PCM2 Ultrasound Workshop – Cardiac

Outline

Instructional Videos:

Introduction to Echocardiography (2:17):
https://www.youtube.com/watch?v=JMocr_oz1Jo&list=PLGEKJJ3ekUkxM6M99El4kk4XpZgUee_al

Subxiphoid View (1:15)
https://www.youtube.com/watch?v=zcFFTKteaUQ&list=PLGEKJJ3ekUkxM6M99El4kk4XpZgUee_al&index=6

Parasternal Long Axis View (1:14):
https://www.youtube.com/watch?v=mZtK4PMdacE&list=PLGEKJJ3ekUkxM6M99El4kk4XpZgUee_al&index=2

Parasternal Short Axis View (2:02):
https://www.youtube.com/watch?v=P6vBKAS0TNo&list=PLGEKJJ3ekUkxM6M99El4kk4XpZgUee_al&index=3

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Scan Checklist

Cardiac	
Subxiphoid	Pericardium
	Right Ventricle
	Right Atrium
	Left Ventricle
	Left Atrium
	Liver
	IVC (Longitudinal view)
Parasternal Long Axis	Pericardium
	Left Atrium
	Mitral Valve
	Left Ventricle
	Aortic Valve
	Aortic Outflow Tract
	Right Ventricle
Parasternal Short Axis	Right Ventricle
	Left Ventricle
	Mitral Valve
	Papillary Muscles
	Aortic Valve

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Ultrasound Review

How Does Ultrasound Work? – Piezoelectric Effect

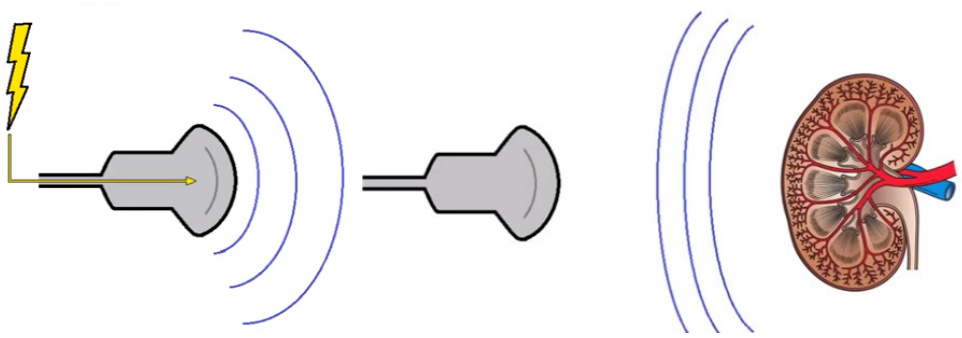

Image Credit: Eric Shappell Loyola '13

When electricity is applied to piezoelectric crystals, the vibrations produce sound waves that travel outward. The waves hit objects and bounce back to the piezoelectric crystals, and the mechanical energy produced from the vibration of the crystal is converted into electrical energy. The ultrasound machine calculates the time it takes for sound waves to travel back to the probe and produces an image on the screen.

Knobology:

- Find 'ON' button
- Depth
- Gain

Probes and Frequency (*range depends on specific probe):

- Linear (6-13 MHz)
- Endocavitary (5-8 MHz)
- Curvilinear (2-5MHz)
- Phased Array (1-5 MHz)

- High frequency probes (high resolution, low penetration)
- Low frequency probes (low resolution, high penetration)

Basic Motions:

- Slide
- Fan
- Rotate
- Rock (Heel-Toe)

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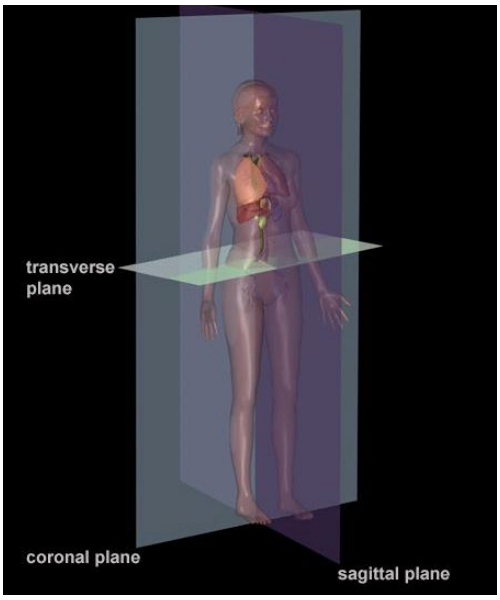
Ultrasound Convention:

- Probe indicator toward patient's right or head

Scanning Planes:

- Sagittal (Longitudinal)
- Transverse (Axial)
- Coronal



Basic Terminology:

-Echogenic – Structure or medium capable of reflecting or transmitting ultrasound waves

-Anechoic – Image appears dark (black). Ex: Fluid-filled structures such as bladder, blood vessel

-Hyperechoic – Ultrasound Image Appears Brighter Than Surroundings (White). Ex: Bone

-Hypoechoic – Ultrasound image appears darker than surrounding structures

-Isoechoic – Ultrasound image appears similar in brightness to surrounding structures

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Cardiac Exam

Case Scenario:

A middle-aged appearing man is brought in by EMS who was found unresponsive outside. He is noted to have agonal breathing, systolic BP is 60/palp; his heart rate is 155 bpm.

Indications for Cardiac Exam:

- Undifferentiated hypotension
- Chest pain
- Dyspnea
- Suspicion of cardiogenic shock

Purpose:

- Evaluate for pericardial effusion
- Evaluate cardiac contractility and motion
- Evaluate chamber sizes
- Evaluate volume status

US Basics:

- Probe selection: phased array (cardiac) probe – smaller footprint allows minimal obstruction from ribs.
- Free fluid (blood) appears black (anechoic).
- In EM/general convention the screen indicator marker is to the **Left.**
- In Cardiology convention the screen indicator marker is on the **Right**.
- Consider adjusting depth and gain to optimize image visualization.

Cardiac Anatomy:

- The normal heart sits in the left chest with its base anchored by the great vessels: the aorta, superior vena cava, main pulmonary artery.
- Cardiac apex points anteriorly and inferiorly, ~60 degrees to the left. Correlates with the point of maximal impulse (PMI) on the physical exam.

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Scanning Technique:

1. Subxiphoid View
   - Place probe beneath and slightly right of the xiphoid process.
   - The indicator is to be directed to the patient's right side (EM convention).
   - Point the probe towards the patient's head with the probe nearly flattened and parallel to the abdominal surface.
   - Visualize both inferior and superior pericardial borders. Pericardial fluid can accumulate in one area and not the other.
   - Tips:
     - Hold the probe like a computer mouse – allows downward pressure with your index and middle fingers.
     - Use the liver as an acoustic window – aids in image quality by avoiding bowel gas.
     - Have the patient take a deep breath and hold, which lowers the heart towards the probe, improving visualization.
   - Clinical Assessment:
     - Presence of pericardial effusion
     - Cardiac tamponade

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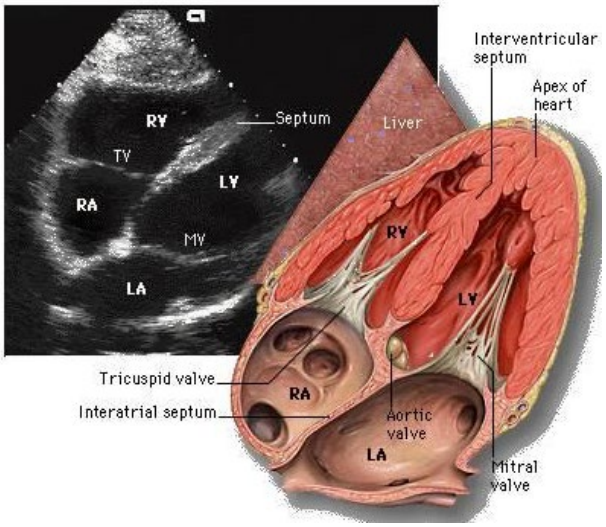

2. Subxiphoid Long Axis View of IVC
   - From the subxiphoid cardiac view, rotate the probe marker clockwise towards the patient's head (EM convention) and place the transducer below the xiphoid process, slightly right of midline. Rock the probe slightly towards the patient's head to visualize the IVC draining into the right atrium.
   - The hepatic vein may be seen entering the IVC distal to the right atria.
   - In normal conditions in spontaneously breathing patients, IVC diameter varies with the respiratory cycle – decreases in size with inspiration due to decreased intra-thoracic pressure.
   - Tips:
     - Confirm the IVC by visualizing it draining into the right atrium. The IVC can be easily mistaken for the aorta without this confirmation.
   - Clinical Assessment:
     - Evaluation of the IVC diameter (measured 2-3 cm from the IVC/RA junction) and variation with respiration reflects right atrial pressure and an estimate of central venous pressure (CVP).
     - A small IVC and significant collapsibility suggests low CVP. A plethoric IVC and minimal variability in IVC size suggests high CVP.

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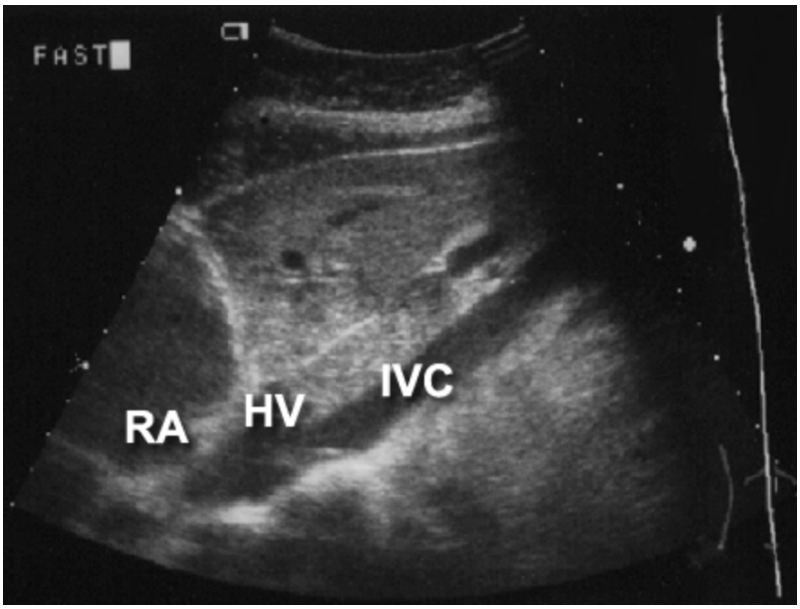

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3. Parasternal Long Axis View
   - Place the probe between the 3rd to 4th intercostal space, left of the sternum.
   - In EM convention, aim the probe marker towards the left hip.
   - Adjust depth so the pericardium and posterior wall of the left ventricle are visible.
   - Tips:
     - The heart will come closer to the chest wall if the patient can turn into a left lateral decubitus position, improving visualization.
     - Start by placing the probe high (just under the clavicle) and medial (left of the sternum). Continue sliding down a rib space and slowly fan through the space until the ideal view is obtained.
     - Slowly rotate the probe while maintaining the direction of the probe marker.
   - Clinical Assessment
     - LV function
     - Chamber size
     - Pericardial effusion
     - Cardiac tamponade

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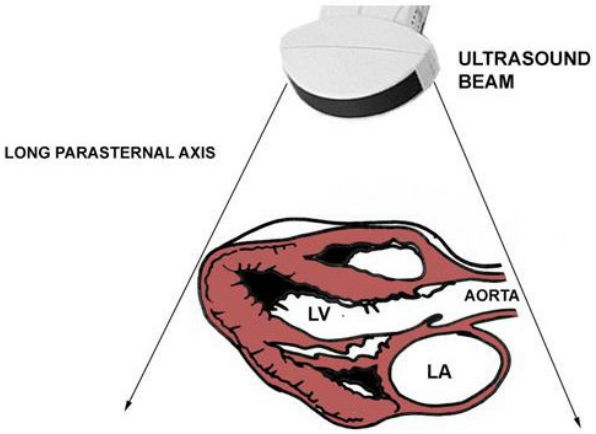

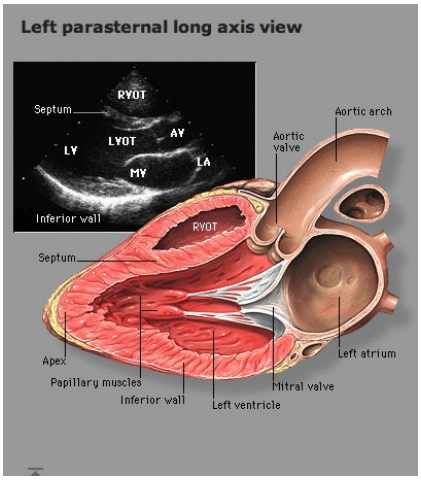

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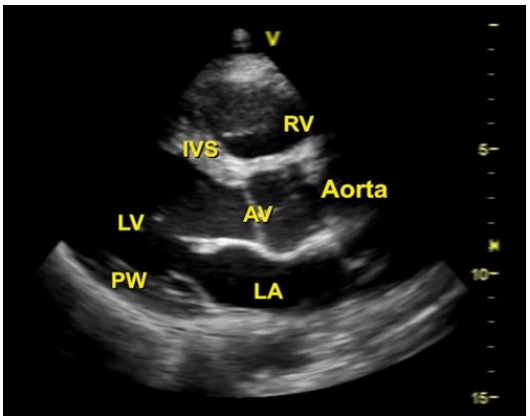

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4. Parasternal Short Axis View
   - From parasternal long view turn the probe 90° clockwise.
   - Point probe marker to right hip (EM convention)
   - Fanning the probe from the base to the apex provides different views:
     - Base: Aortic valve level ("Mercedes-Benz sign")
     - Mid: Mitral valve level ("Fish-mouth view")
     - Apex: Papillary muscles.
   - Tips:
     - Find the ideal parasternal long view, then rotate the probe clockwise in place.
   - Clinical Assessment
     - Pericardial effusion
     - Cardiac Tamponade
     - RV dilation
     - Evaluating global LV function

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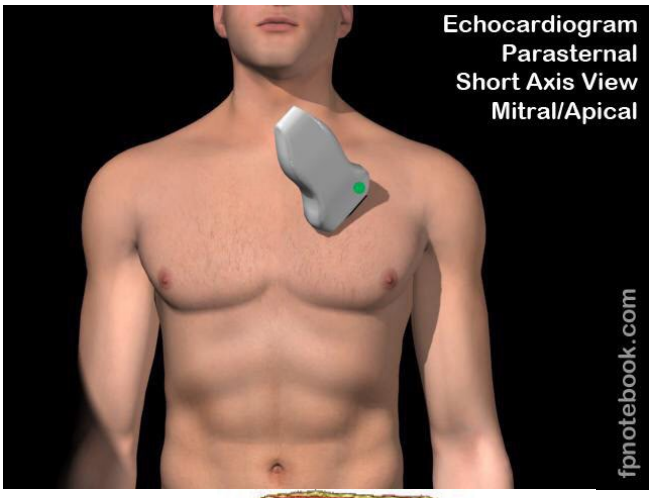

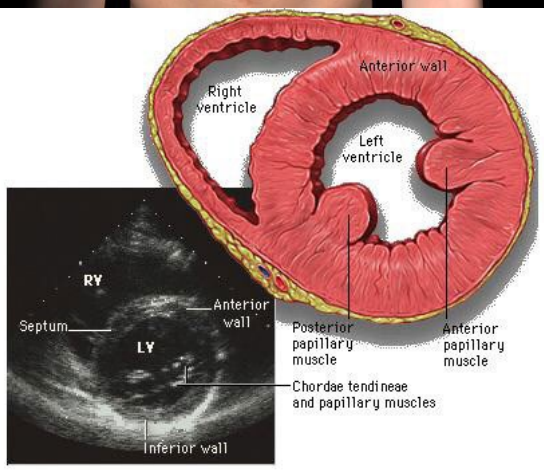

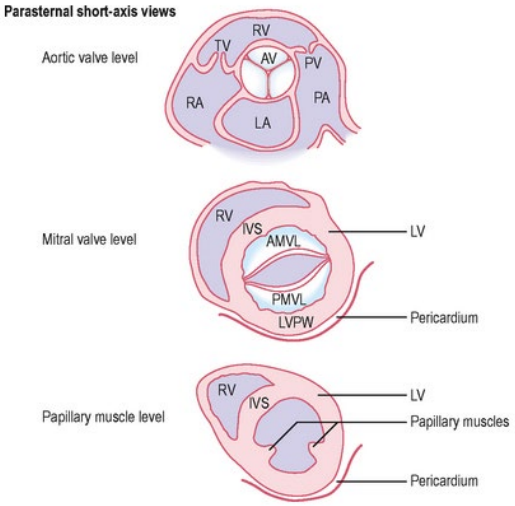

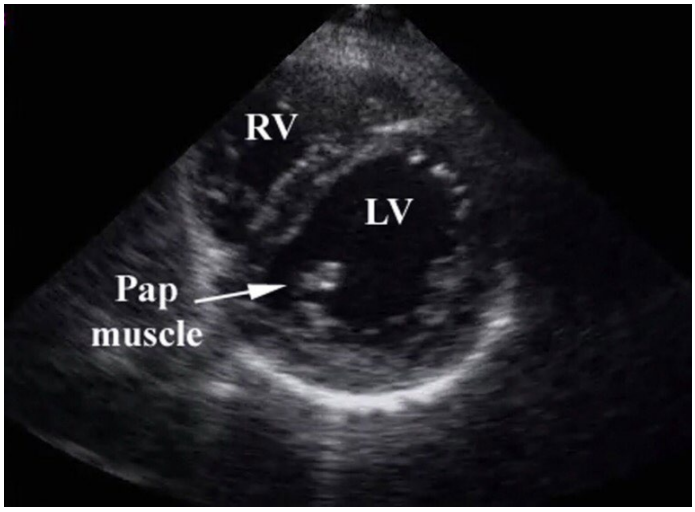

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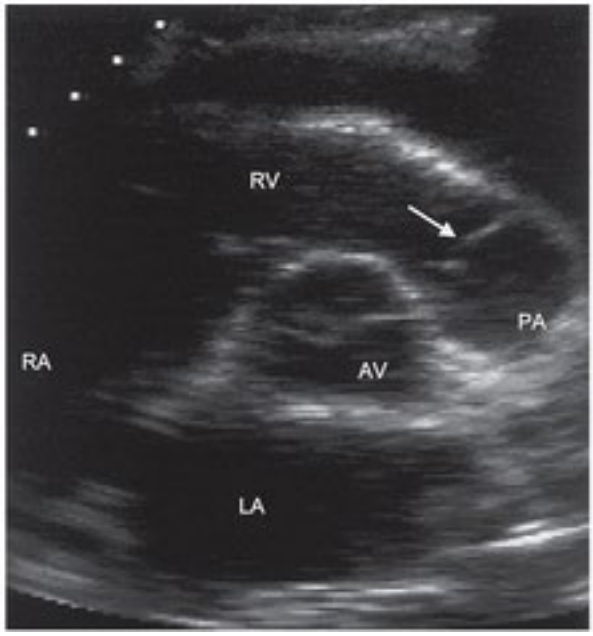
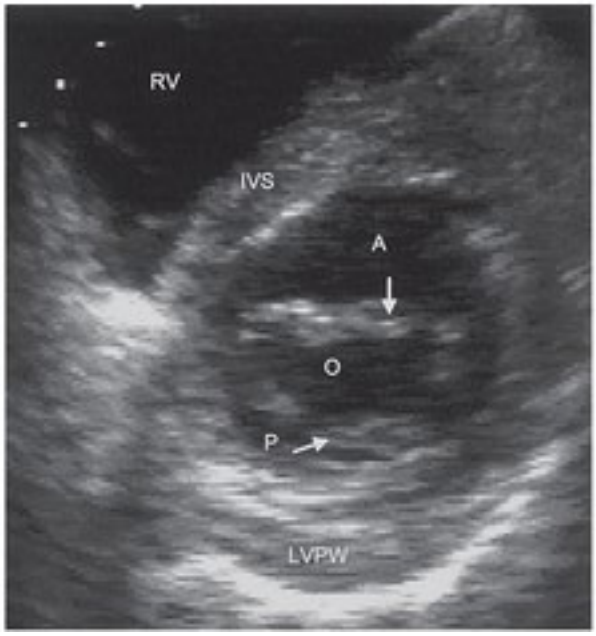


Level of the Aortic Valve (Towards Base)



Level of the Mitral Valve

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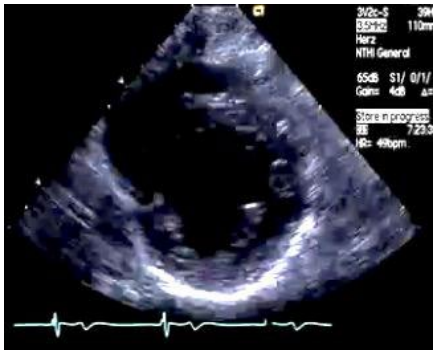
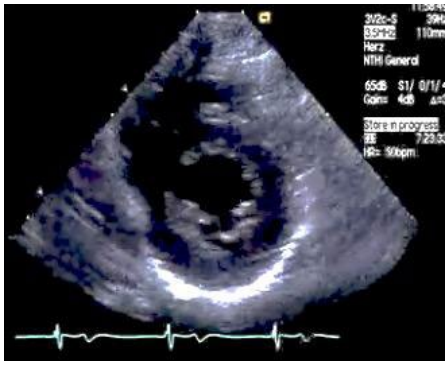
Clinical Assessment:

1. Left Ventricular Function
   - Range of function: stand still to hyperdynamic ejection fraction
   - Assess systolic function by evaluating the ventricular walls moving towards the center of the chamber and thickening of the myocardial walls as the muscle contracts.
   - Classification of systolic function:
     - Severely depressed (EF < 30%)
     - Mild-moderate depression (EF 30-55%)
     - Normal (EF 55-70%)
     - Hyperdynamic (EF > 70%)
   - If hyperdynamic, the ventricular cavity will be obliterated during systole; consider hypovolemia or vasodilation.

Normal: Diastole vs Systole

Hyperdynamic: Diastole vs Systole


Hypodynamic: Diastole vs Systole

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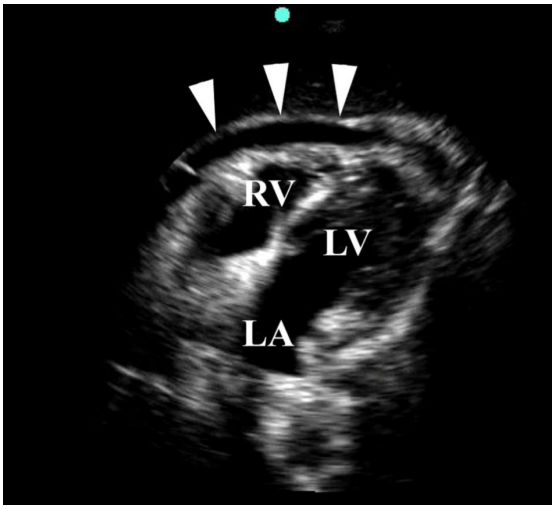
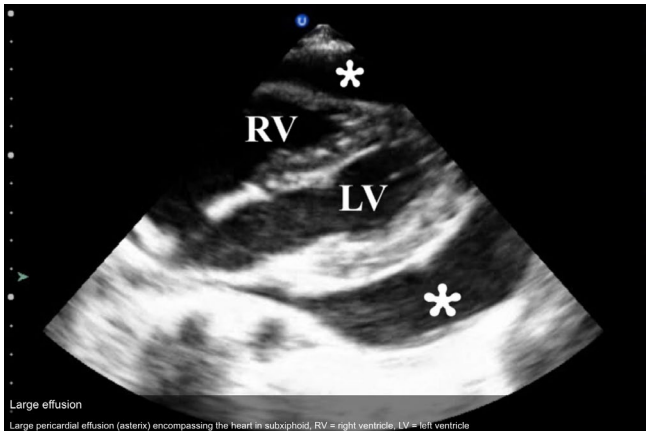
2. Pericardial effusion

   - Appears as an anechoic stripe between the heart and pericardial sac
   - Small pericardial effusions are located inferiorly (at the Right Ventricle)
   - Large effusions can fill the entire pericardial sac





3. Pericardial Tamponade
   - Results from rapidly accumulating effusion. Consequence is decreased pre-load, decreased RV filling, decreased cardiac output.
   - Classic finding: RV free wall collapse during early diastole.
   - Most common and early sign: RA free wall collapse during late diastole.
   - Other correlating finds:
     - IVC usually dilated with minimal variation during respiration.
     - Electrical alternans on EKG
     - Beck's triad (hypotension, distant heart sounds, distended jugular veins)
     - Pulsus paradoxus

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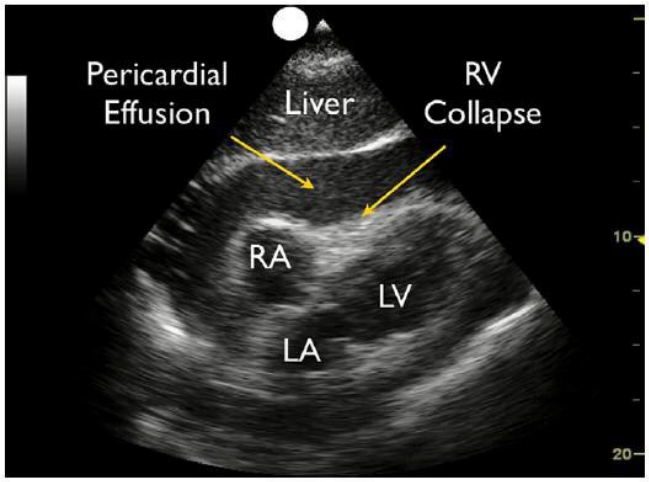

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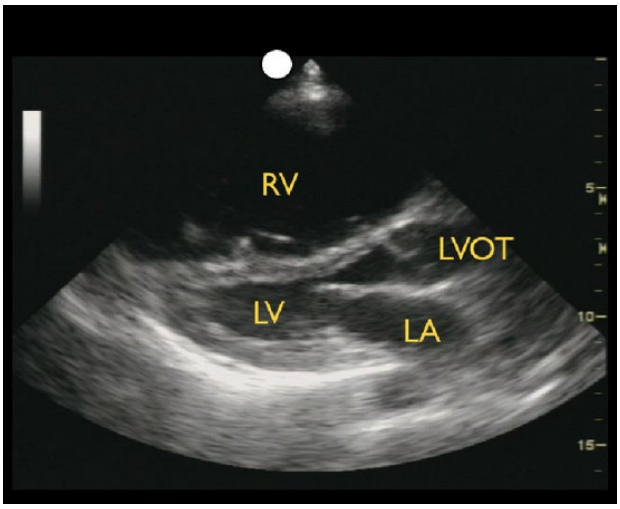
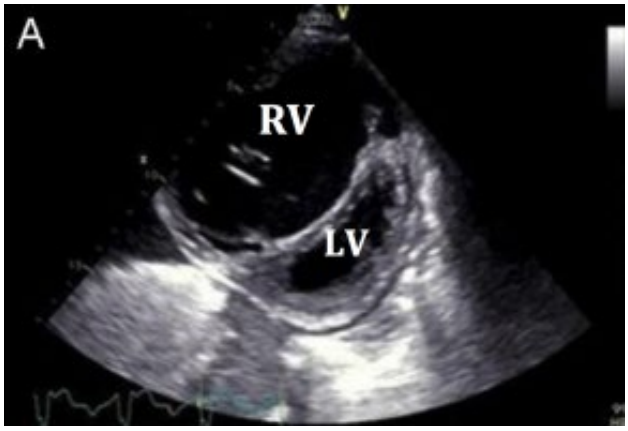
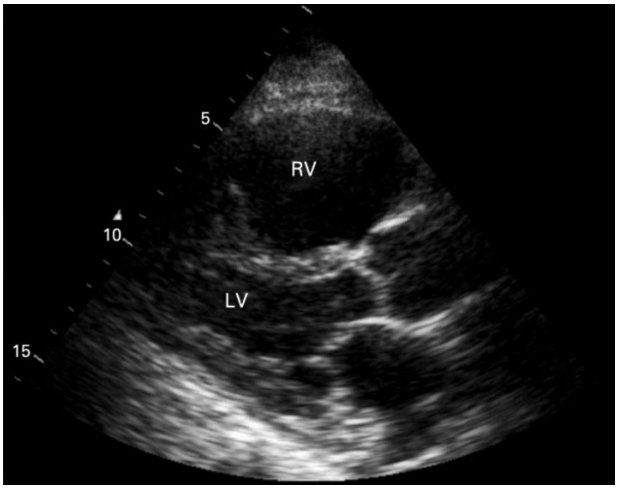
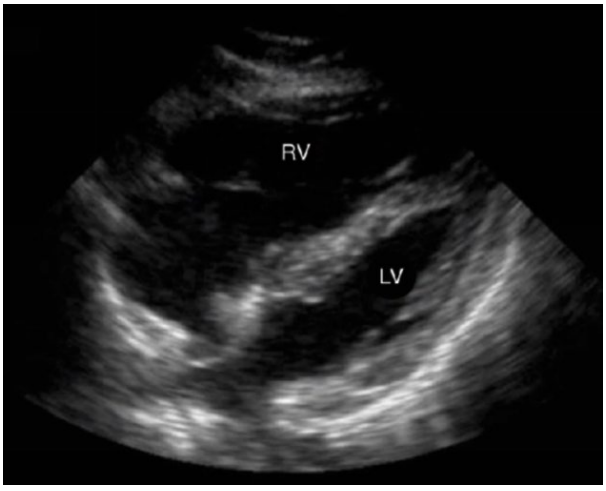
4. Right Heart Strain (high RV pressure)
   - US findings include:
     - Bowing of the intraventricular septum (between the RV and LV) into the LV frequently seen on parasternal short view ("D" Sign)
     - Dilation of the Right ventricle
       - Normal RV is 2/3 the size of the LV
       - Moderate dilation: RV=LV
       - Severe dilation: RV>LV
   - Causes of right heart strain: Pulmonary embolism, RV infarct, Pulmonary hypertension, COPD









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