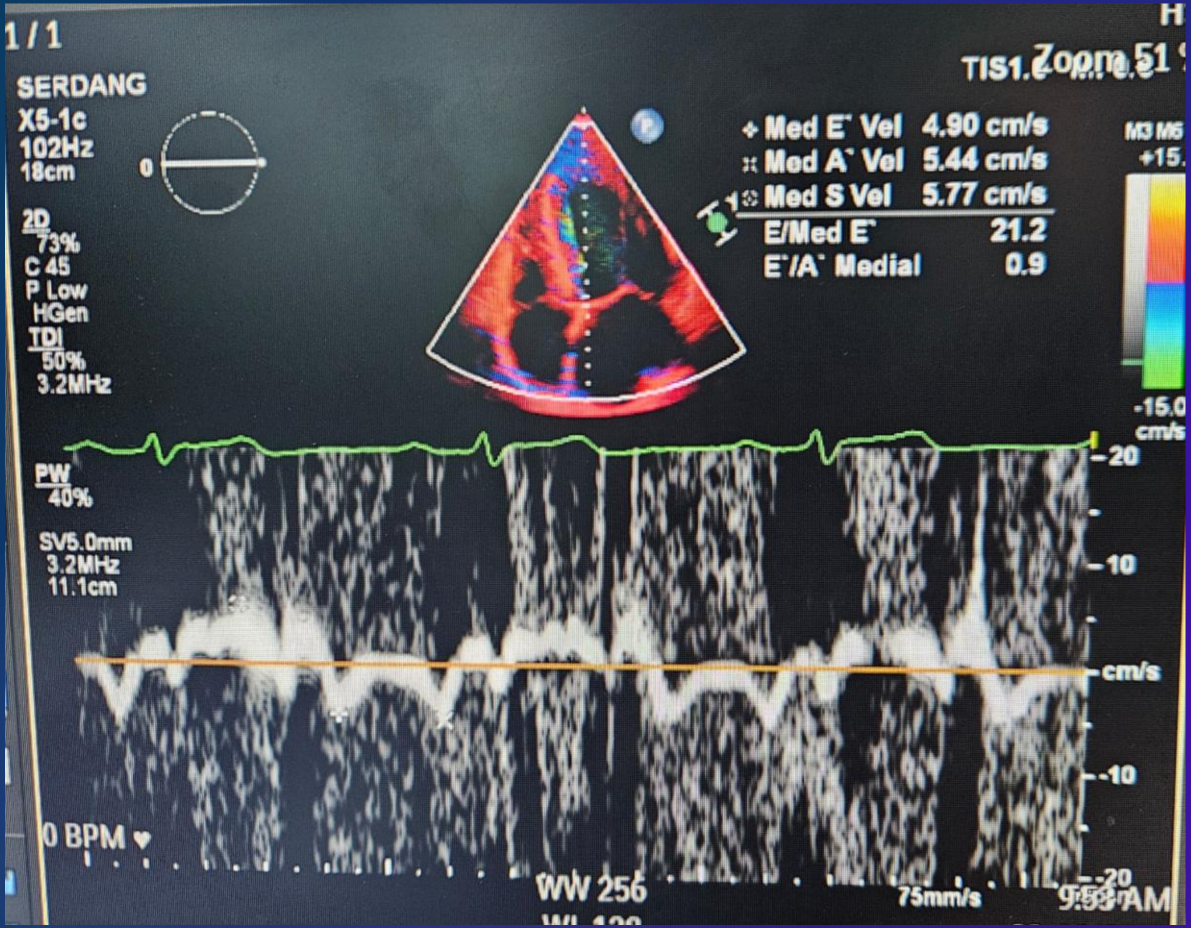


Tissue doppler echo

- This transmits and receives ultrasound images through cardiac tissue instead of blood flow using any of the doppler echo.



RV septal velocity



LV septal wall

LV lateral wall

Summary of Key Concepts:

- **Echocardiography** is a non-invasive imaging technique to assess cardiac structure and function.
- **M-mode** is used to measure cardiac structure and motion.
- **Pulse Wave Doppler (PW)** measures velocity at a specific point.
- **Continuous Wave Doppler (CW)** measures high-velocity blood flow across the heart.
- **Color Doppler** shows blood flow direction and velocity on a 2D echocardiogram.

- **Final Tip for Young Doctors**: Regular practice and familiarity with different modes (M-mode, PW, CW, and Color Doppler) will significantly enhance your diagnostic accuracy in clinical practice.

Thank you