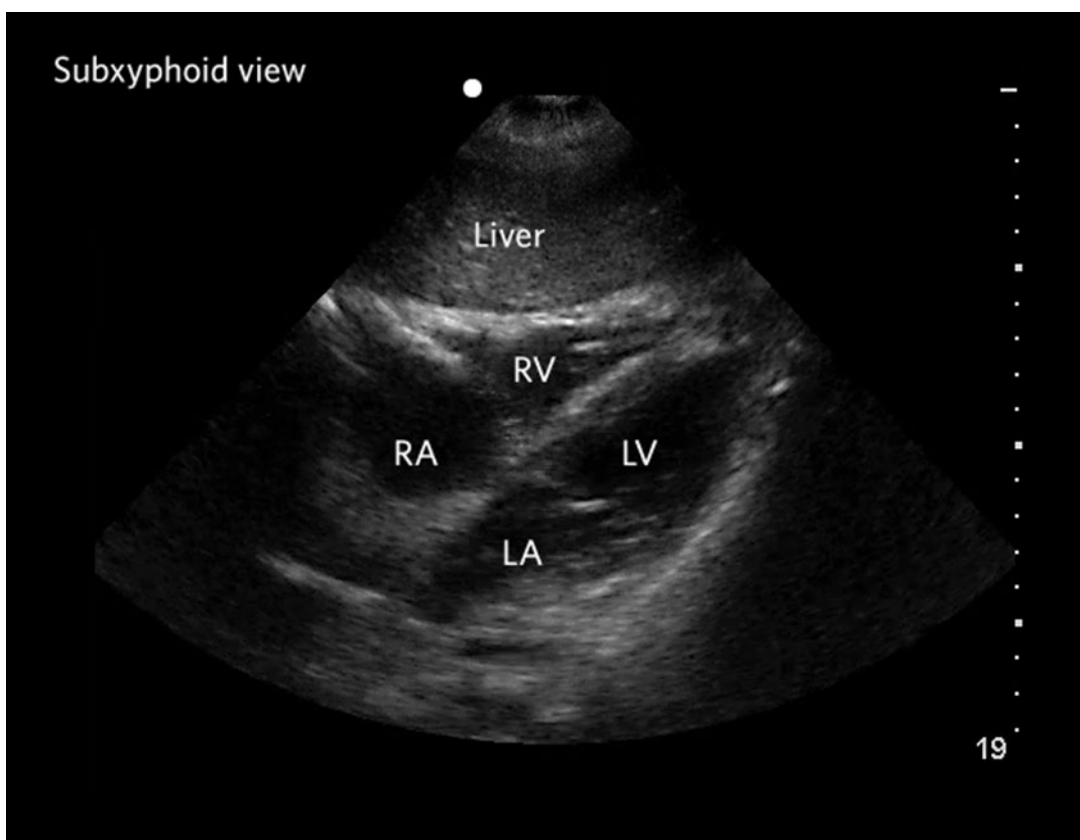


# How-To Guide

## Cardiac Ultrasound

Subxyphoid view of the heart:



### How to do it:

1. Position the patient in supine. Flexion at the knees can help, by relaxing the abdominal muscles.
2. Start with a high depth setting.
3. Hold the probe like a computer mouse (overhand grip).
4. Think “LUMPS” – Start Low on abdomen, slide Up to rest probe against xiphoid process, Magnify image by adjusting depth, Sweep heart.

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5. Place the transducer into the sub-xiphoid space in the transverse plane. Ensure that there is direct contact between the xiphoid process and the probe.
6. Apply gentle compression towards the spine, to allow the beam to pass below the sternum.
7. Aim the probe towards the left side of the chest, where you expect the heart to be. The heart will come into view on your screen. Continue tilting until all 4 chambers are visible.
8. If necessary, rotate the probe until the chamber sizes are fully appreciated.
9. Adjust the depth to ensure that beam penetrates beyond the deep borders of the heart.
10. Sweep the beam through the entire heart.
11. If bowel gas is an obstacle, try asking the patient to take a deep breath and hold it. You can also try sliding the transducer slightly to patient right.

## How to do it better:

This is the ideal view for checking for pericardial effusion, and is also the most accessible view if CPR is in progress.

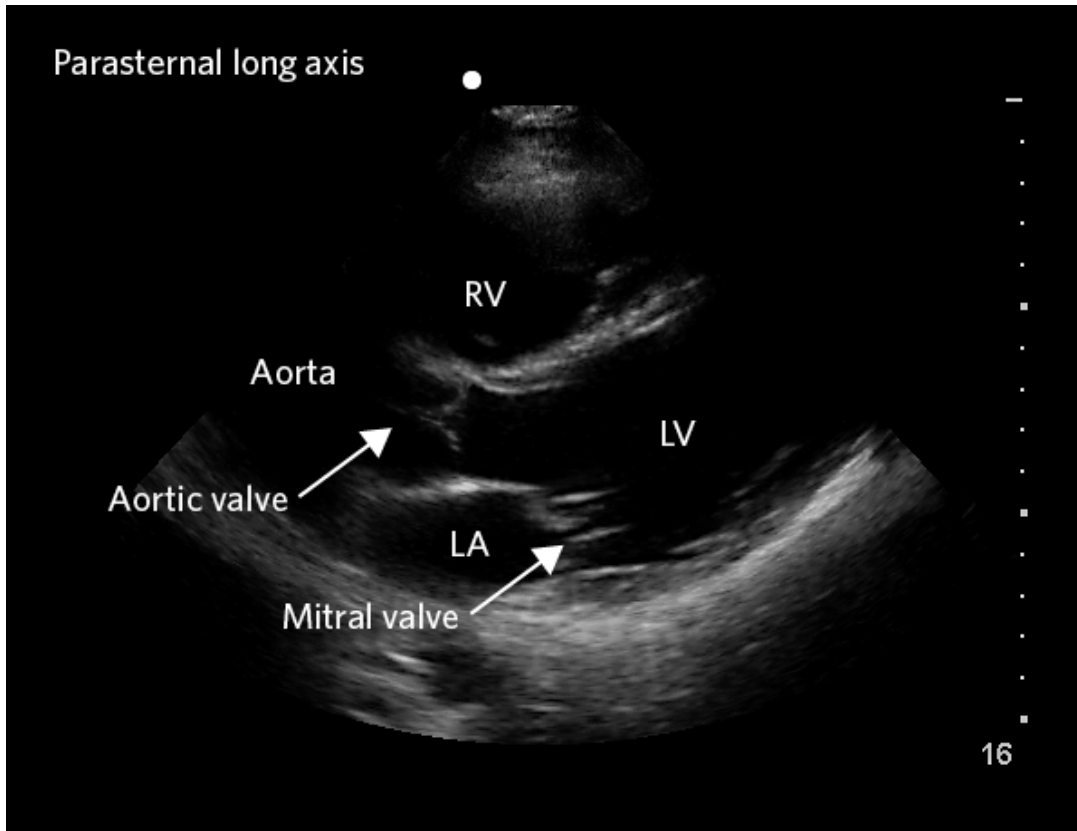
### **Pericardial effusions**

An effusion will appear as a black stripe abutting the heart. It is often seen circumferentially, but location of fluid is variable. Small effusions may only be seen in the dependent regions. As you sweep the heart, be sure to look for asymmetrical pockets of fluid. It is important to differentiate pericardial effusions from ascites. Generally speaking, ascites will follow the contour of the liver, while a pericardial effusion will follow the contour of the heart

### **LV systolic function**

It's generally not as informative as the parasternal views for this purpose.

## Parasternal long axis view (PSL):



## How to do it:

1. Position the patient. Left lateral decubitus is generally best, although supine might be adequate (have the patient extend left arm up beside the head to move it out of the way).
2. Orient your probe.
  - If the image marker is on the left side of the screen orient the probe marker towards the patient's right shoulder.
  - If the image marker is on the right side of the screen orient the probe marker towards the left elbow.
3. The best image is generally produced with the transducer near the sternum in the 3rd or 4th intercostal space, with the probe in oblique, aligned to the long axis of the heart.
4. Identify which rib interspace gives the best view (survey the 2nd through 5th intercostal spaces in quick succession to identify the most promising window).
5. Optimize the image.

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- Place the transducer as close to the sternal border as possible. If this is not successful, try sliding away from the sternum.
- Display the LV lying relatively horizontal across the screen. If the LV is not horizontal, try moving the transducer up a rib space.
- The mitral valve leaflets should be centred on the screen. LV apex is not visualized. Use a rocking motion to centre the image in the desired position.
- View the descending aorta (in short axis) just deep to the LA/mitral valve annulus by adjusting the depth.
- Adjust the axis (probe rotation) to reveal communication between the LA and LV as well as the LVOT and aortic root.

## How to do it better:

The parasternal long axis view is used to assess:

### Gross LV systolic function

Categorize the LV function into hyperdynamic, grossly normal (EF > 50%), moderate systolic dysfunction (EF > 30%) and severe systolic dysfunction (EF < 30%). Estimating systolic function is subjective and requires some experience. The following features should be considered together:

- The change in LV cavity diameter during systole (ie. fractional shortening).
- Presence or absence of observable thickening of the myocardium during systole.
- Check for septal slap, (also known as End Point Septal Separation, or EPSS). Observe the motion of the mitral valve leaflet swinging towards the septum. A normal 'septal slap' should appear to touch or nearly touch the interventricular septum. If it appears to come no more than 1 cm from the septum, suspect systolic dysfunction. Severe systolic dysfunction can lead to 2 or more cm of separation. Most POCUS users eyeball this and estimate, if necessary, by using the ruler on the side of the screen.
- LV function should also be assessed in a second view to confirm impression.

### Pericardial effusions

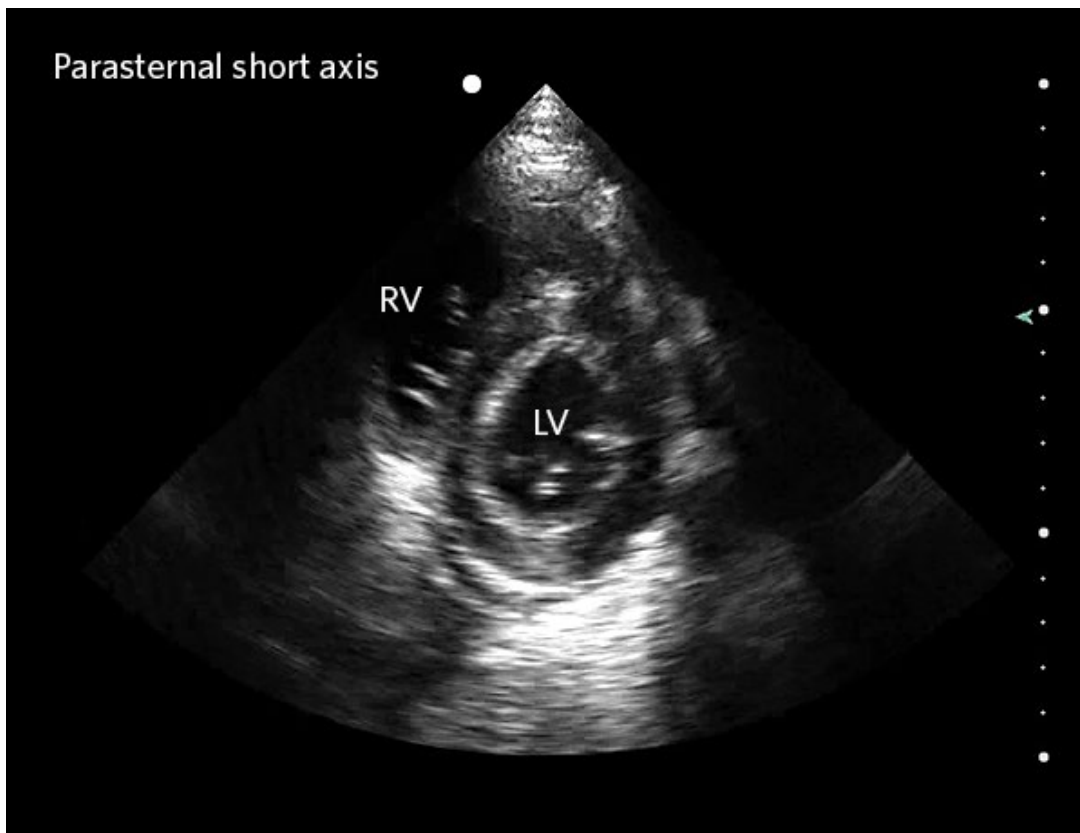
- An effusion will appear as an anechoic stripe abutting the heart. It is often seen circumferentially, but location of fluid is variable and small effusions may only be seen in the dependent regions. Be sure to sweep the heart to look for asymmetrical pockets of fluid.
- It is important to differentiate pericardial effusions from left pleural effusions. A pericardial effusion will pass anteriorly to the descending aorta, while a pleural effusion will reflect away from the descending aorta.

### Chamber sizes

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- A gross assessment for LA, aortic root and RV enlargement can be made by comparing the relative sizes of each of these chambers to one another.
- Commonly referred to as the rule of thirds, the AP diameter of these chambers should approximate a 1:1:1 ratio.
- If one appears much larger than the others, it may be enlarged.

## Parasternal short axis view (PSS):



## How to do it:

The parasternal short axis view uses the same window as the parasternal long axis view.

1. From the parasternal long axis view, rotate the probe counter-clockwise 90 degrees.
  - The transducer marker will be oriented to the patients left shoulder in the cardiology convention and the right elbow in the radiology convention.
  - During rotation, maintain an image of the LV on the screen, to preserve image quality.

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- The LV is donut shaped when viewed in short axis. Continue rotating the transducer until the donut shape is achieved.
2. From the donut shape view of the LV, the entire length of the LV can be surveyed by aiming the beam towards the cardiac apex.
  3. Find the papillary muscles at the level of the mid ventricle. This is the best site to assess LV function.
  4. Mitral valve is assessed by aiming the beam in the direction of the right shoulder. The characteristic fish mouth appearance of the mitral valve is found cephalad to the papillary muscles.
  5. Aortic valve - From the fish mouth view of the mitral valve, the aortic valve may be assessed by tilting the beam further in the direction of the right shoulder. The characteristic Mercedes sign appearance of the tri-leaflet aortic valve is cephalad to the mitral valve.

## How to do it better:

### LV systolic function

- This is best done at the papillary muscle level, but view the entire LV in order to provide a more comprehensive assessment.
- Normal LV systolic function is characterized by significant shortening of the LV diameter and thickening of the myocardium during systole. The LV walls should be seen to contract towards a central point.

### Increased RV pressure

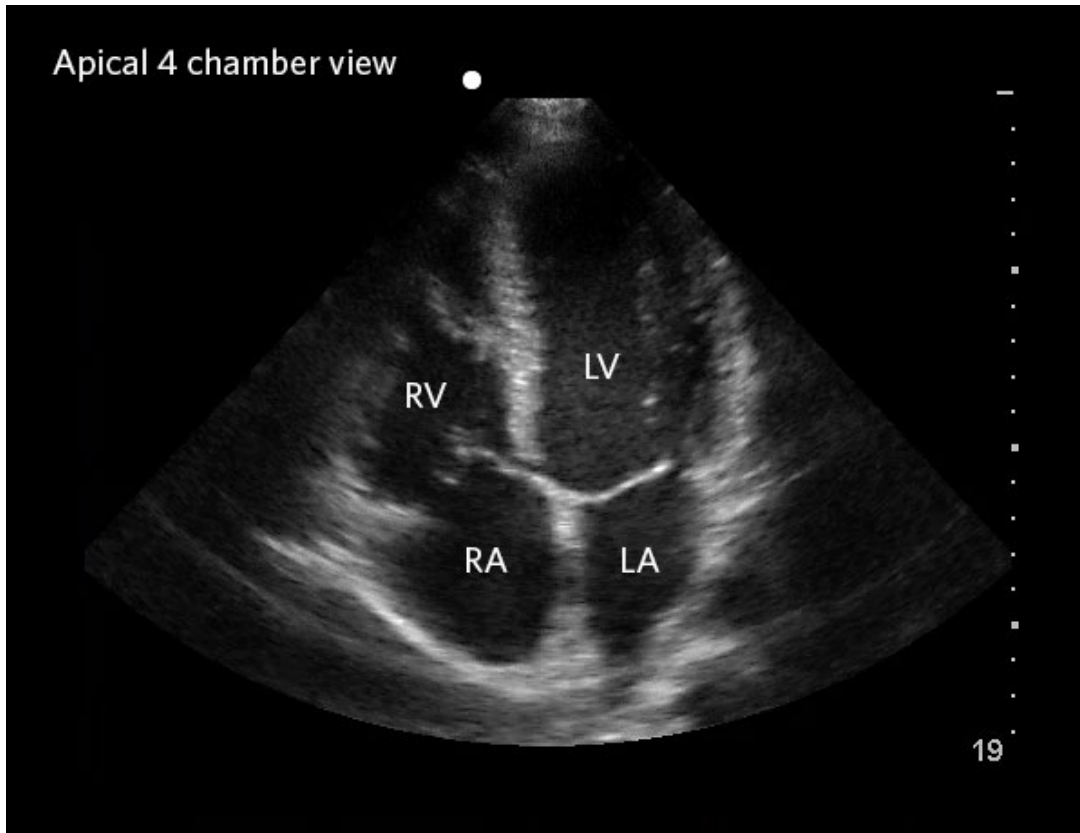
- Normally the LV is circular and the interventricular septum projects into the RV. With increased RV pressure this will change and you will see a flattening of the interventricular septum, giving a characteristic D shape to the LV cavity.

### Pericardial effusions can be seen as an anechoic region surrounding outlining the heart

### Valve assessments - a gross subjective assessment of the MV and AV may be accomplished. This includes:

- Looking for valve thickening or calcification.
- Quantifying the number of valve leaflets.
- Gross assessment of valve opening.
- It is NOT possible to classify the severity of valve disease based on gross visual assessment.

## Apical 4 chamber view:



## How to do it:

This view is achieved when the heart is positioned vertically on the screen. The septum will be vertical, the right side of the heart is on screen left, and the left side of the heart is on screen right.

1. Left lateral decubitus is usually better than supine.
2. Transducer orientation depends on the machine pre-set.
3. If the image marker is on the right side of the screen, orient the probe marker to the patient's left.
4. If the image marker is on the left side of the screen, orient the probe marker to the patient's right.
5. Begin by placing the transducer in the cardiac apex area, in the transverse plane.
6. This is often just interior and lateral to the nipple in men, or at the base of the left breast in women. However, this varies greatly with cardiac pathology and thoracic disorders.
7. To optimize the view:
  - Aim the beam towards the right axilla. If the LVOT is visible (5th chamber) the beam has been tilted too far.

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- Rotate the transducer as necessary to best view the chamber sizes.
- If the apex appears rounded rather than bullet shaped, the LV has been foreshortened (the beam is slicing through the anterior LV wall rather than the apex). Move the probe down 1 rib space.
- If the heart is lying obliquely instead of vertical, with the apex to the right of the screen, the transducer is too medial. Correct by sliding the transducer laterally.
- Adjust the depth so that the beam penetrates beyond the deep borders of the heart.
- Sweep the heart.

## How to do it better:

### Chamber sizes

- The RV should be about 2/3 LV size.
- A ratio approaching 1:1 is suggestive of moderate RV enlargement.
- RV that is clearly larger than the LV is suggestive of severe RV dilatation.

**Pericardial effusions can be seen as an anechoic area surrounding the heart.**

### LV systolic function

- It should be used as an adjunct with other views for this purpose. It is generally not as informative as the parasternal views.

**Doppler assessments for hemodynamic and valve assessments can be performed, but are an advanced skill.**

## Cardiac Ultrasound Overview:

### How to do it:

1. Select phased array or 'cardiac' probe. If this probe is unavailable, you may also be able to generate good views with the curved array, or 'abdominal' probe.
2. Select the 'General' cardiac pre-set.
3. Orient your probe.
4. Probe orientation depends upon the pre-set of your machine (and can be altered). Essentially the probe marker and the screen marker should be on the same side.
5. If the image marker is on the right side of the screen (cardiology convention), orient the probe marker to patient left.

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6. If the image marker is on the left side of the screen (radiology convention), orient the probe marker to patient right. Most POCUS users, and this document, follow the radiology convention.
7. Position your patient. Optimal patient positioning varies, depending on the particular view.

## How to do it better:

The cardiac axis is highly variable. The suggested probe position and orientation is simply a place to start. The correct orientation is the one that generates the desired image. Memorize what the heart should look like in each of the views and adjust the transducer placement to achieve that.

The best views are obtained by bring the heart close to the transducer and avoiding obstacles.

- Placing a patient into the left lateral decubitus position can often improve a difficult parasternal or apical view.
- Having a patient take a deep breath in and holding it can improve a subxyphoid view.

Gentle compression into the rib space can improve contact and allow better beam penetration.

A dark image is the result of beam attenuation. Increasing gain may be helpful, but may simply result in filling artifact. Try lowering the frequency to allow deeper beam penetration.

Remember that cardiac views are difficult to generate at the best of times!

## How to do it safely:

Always use confirm findings in more than one view. This will decrease the chances of misinterpretation as the result of artifact or regional variations that don't reflect global characteristics.

Stay within your comfort zone. Spend your time acquiring skills in one view before moving on to other views. We suggest you do so in the order listed in this document (i.e. subxyphoid view is an easier skill to acquire than the apical 4 chamber view).

Do not interpret off axis images. An improper axis may artificially alter the appearance and perceived movement of structures and lead to misinterpretation. Achieve the ideal view before interpreting the image.

### LV systolic function

- Consider multiple features of LV systolic assessment and at least 2 views. Multiple data points will minimize the effects of regional abnormalities and artifacts on what is a global characteristic.
- When assessing the motion of the anterior leaflet of the mitral valve, consider:
  - a. Mitral stenosis may result in an underestimation of systolic function.
  - b. Significant aortic regurgitation may result in underestimation of systolic function.
  - c. Significant interventricular hypertrophy may result in overestimation of systolic function.

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- d. Significant LV dilatation may result in underestimation of systolic function.

## Pericardial effusions

- The RV epicardial fat pad is often visible sitting anteriorly over the RV in the parasternal long axis view and can be confused for an effusion. It usually has some internal echoes, but generally appears hypoechoic or nearly anechoic. It is differentiated from an effusion based on:
  - a. Its consistent location in a non-dependent region only.
  - b. The internal echoes move uniformly (as expected with soft tissue) with cardiac motion. Debris in an effusion can produce echoes, but that motion is random rather than uniform.
- Loculated effusions can be easy to miss. It is important to sweep through the heart to minimize false negatives.
- It is easy to mistake pleural effusions for pericardial effusions. These can be differentiated by:
  - Obtaining multiple views.
  - Using landmarks such as the descending aorta in the parasternal long axis view. Pericardial fluid will lie anterior to the aorta, while pleural fluid will reflect posteriorly.

## How to use this in practice:

Exercise caution. Obtaining and interpreting cardiac images is one of the most difficult POCUS skills, because obtaining a good quality image is challenging. Give yourself plenty of time to practice this skill before incorporating cardiac scanning into your clinical practice.

Cardiac scanning is useful for the assessment of patients with undifferentiated hypotension. A hyperdynamic LV with a collapsed IVC suggests hypovolemia, while severe LV systolic dysfunction and a plethoric IVC suggest cardiogenic shock. A large pericardial effusion with a plethoric IVC suggests tamponade. Your cardiac views may enable you to confidently diagnose the cause of shock.

Cardiac scanning is often useful for guiding fluid management. The initial couple liters of fluid resuscitation in sepsis are generally pretty straight forward, but as resuscitation continues there is often concern regarding ongoing fluid tolerance. A hyperdynamic heart and collapsible IVC suggests that the patient will likely tolerate ongoing aggressive fluid delivery, while a change may be warranted if the cardiac scan reveals severe systolic dysfunction and a plethoric IVC.

Cardiac scanning is often useful in the initial assessment of acute dyspnea NYD. A scan that reveals severe LV systolic dysfunction and a plethoric IVC is in keeping with cardiogenic cause. Likewise, a pericardial effusion or evidence of diastolic dysfunction (dilated LA, concentric LV hypertrophy, plethoric IVC) is also in keeping with a cardiogenic cause. As a matter of routine practice, I will always look for a pericardial effusion in new or worsening dyspnea in those who have known metastatic cancer.

Cardiac scanning is often useful in the initial assessment of chest pain NYD. A scan that reveals RV enlargement and a plethoric IVC may suggest a large PE. A new pericardial effusion may be in keeping with pericarditis.

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