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# Pericardial tamponade – diagnosis & management

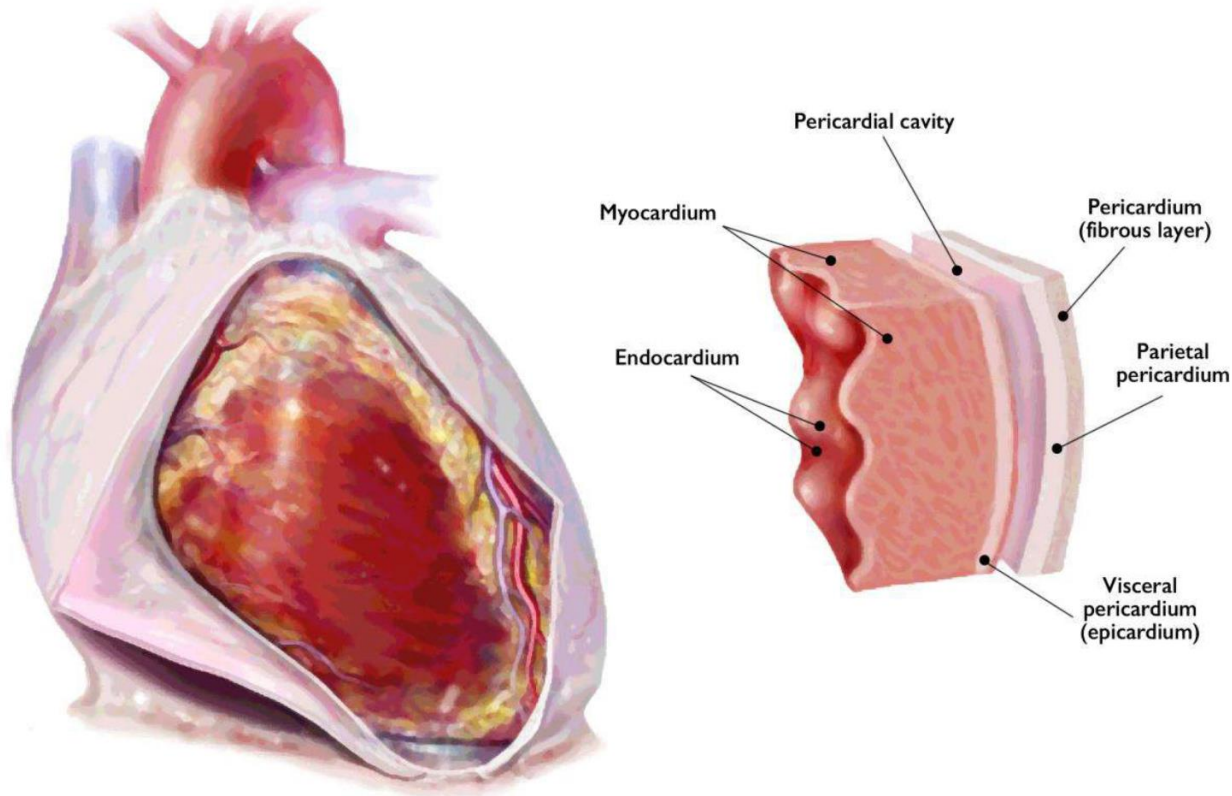
Dr. K Kam

Associate consultant, Division of Cardiology

Department of Medicine & Therapeutics

PWH, CUHK

# Pericardium



Pericardial fluid volume: about 50 cc  
Visceral pericardium: single cell layer  
Parietal : < 2mm thick (collagen)

Intrapericardial pressure

end-inspiration	- 6 mmHg
end-expiration	- 3 mmHg

[www.escardio.org](http://www.escardio.org)

*European Heart Journal (2015) -  
doi:10.1093/eurheartj/ehv318*



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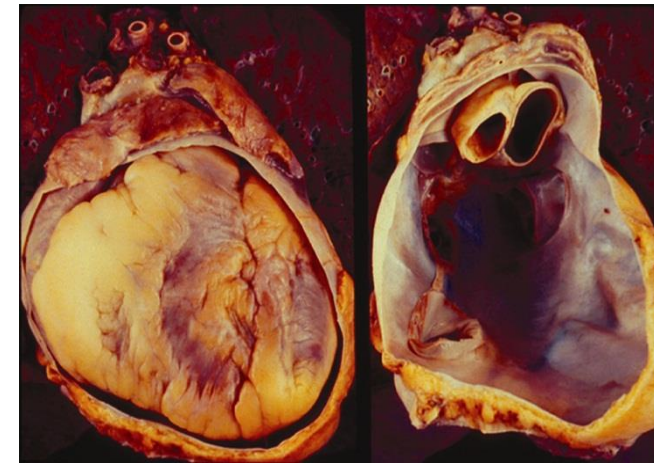
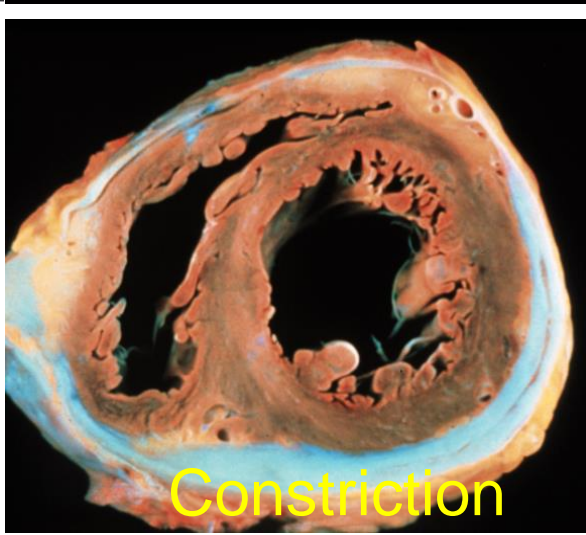
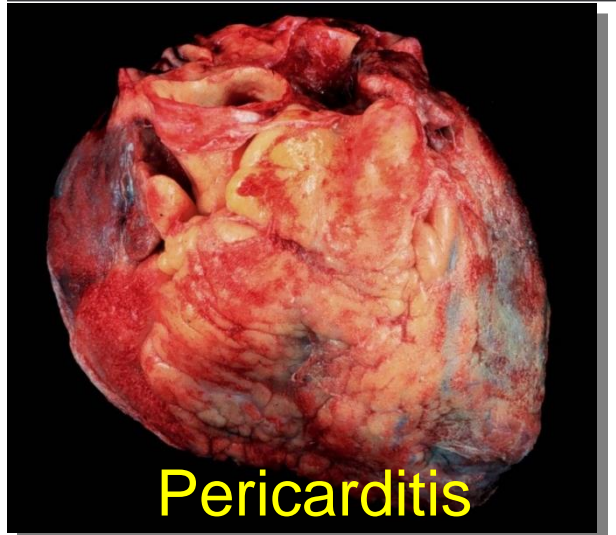
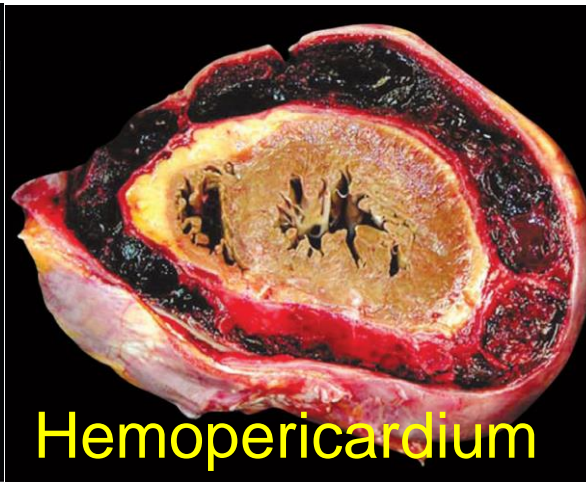
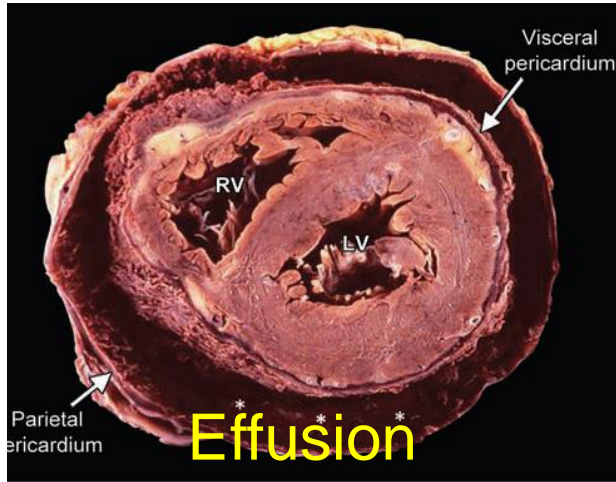
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# Pericardial Diseases



- Tamponade/effusion
  - Tumor
  - Trauma
  - Perforation
  - Endocarditis/Infection
  - Aortic Dissection
- Effusive CP



# Etiology of pericardial effusion

- Idiopathic
- Iatrogenic – catheter procedure (PCI, CIED implantation, structural heart intervention), post pericardiotomy syndrome
- Neoplastic – fixed mass at pericardium
- Inflammation – infectious, autoimmune, radiation
- Metabolic – hypothyroidism, renal failure (uraemia)
- Acute aortic dissection
- Myocardial infarction – free wall rupture
- Hemodynamic -- CHF, pulmonary hypertension hypoalbuminaemia

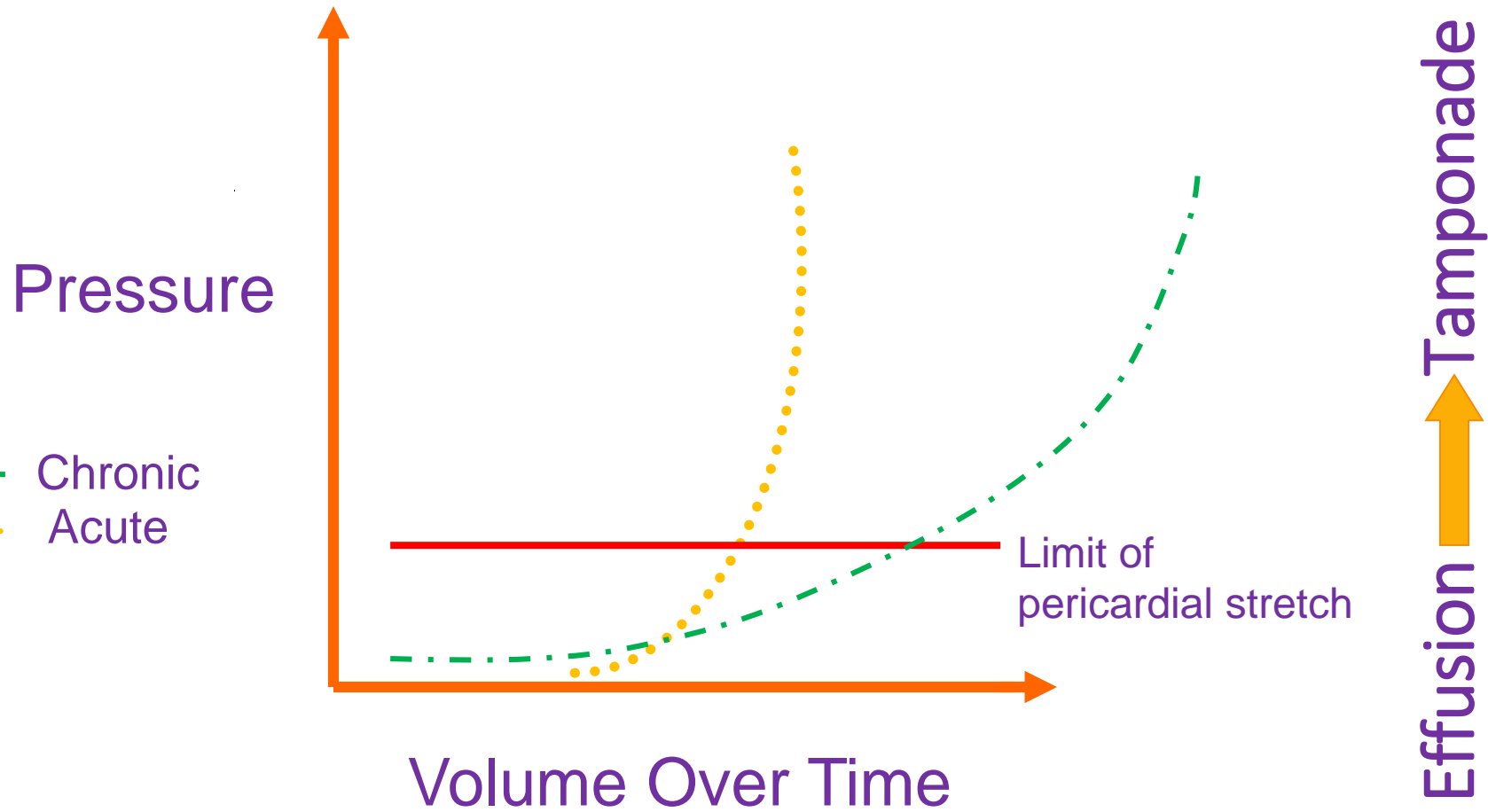


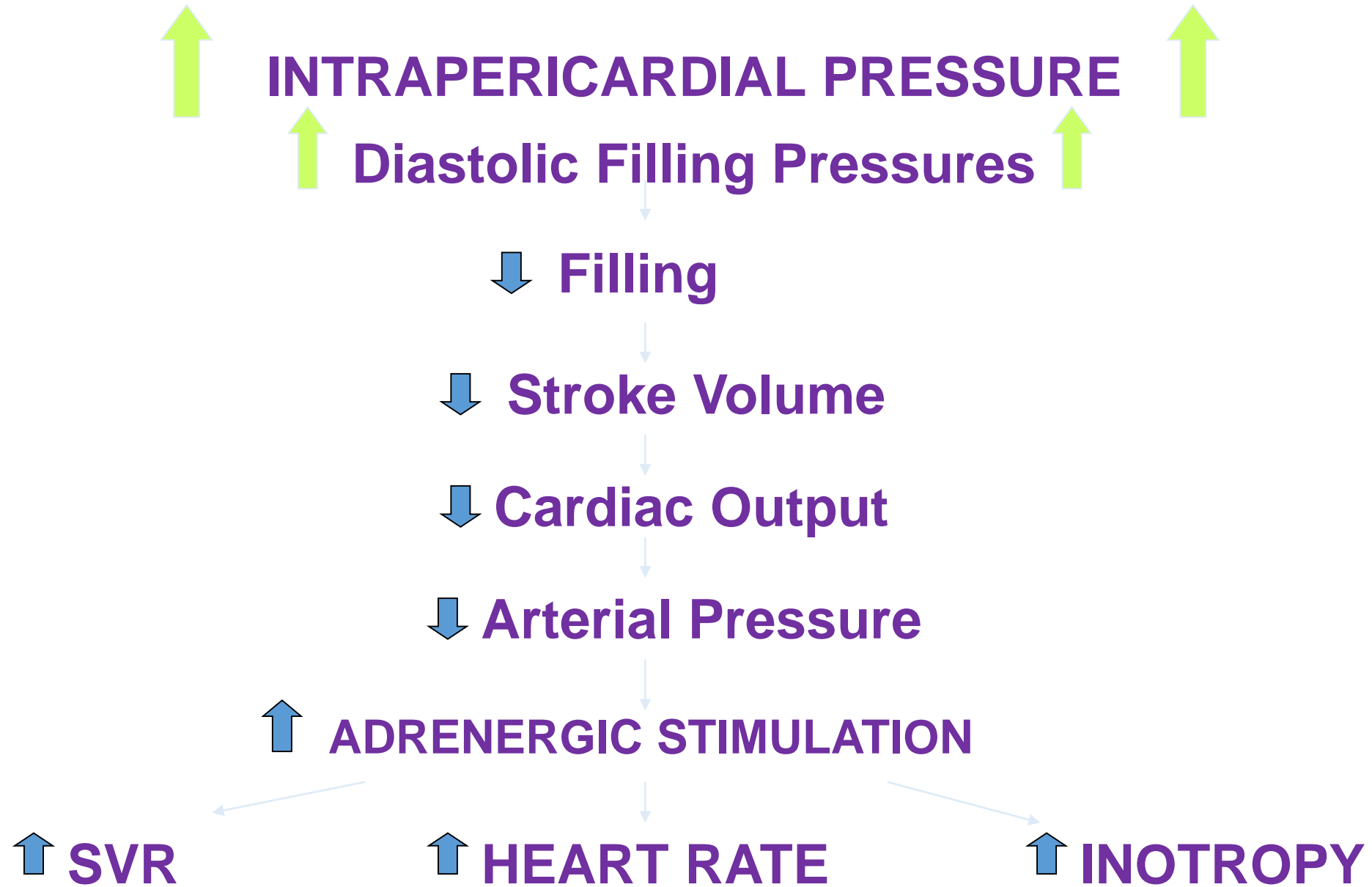
# Likelihood of causing tamponade

- Likely:
  - Neoplastic, infection and iatrogenic
  - Haemopericardium in aortic dissection and MI
  - ESRF
- Rarely:
  - Autoimmune, Dressler's syndrome and hypothyroidism
- Never
  - Pericardial transudation in heart failure
  - Pulmonary hypertension
  - Last trimester of pregnancy



# Pericardial Pressure – Volume Relationship





# Clinical Presentation

- Symptoms

- Chest Pain, dyspnea, near-syncope : rather non-specific
- Generally more comfortable sitting forward

- Physical Exam

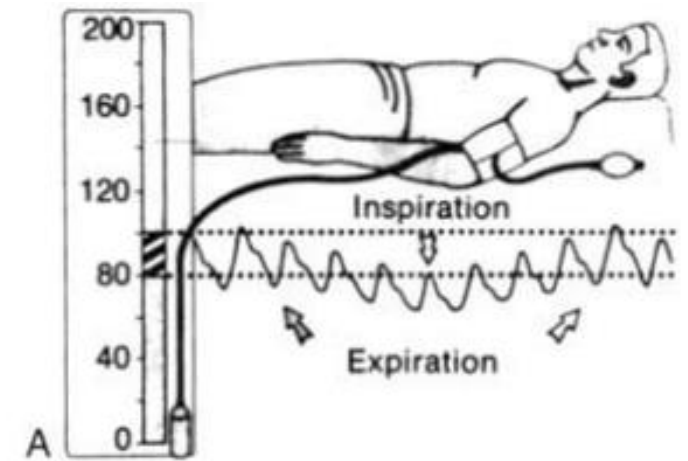
- Beck's Triad - JVP, hypotension, heart sounds
  - JVP w/ preserved x descent and dampened or absent y descent
  - Generally w/ narrow pulse pressure
- Tachycardia, other signs of HF (tachypnea, diaphoresis, cool extremities)
- Pulsus paradoxus
- Decreased or absent cardiac impulse
- +/- Friction rub





# Pulsus Paradoxus

- Dec in SBP > 10 mmHg during inspiration
- Can also occur in pts with COPD, PTX, severe asthma (significant respiratory distress)
- Can have tamponade without pulsus paradoxus
  - Those with pre-existing elevation in diastolic pressures (e.g LV systolic dysfx, ASD, Pul HT)



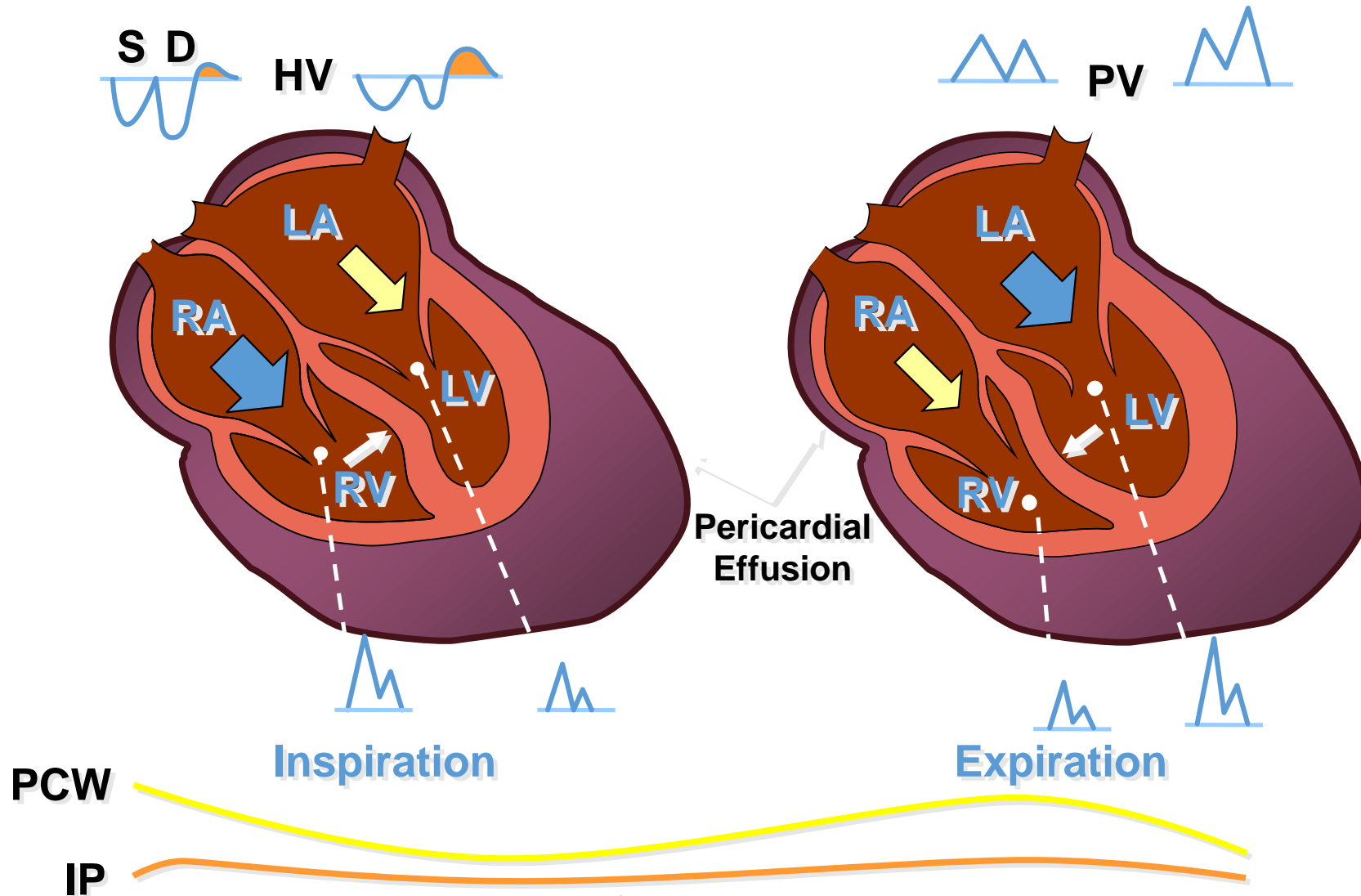
## PROCEDURE FOR THE MEASUREMENT OF PULSUS PARADOXUS

Patient should be reclining at a 30 to 45° angle and instructed to breathe normally.

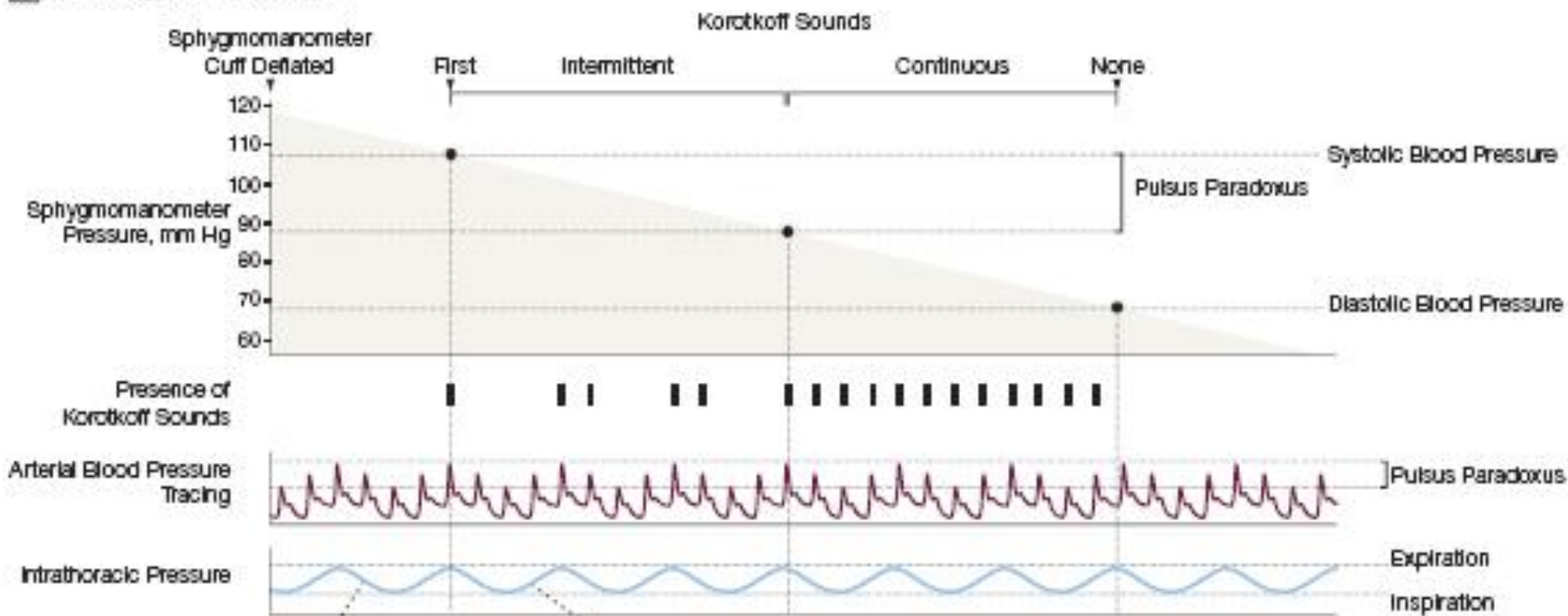
1. Inflate standard blood pressure cuff until Korotkoff sounds over brachial artery disappear.
2. Lower pressure in cuff a few millimeters of mercury per second until first Korotkoff sounds appear during expiration.
3. Maintain pressure at this level and observe disappearance of sounds during inspiration. Record this cuff pressure.
4. Very slowly lower cuff pressure until Korotkoff sounds are heard throughout the respiratory cycle. Record this cuff pressure.
5. The difference between pressures recorded in the 2 previous steps is then recorded as the measurement (in mm Hg) of pulsus paradoxus. A pulsus paradoxus >12 mm Hg is abnormal. (see text).

# Tamponade Pathophysiology

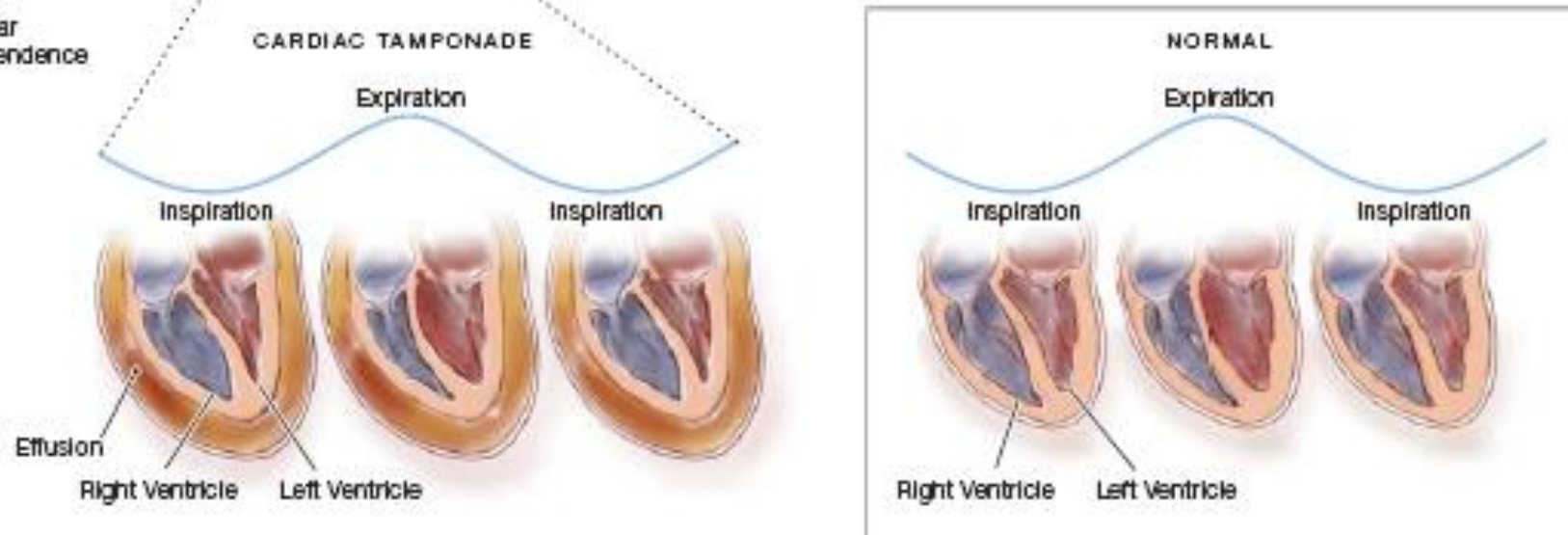
## Similar to Constriction



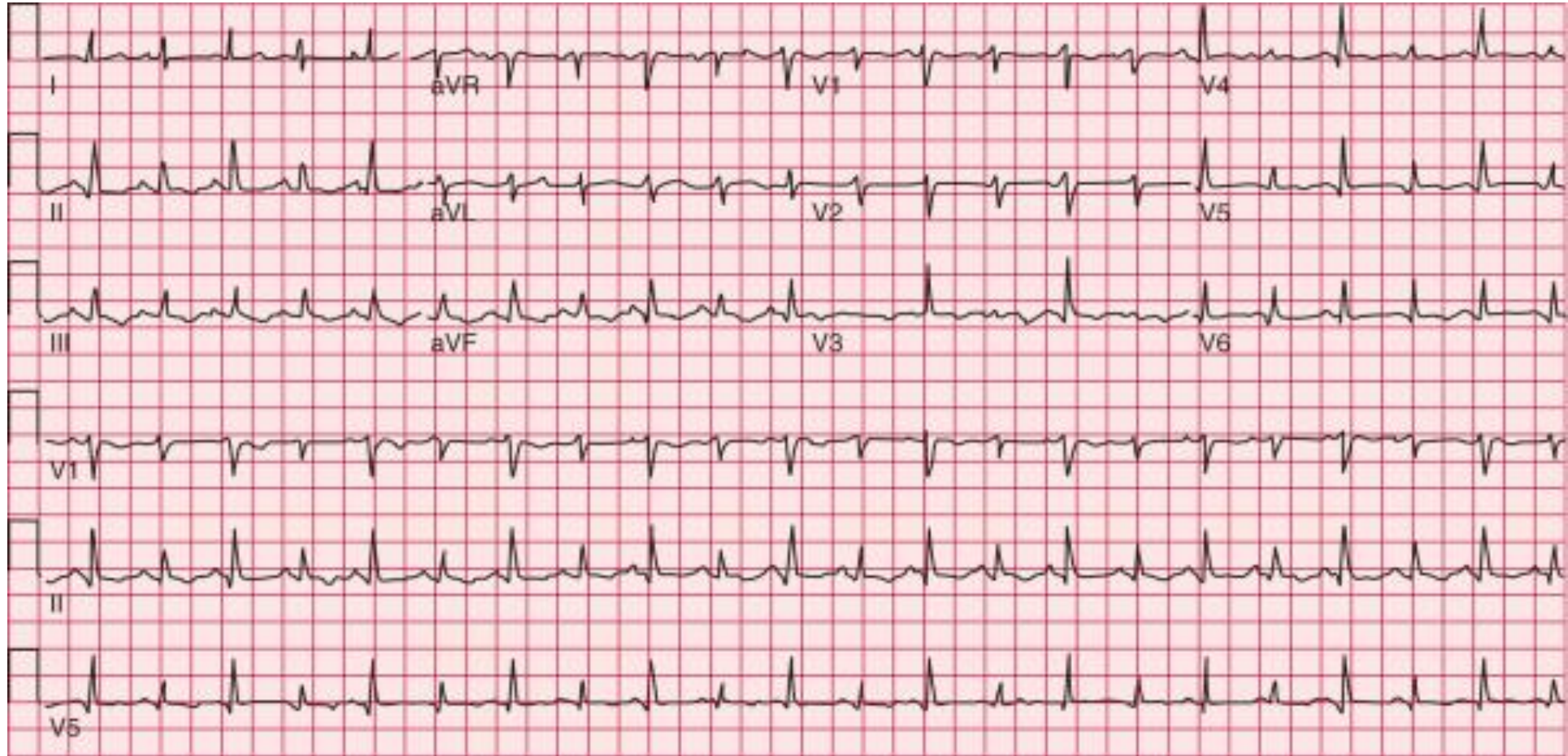
**A** Measuring Pulsus Paradoxus



**B** Ventricular Interdependence

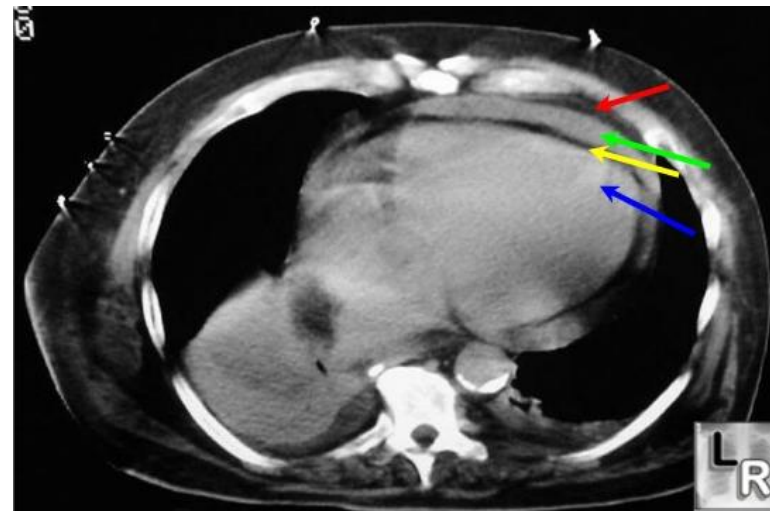
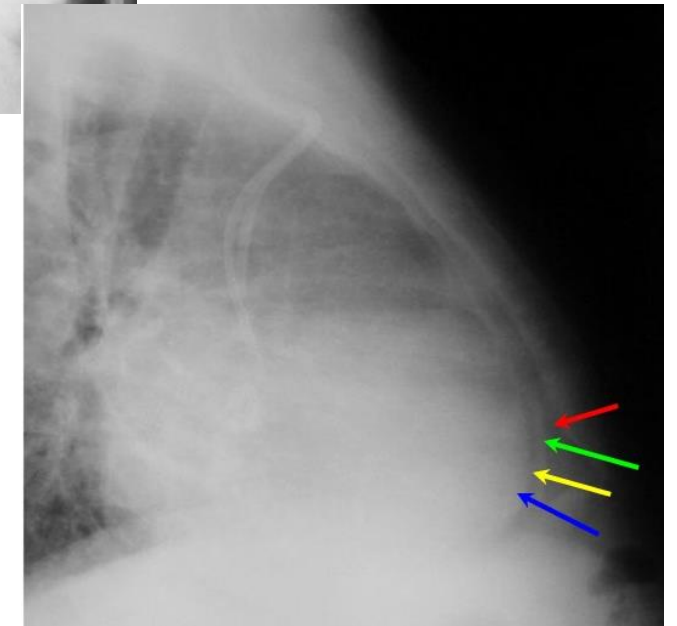


# ECG Findings



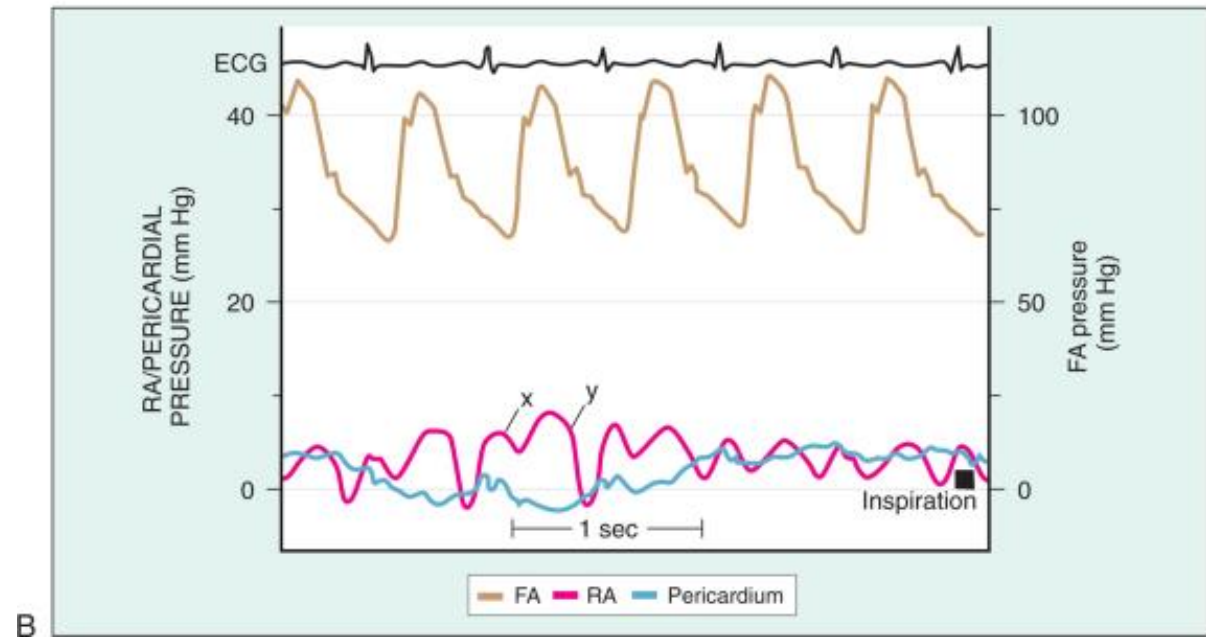
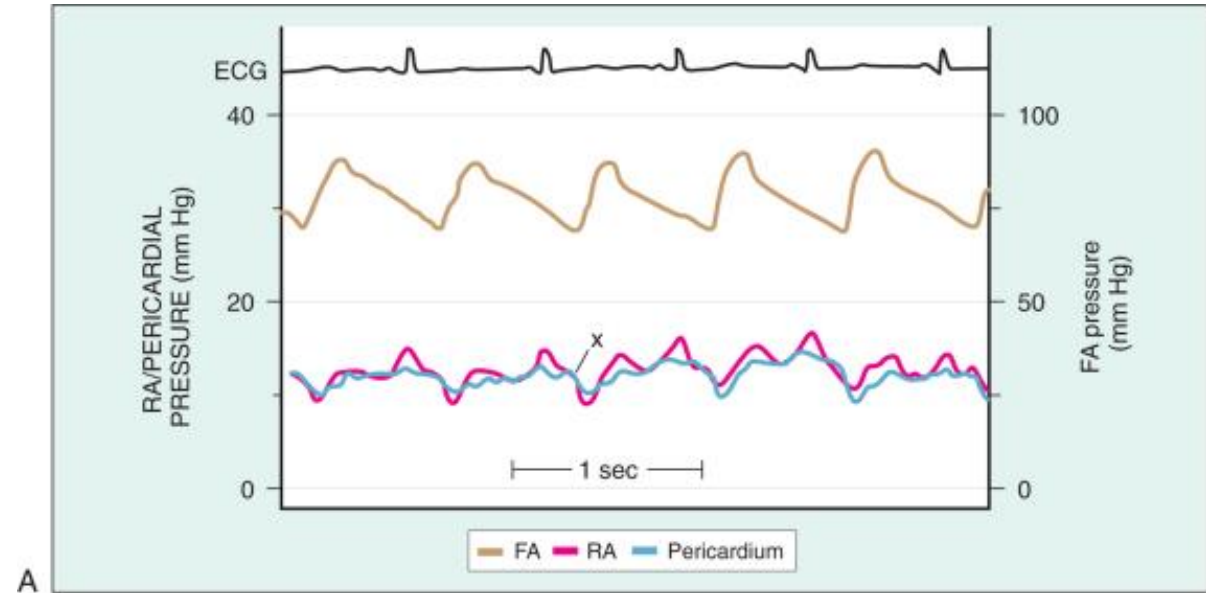
# CXR Findings

- Sudden increase in size of cardiac silhouette without specific chamber enlargement
  - “Water-bottle” sign
- Lateral CXR showed positive fat pad sign
  - Separation of mediastinal fat and epicardial fat by  $> 2$  mm



# Rt heart cath

- Near equalization (within 5 mm Hg) of the RA, RV, PCWP, RV diastolic, & LV diastolic pressures
- RA pressure tracings show diminished systolic  $\gamma$  descent

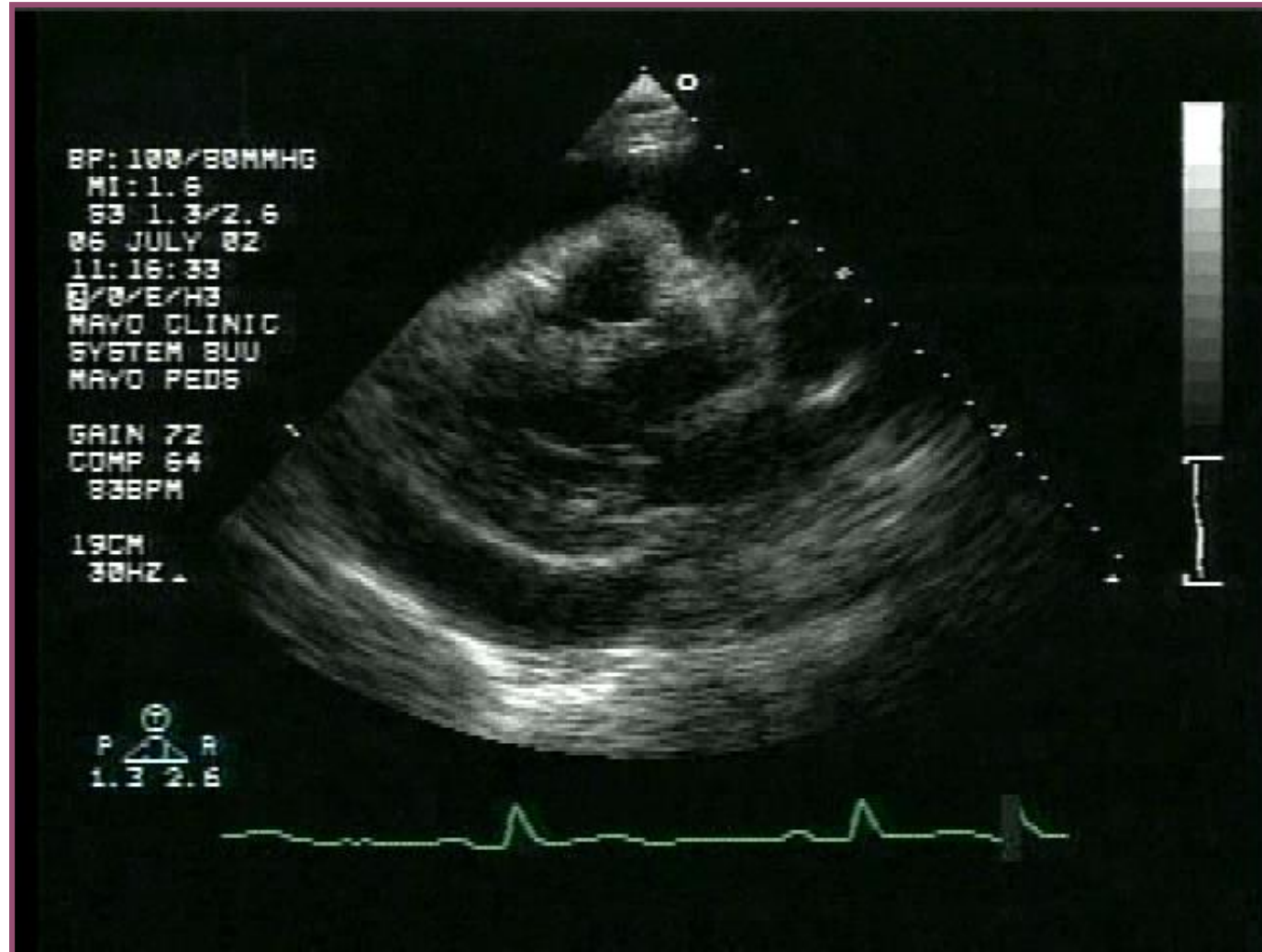


# Cardiac Tamponade

- Clinical syndrome of hypotension, tachycardia, and symptoms, occurring when intrapericardial pressure exceeds intracardiac pressure
- Slowly developing effusions – pericardium stretches; tamponade occurs with larger volume
- Rapidly developing effusion – pericardium has no time to stretch; tamponade occurs with small volume

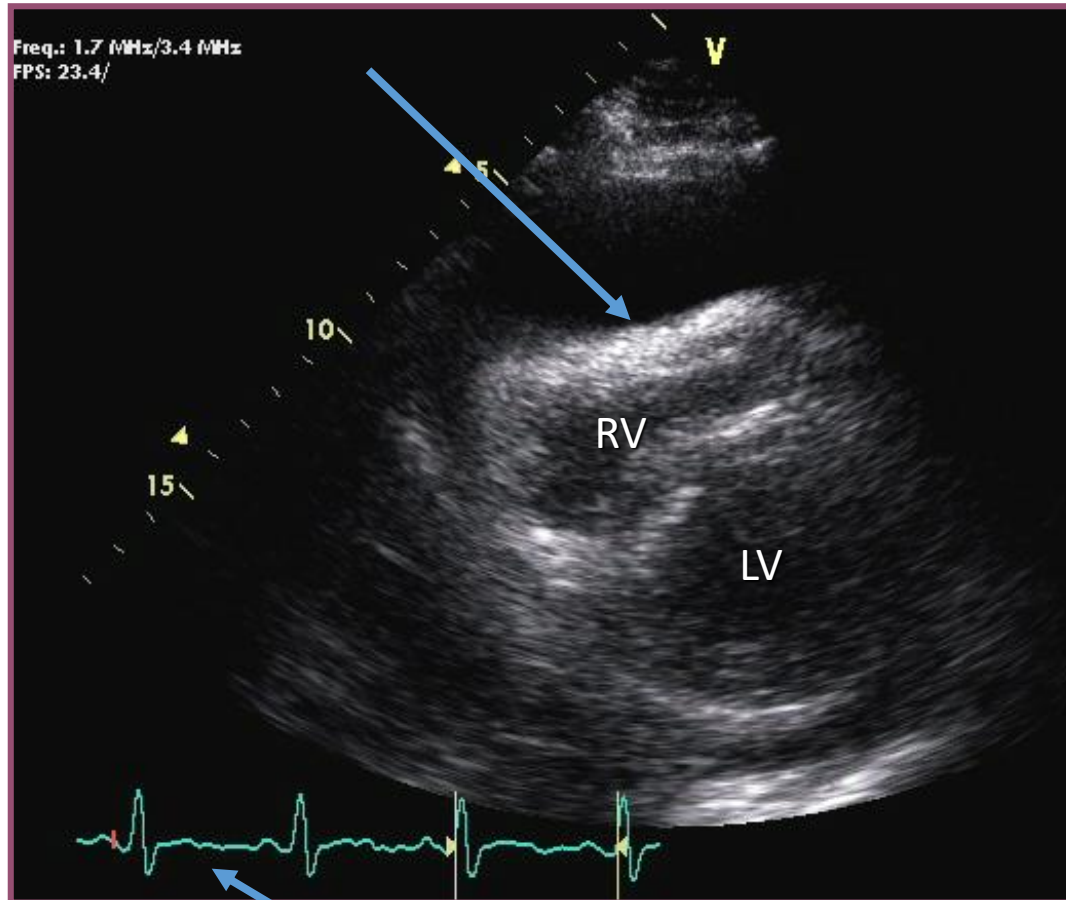
# Tamponade

## Diastolic RV Compression

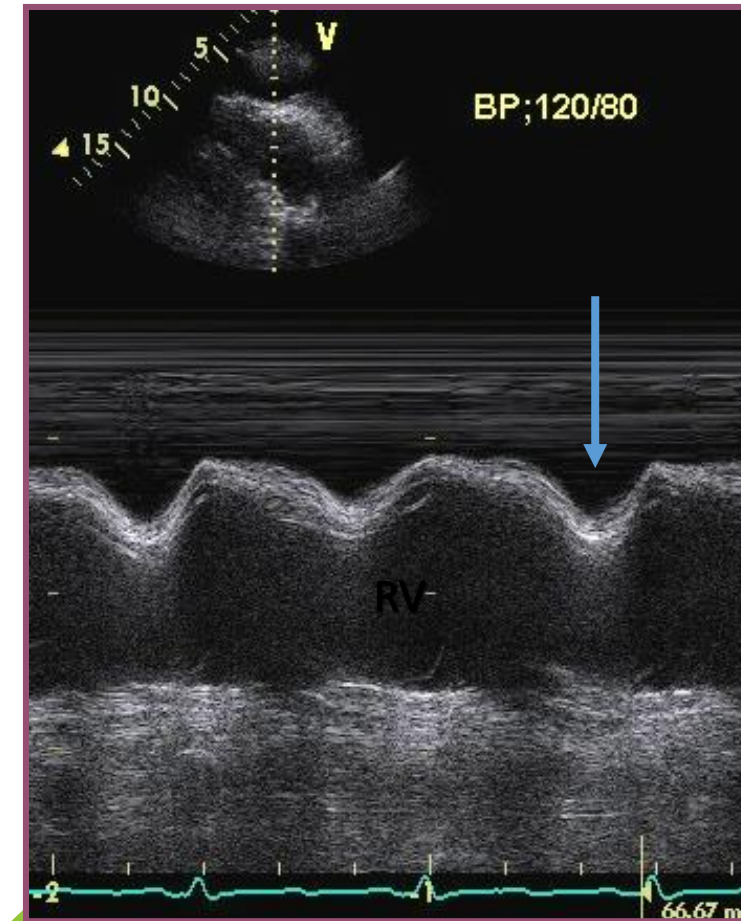




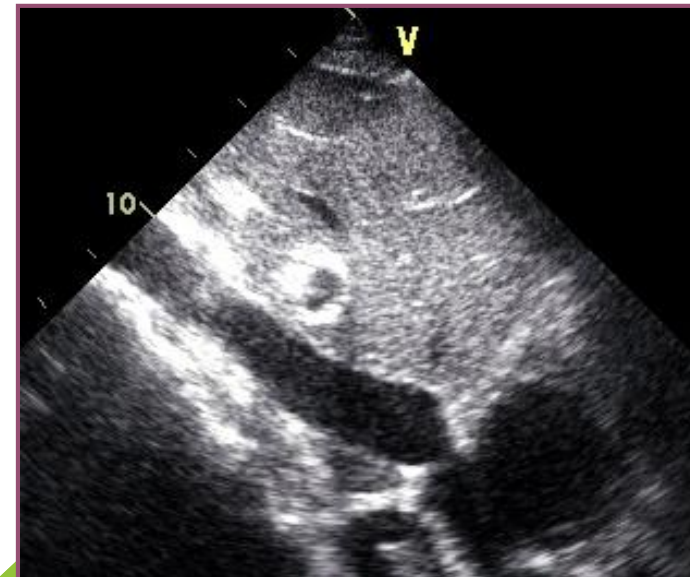
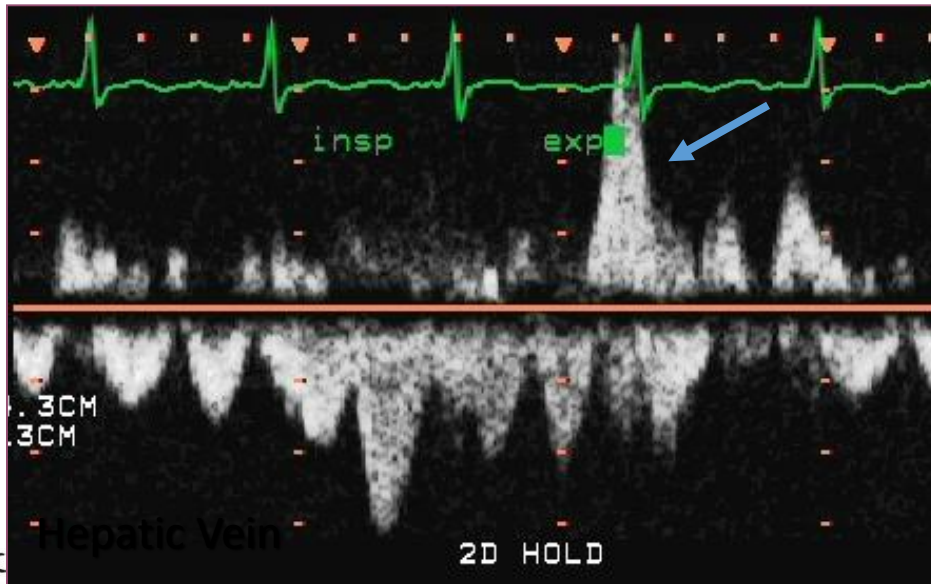
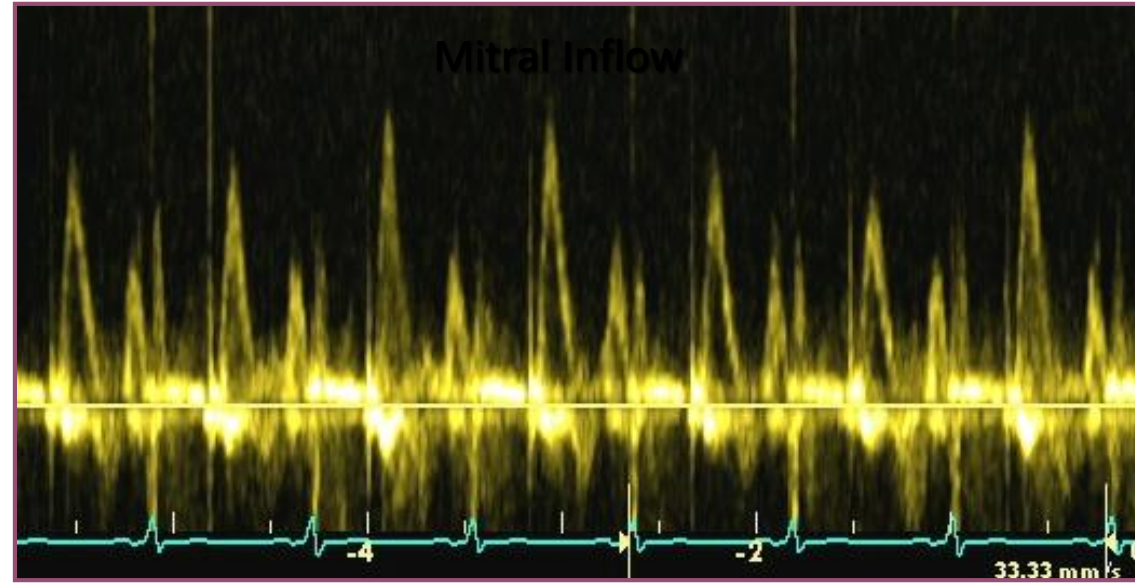
# Tamponade – Diastolic RV Collapse



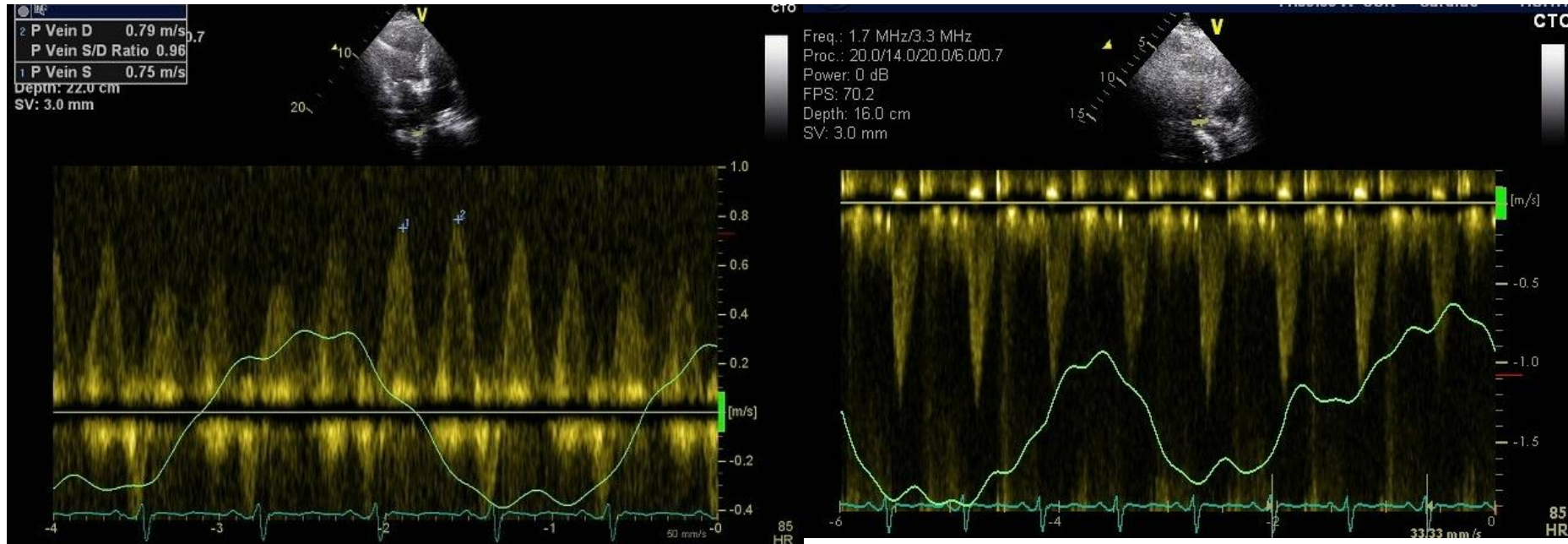
P.S.A.



# Cardiac Tamponade



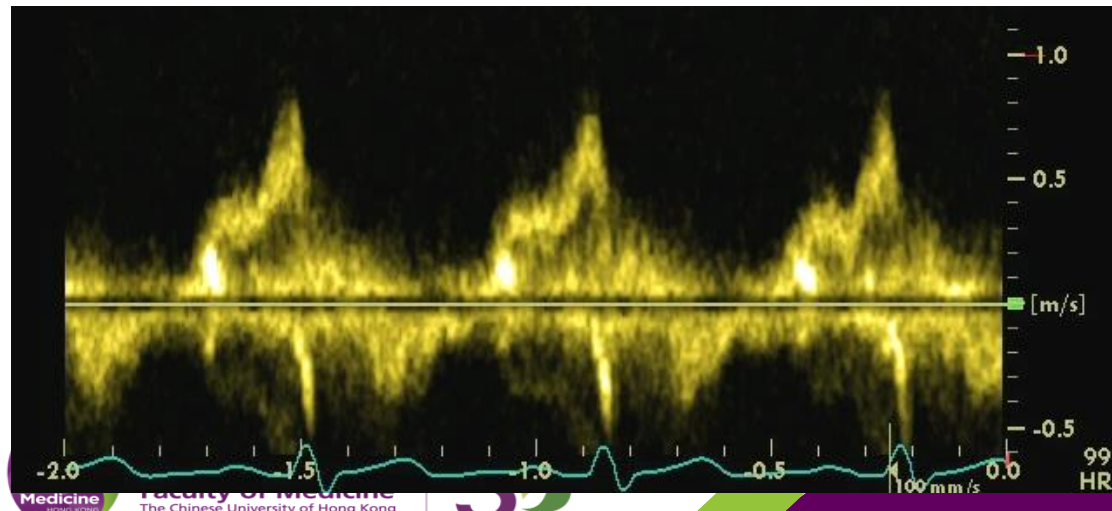
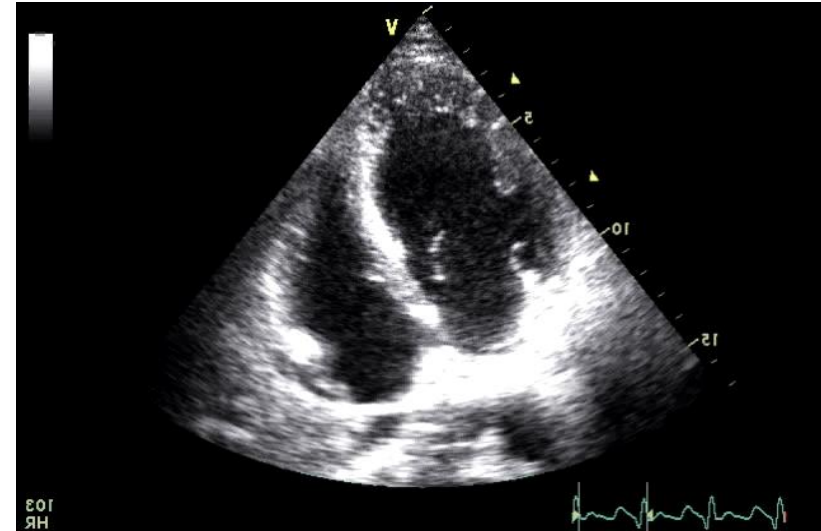
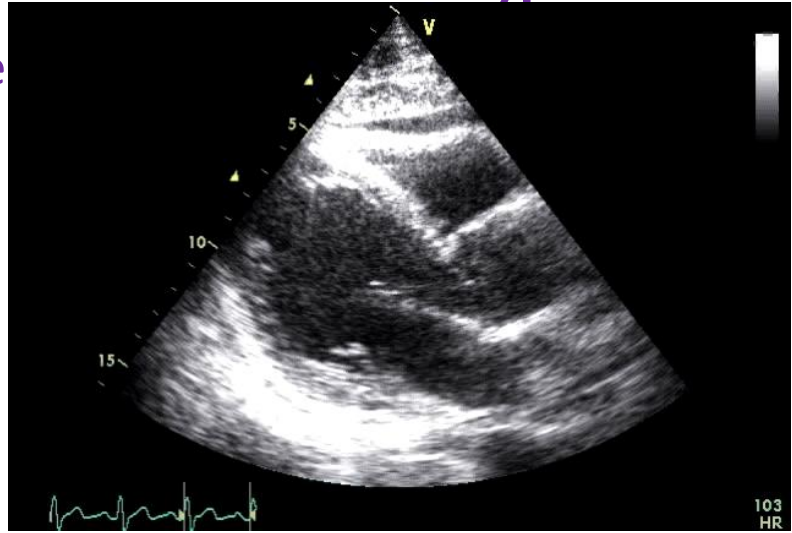
# Pulsus Paradoxus



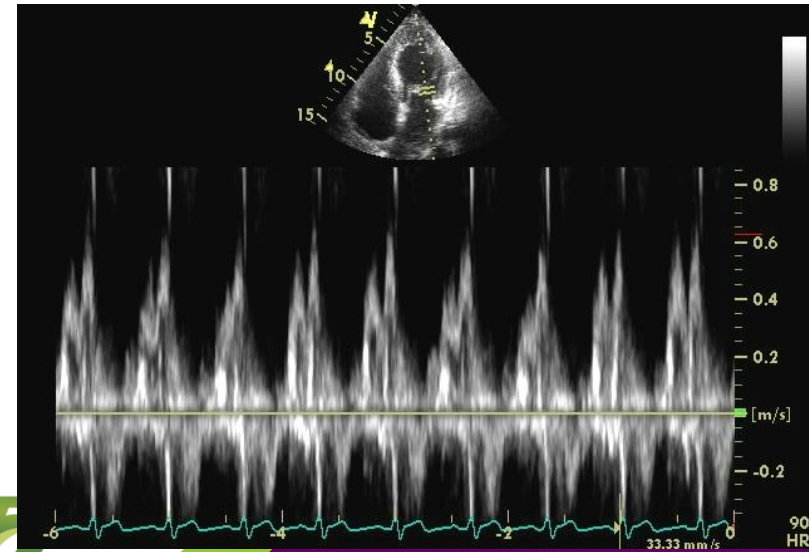
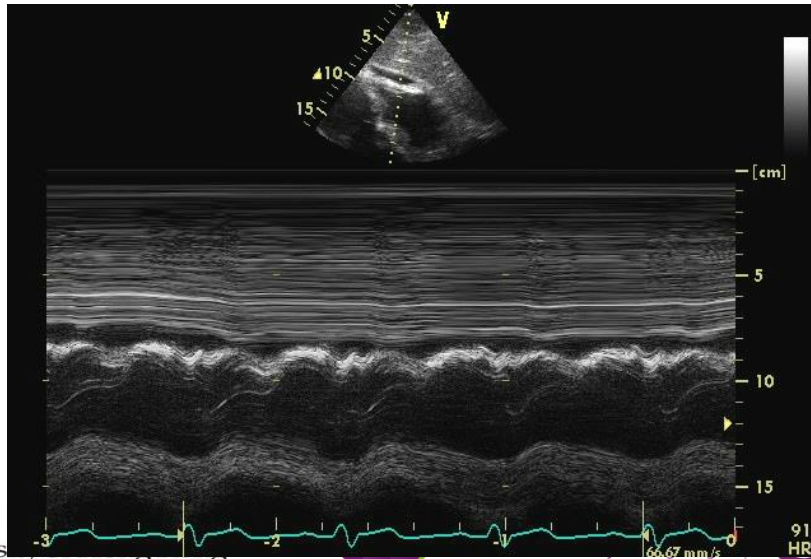
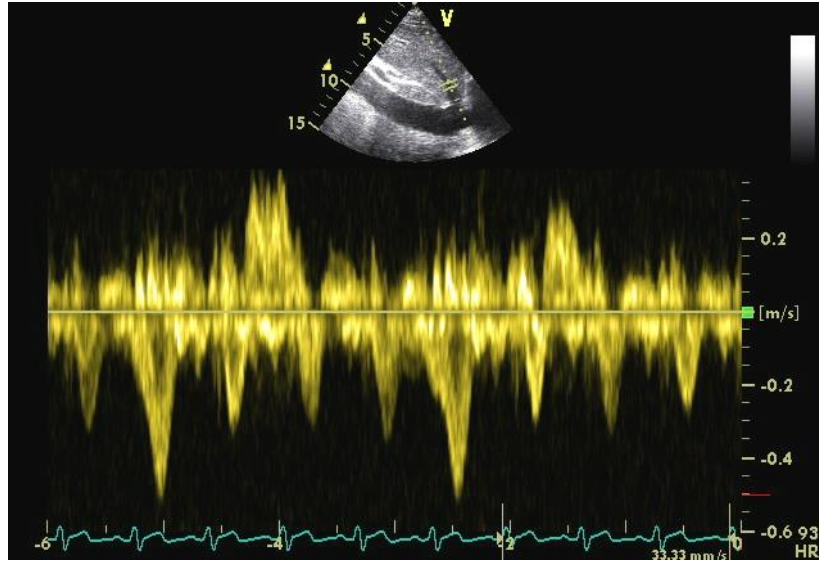
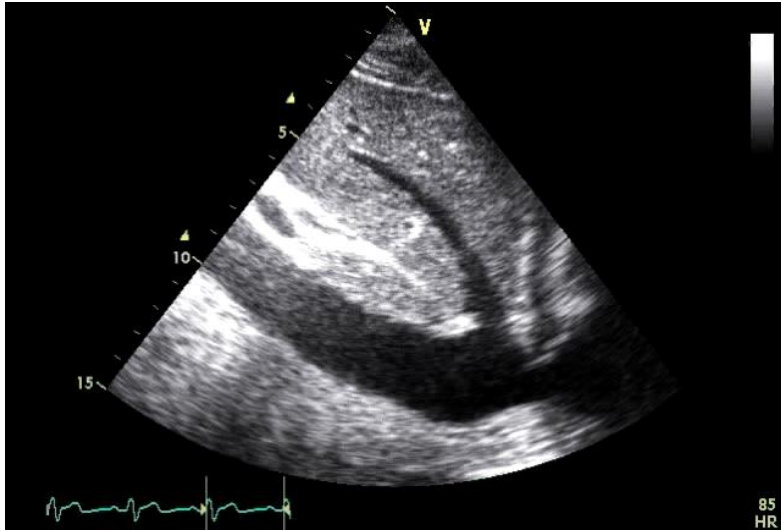
**Case 1**  
**M/57 with STEMI**  
**Thrombolysis with PCI done**  
**Hypotensive and tachycardic**

How do manage the hypotension?

1. Dopamine
2. IABP
3. Fluid
4. Surgery
5. Pericardial tapping



# M/57 with STEMI



# Case 2

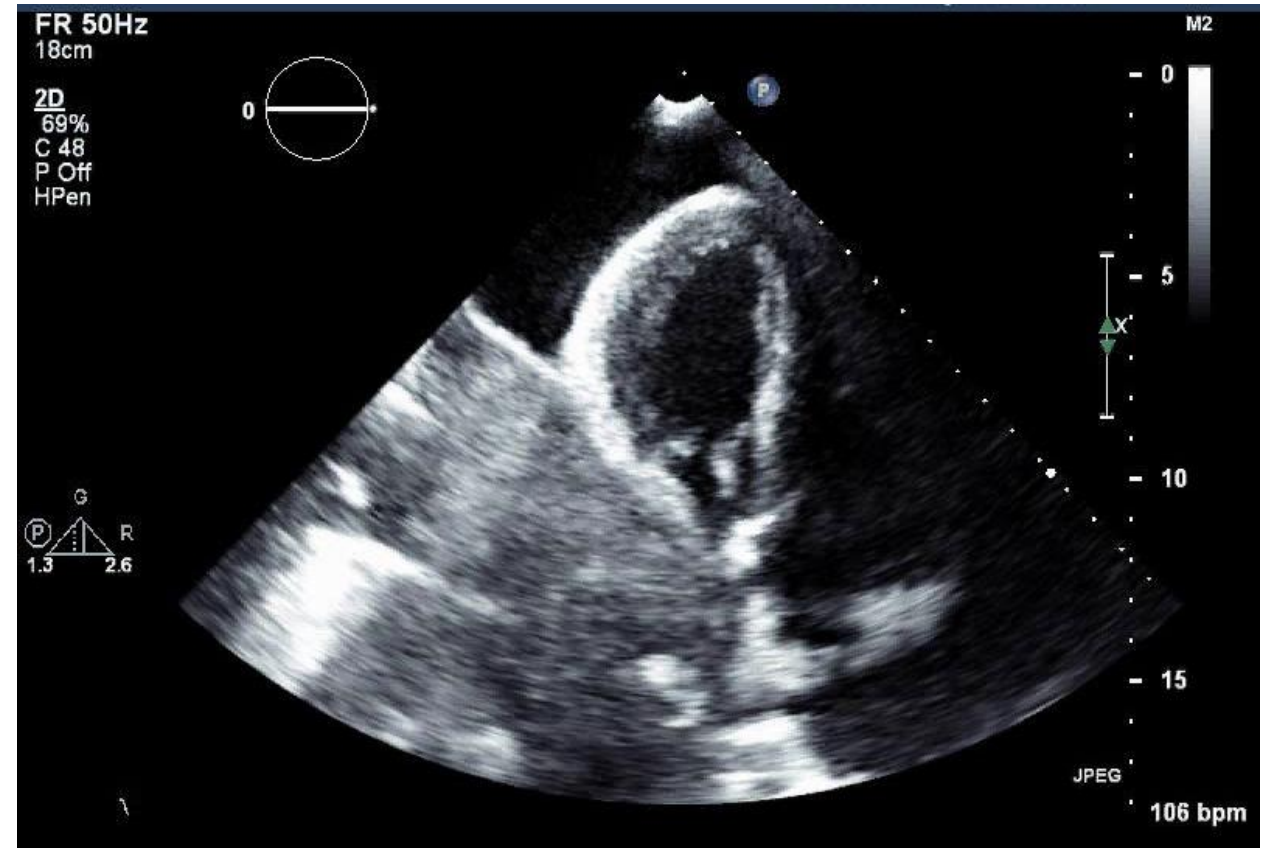
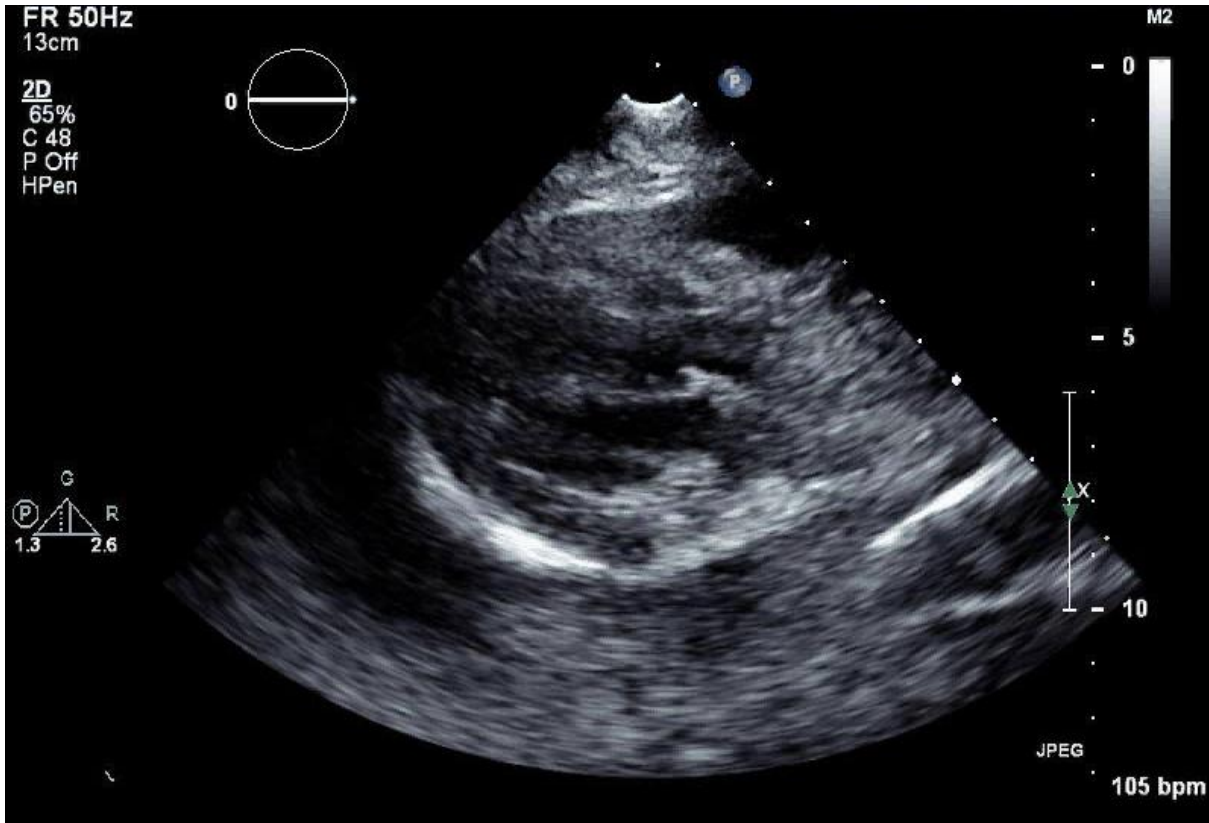
## M/50 with RA

### Increasing dyspnea and weight loss

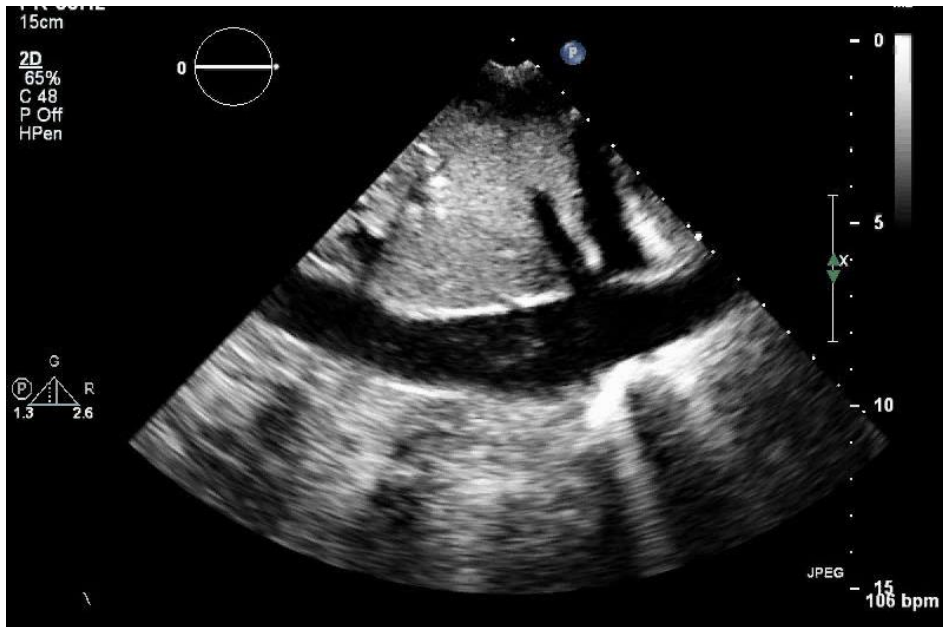
- Cachectic
- JVP is increased
- Decreased breath sounds
- Normal S1 and S2
- No peripheral edema



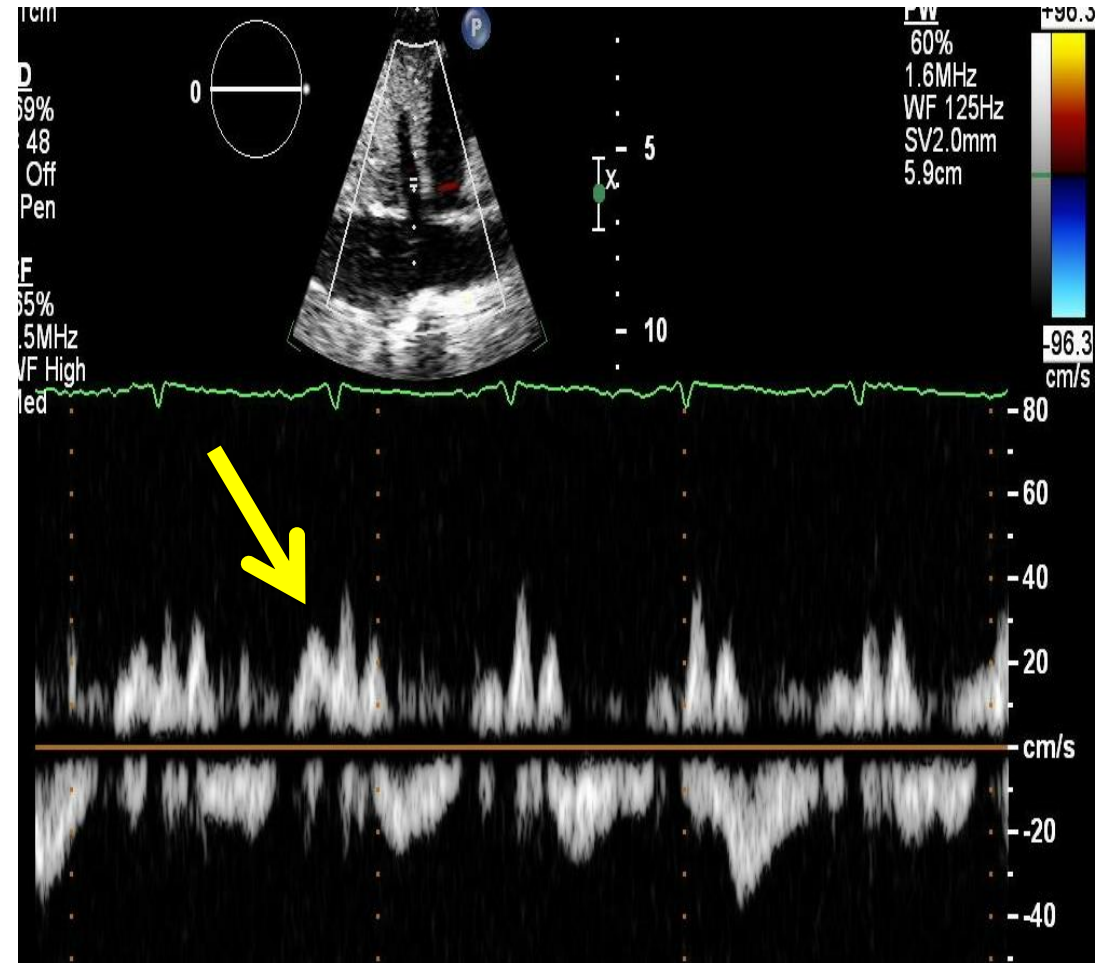
# M/50 with dyspnea



# Hepatic Vein Doppler Expiratory Diastolic Flow Reversal



Plethoric IVC

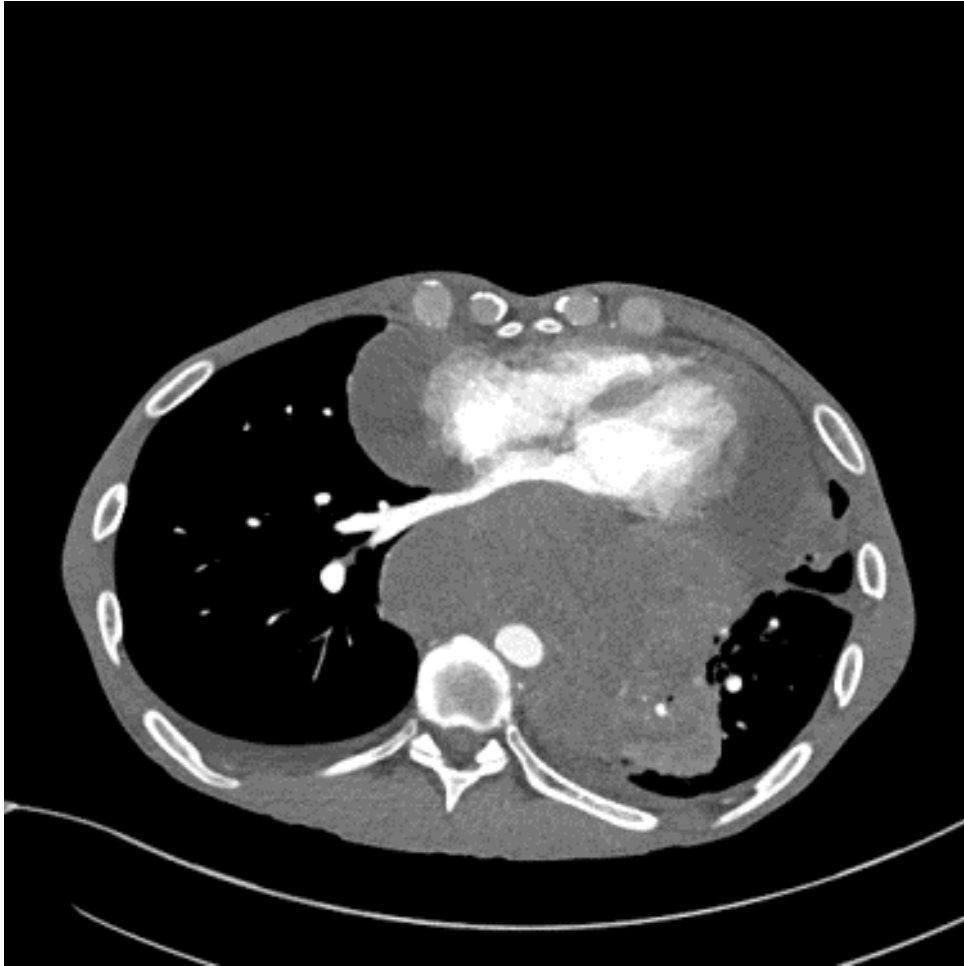


Expiration

Inspiration



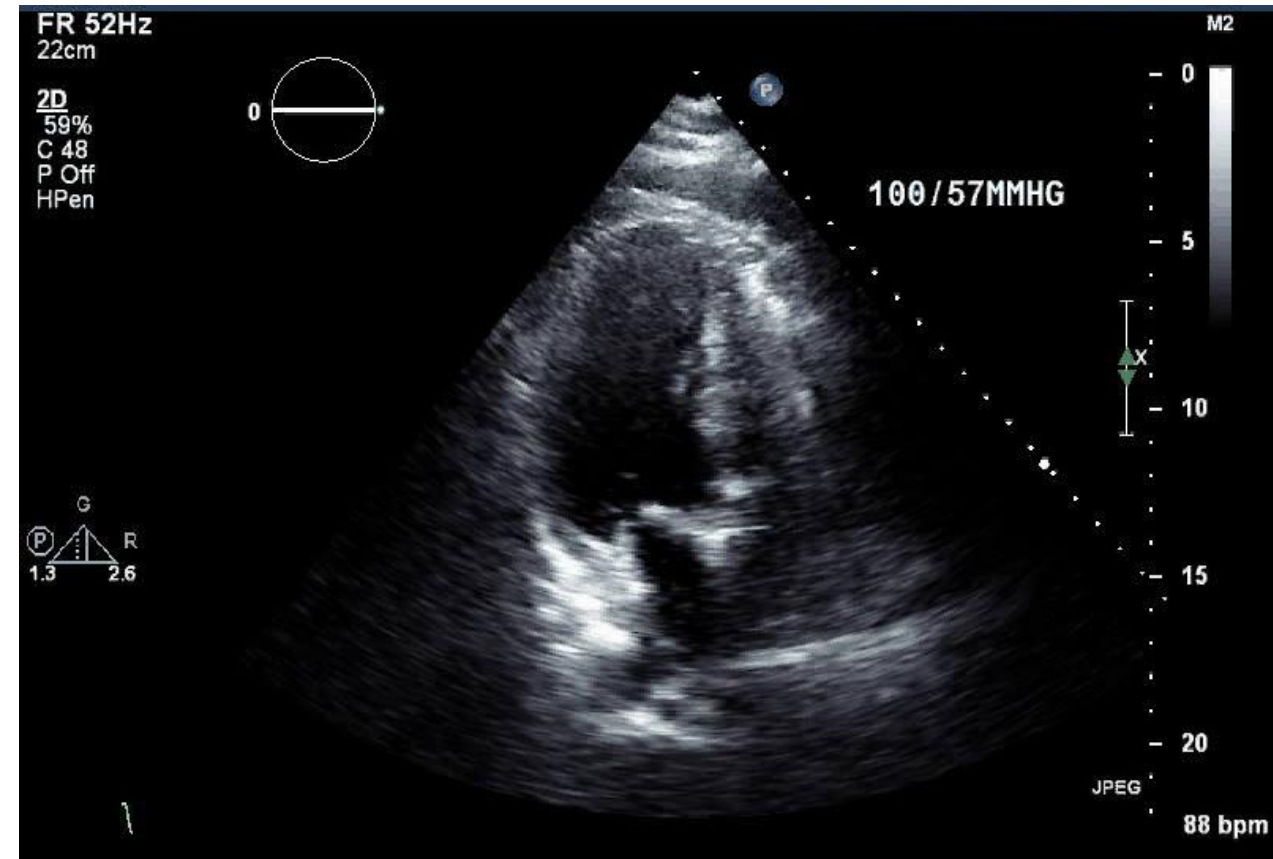
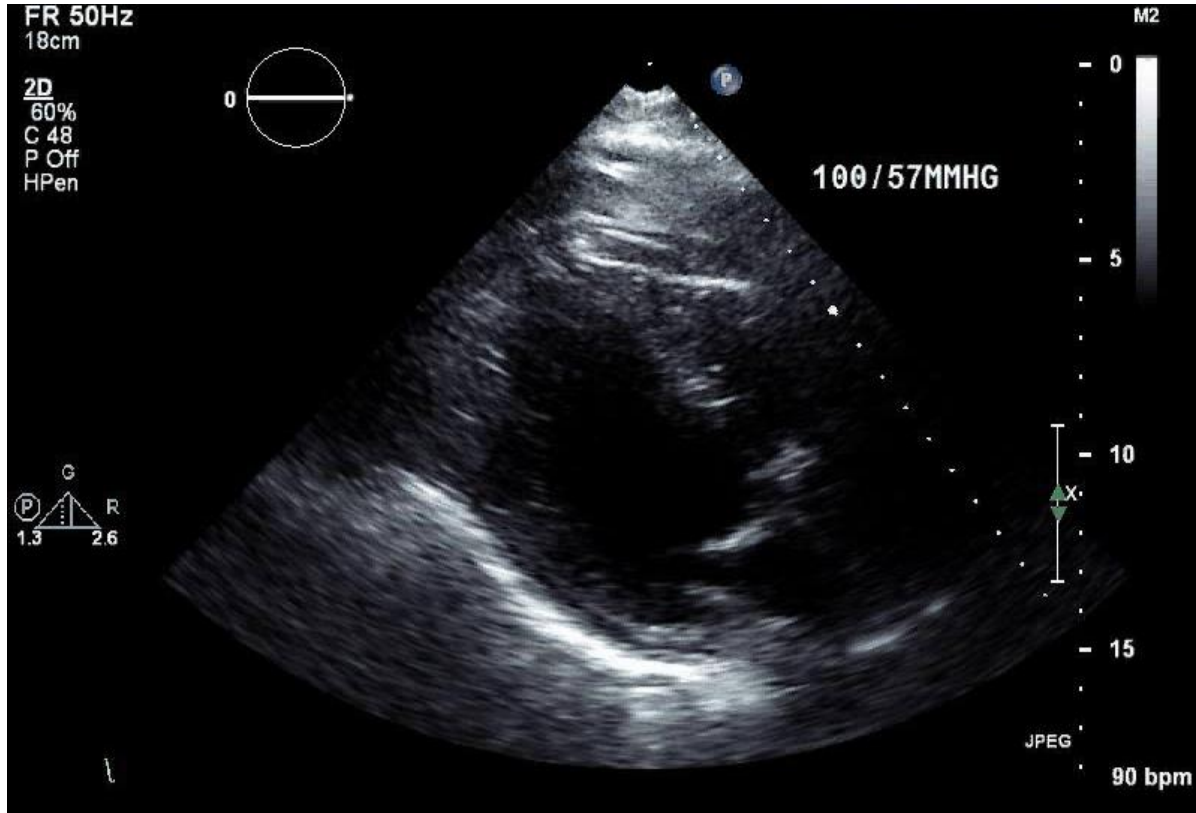
# M/50 with tamponade Small cell cancer



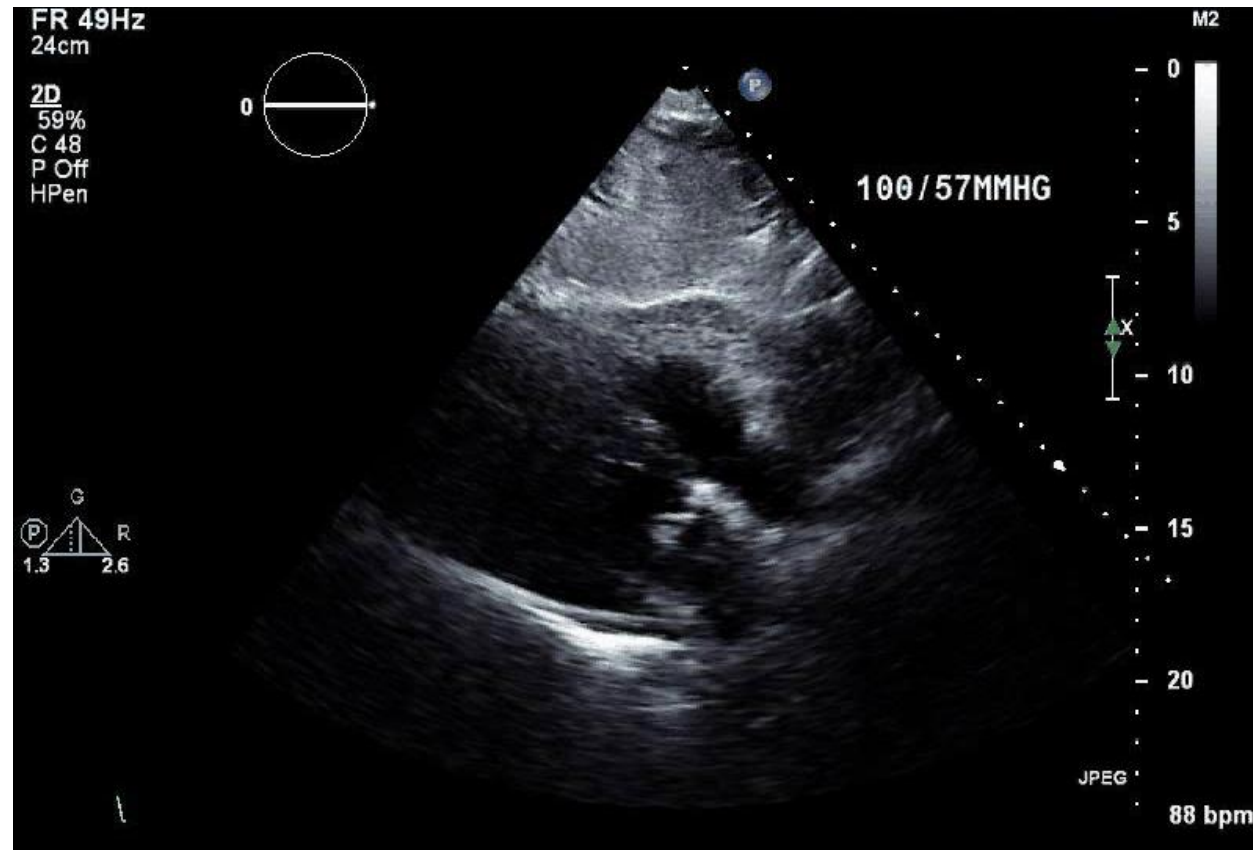
# Case 3

## M/80 with severe aortic stenosis

### TAVR and PM implantation

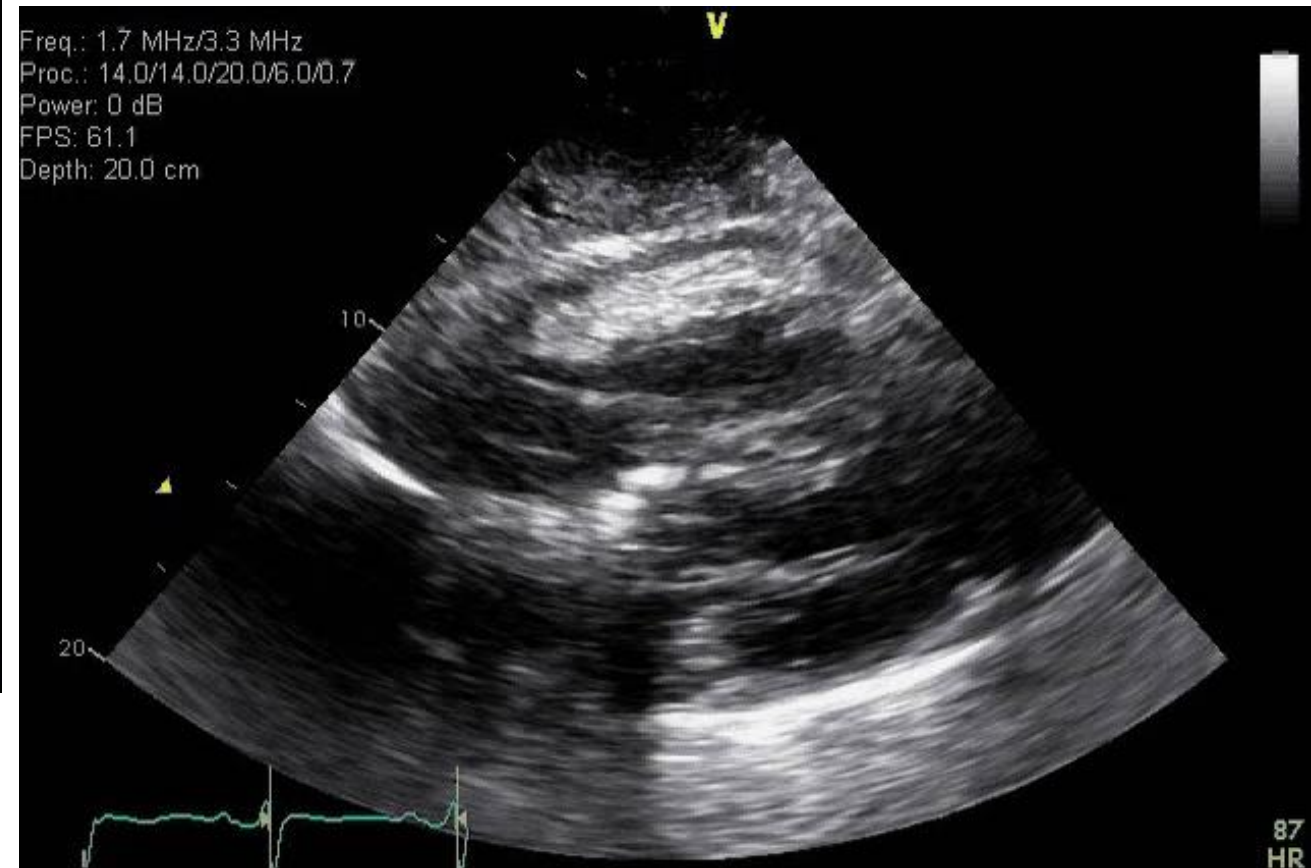
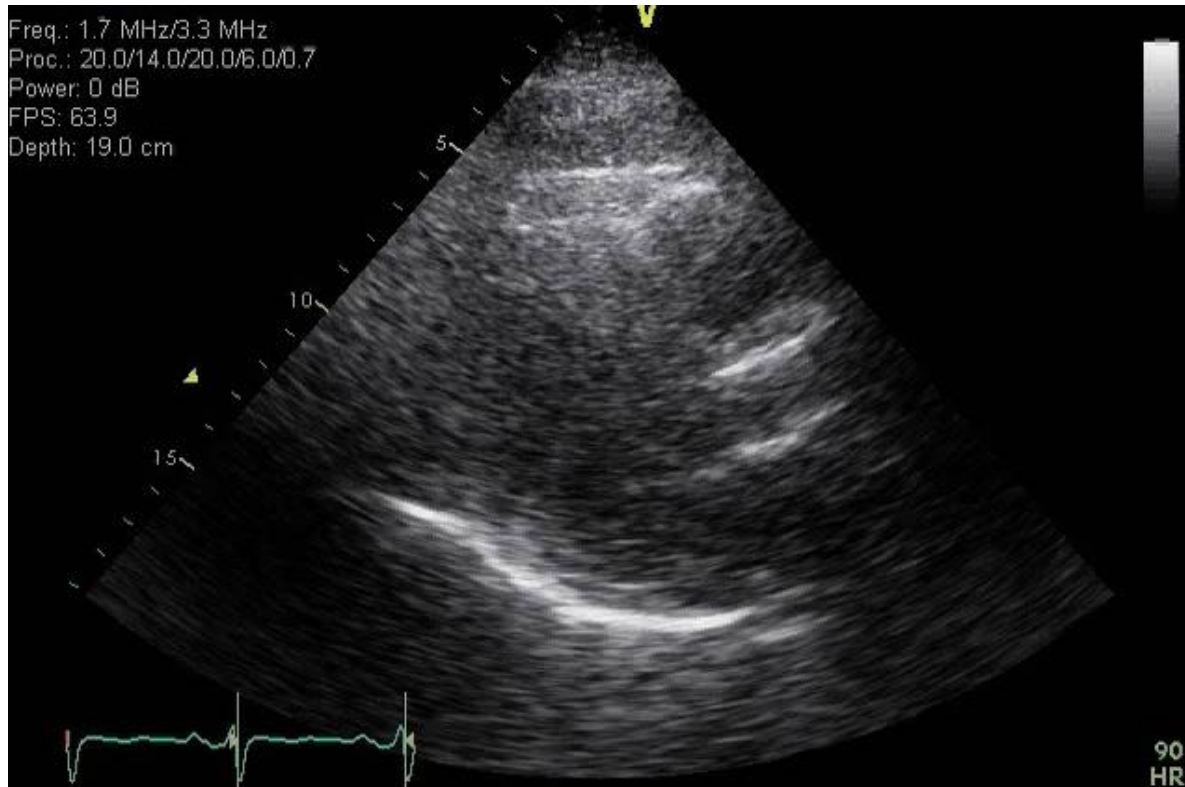


# 77 yo man with severe aortic stenosis TAVR and PM implantation & RV Perforation

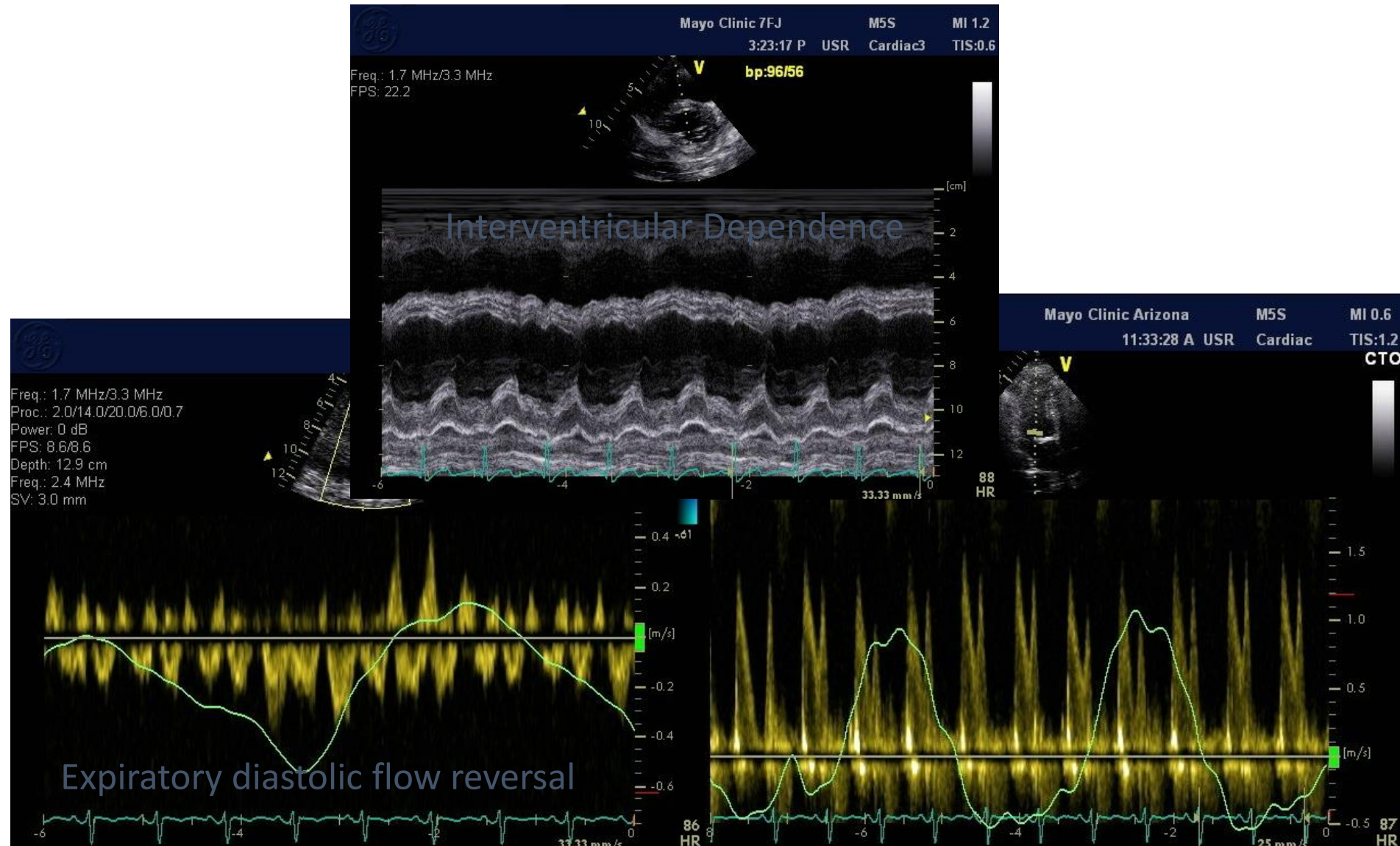


Pericardiocentesis yielded 125 cc of  
bloody fluid

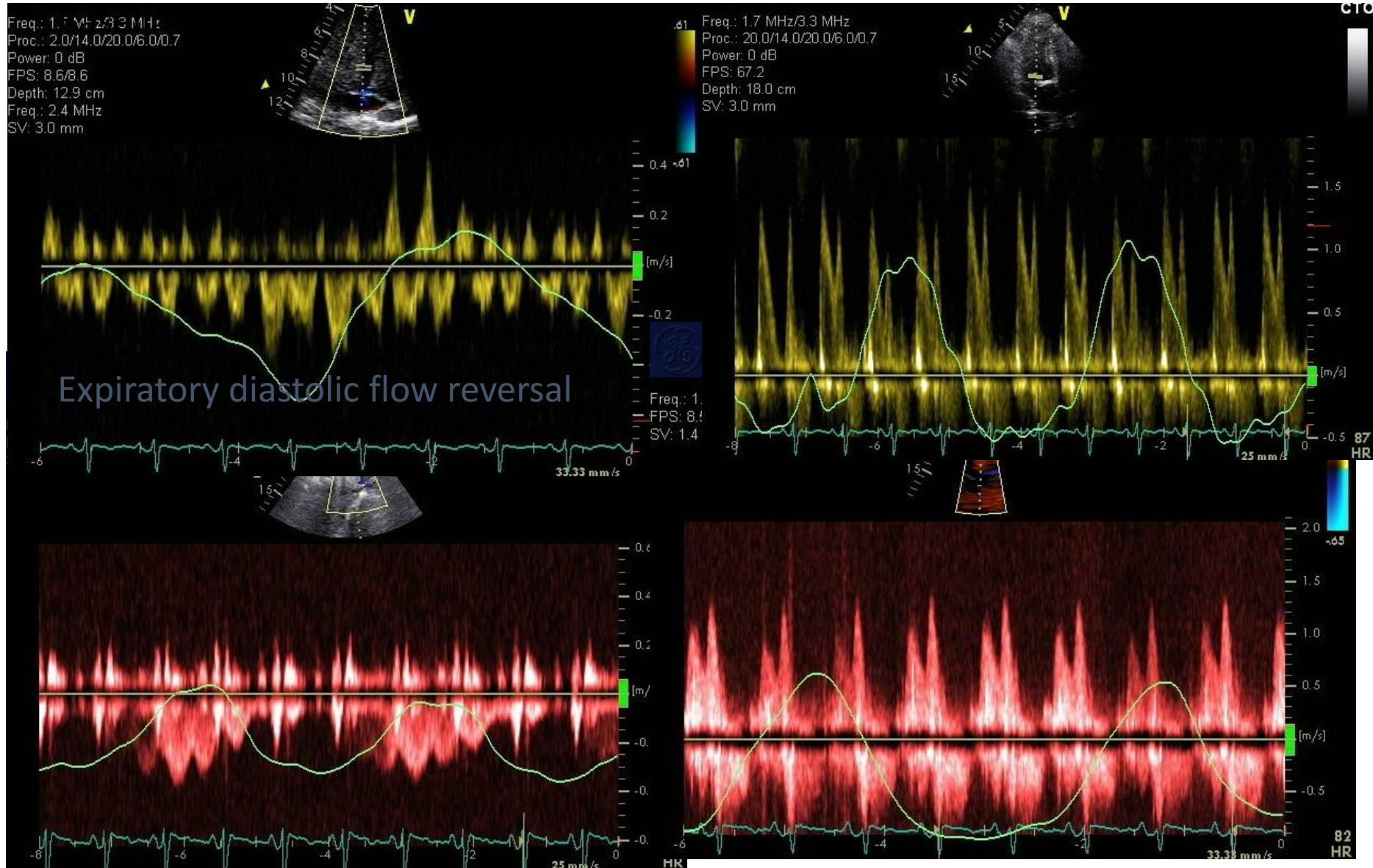
M/80 with severe aortic stenosis  
Increasing dyspnea 2 months after  
pericardiocentesis



# Effusive-Constrictive Pericarditis



# After 2 months of NSAID and Colchicine



# Effusive Constrictive Pericarditis

- From Mayo Clinic: A total of 205 patients (2006-2007) who underwent pericardiocentesis
- Constrictive Echo findings in 33 (16.1%)
- Resolution in most patients (Transient CP)
- Constrictive patients had
  - Higher  $e'$
  - More patients with septal bounce
  - Loculated effusion
  - More inflammatory cell in pericardial fluid
  - Pericardiectomy in one patient

*K Kim, L Sinak et*

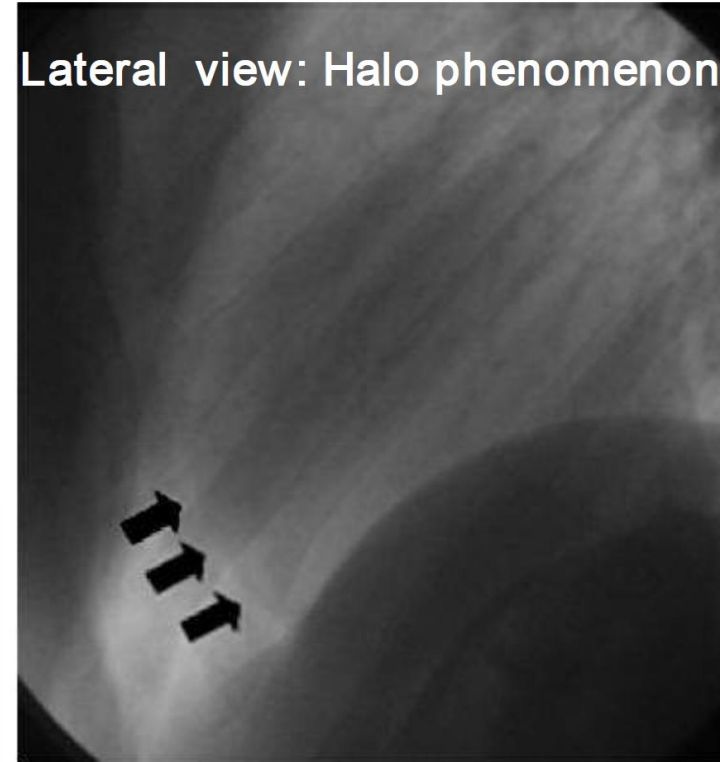
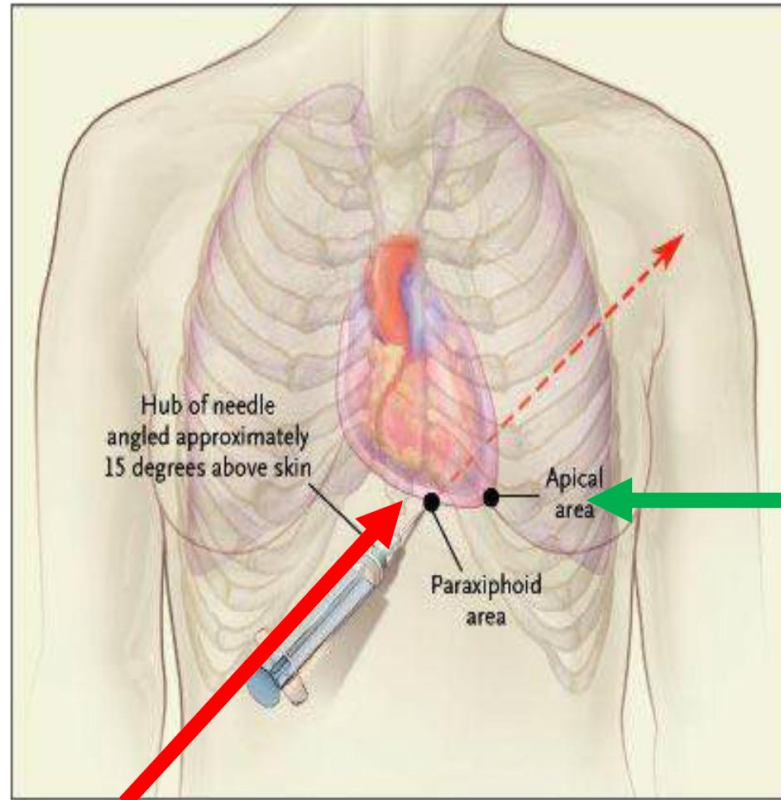
# Low pressure cardiac tamponade

- Rapidly developing cardiac tamponade
  - cardiac perforation during an invasive procedure
  - cardiogenic shock may occur rapidly with relatively small pericardial effusions, IVC may not be dilated
- Uraemic pericarditis
  - In patients with ESEF and chronic significant pericardial effusion right after dialysis
- For patients with low or normal systemic venous pressure
  - giving fluid or blood will improve RA filling and cardiac output, and at least temporarily lessen their tamponade severity





# Pericardiocentesis



Subxyphoid access:  
Lateral view: Halo !  
X-ray control

[www.escardio.org](http://www.escardio.org)

Lateral axillary line:  
Echo control  
- For large or medium effusions



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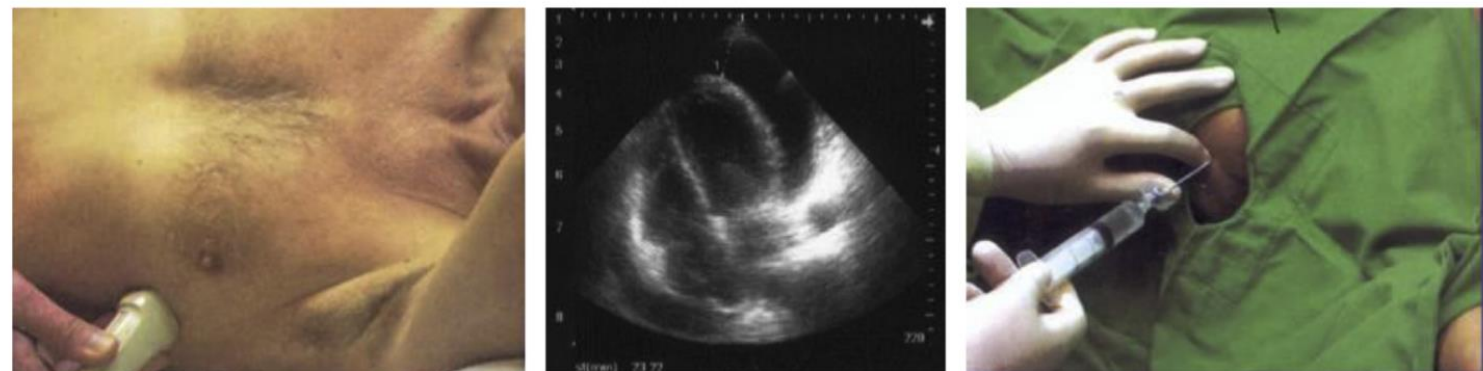
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35  
th Anniversary  
三十五週年

**Table 1**  
Comparative analysis of feasibility and safety of major pericardiocentesis series

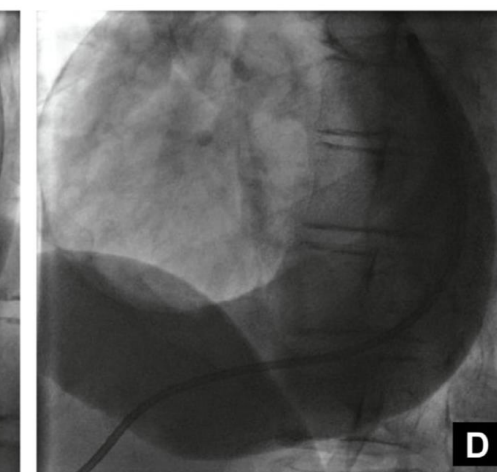
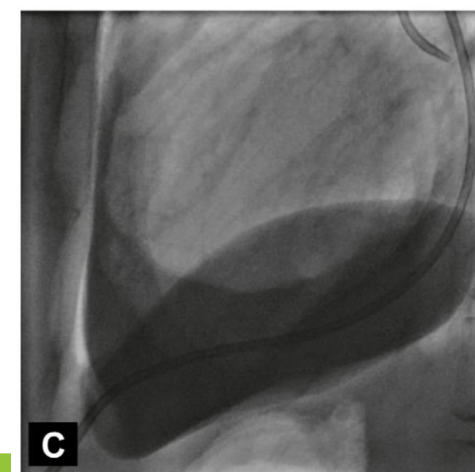
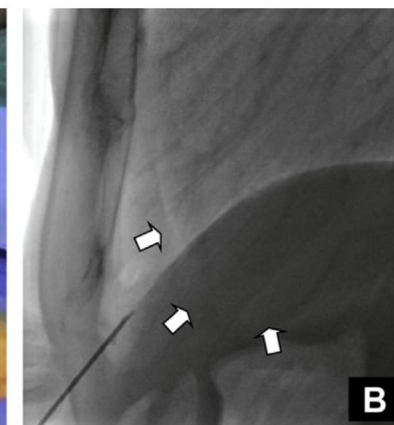
Author, (Reference)	Guidance and Approach	Number of Procedures	Most Frequent Etiologies	Feasibility	Mortality	Major Complications	Minor Complications
Tsang et al, <sup>10</sup> 2002	Echo	1127	Malignancy, iatrogenic or postcardiotomy 70%	97%	0.0009% (1 heart chamber laceration)	1.2% (6 heart chamber lacerations requiring surgery, 1 injury to an intercostal vessel, 5 pneumothoraces requiring drainage, 1 ventricular tachycardia, 1 bacteriemia)	3.5% (11 transient chamber entries, 8 small pneumothoraces, 2 vasovagal reactions, 2 NSVT, 8 pericardial catheter occlusions, 9 pleuropericardial fistulas)
Battistoni et al, <sup>17</sup> 2016	Noncontinuous echo guided	478	Malignancy or postcardiotomy 60%	98%	0%	1%	Not reported
Akyuz et al, <sup>18</sup> 2015	Echo (subxiphoid 85%, intercostal 15%)	301	Malignant 28%, viral 7.3%, uremic 7.9%, postcardiotomy 7.9%, tuberculosis 6.6%, idiopathic/indeterminate 26.3%	97%	0%	1.3% (1 case of pneumothorax, 1 case of right coronary artery perforation, and 2 cases of right ventricular perforation all requiring surgical correction)	1.3% (4 transient arrhythmias, 1 case of sinus bradycardia, 1 case of atrial flutter, and 2 cases of atrial fibrillation)



**Fig. 1.** Echocardiography-guided pericardiocentesis using intercostal approach. Trajectory of the puncturing needle is predetermined by the position and the angle of the echocardiography probe at the point on the chest wall closest to the largest accumulation of pericardial effusion in diastole.

Table 1  
(continued)

Author, (Reference)	Guidance and Approach	Number of Procedures	Most Frequent Etiologies	Feasibility	Mortality	Major Complications	Minor Complications
Duvernoy et al, <sup>23</sup> 1992	Fluoroscopy (subxiphoid 100%)	352 (303 patients)	Postcardiotomy 59.1%, malignant 19.3%, idiopathic pericarditis 14.2%	95.7%	0.6% (1 aortic aneurysm, and 1 postinfarction rupture)	3.7% (3 cardiac perforations, 2 cardiac arrhythmias, 4 cases of arterial bleeding, 2 cases of pneumothorax, 1 infection, and 1 major vagal reaction)	26.1% (accidental cardiac perforation not requiring surgery 20 cases, abdominal pain 4, pneumothorax 2, pain 55, fever/leukocytosis 9, arrhythmia 2)
Maisch et al, <sup>2</sup> 2011; Maisch et al, <sup>24</sup> 2013	Echo + fluoroscopy (subxiphoid 100%)	259	Viral 12%, malignant 28%, autoreactive or lymphocytic 35%	93.3%	0%	0%	1.3% (3 cardiac perforations resolved with autotransfusion with no need for surgery, 1 major vagal reaction (0.4%)
Krikorian and Hancock, <sup>12</sup> 1978	No imaging available, ECG monitoring from the needle tip (subxiphoid 97.6%, intercostal 2.4%)	165 (123 patients)	Idiopathic 13.5%, indeterminate 18%, rheumatic disease 12%, malignant 16%, traumatic 9%, radiation 7.5%, uremic 5%	86.2%	4% (1 perforation of the right ventricle, 2 ongoing hemorrhage, 1 sudden death in a patient with scleroderma and pulmonary hypertension, 1 iatrogenic purulent pericarditis)	4% (hemopericardium with new or increased tamponade, requiring surgery in 4/5 patients)	NSVT 0.8%, several patients with vasovagal hypotension



## Pericardial Effusion

Recommendations	Class	Level
Admission is recommended for high-risk patients with pericardial Effusion <sup>a</sup> .	I	C
A triage of patients with pericardial effusion is recommended as in Figure 3.	I	C

<sup>a</sup>Similar risk criteria as for pericarditis.

Recommendations	Class	Level
It is recommended to target the therapy of pericardial effusion at the aetiology.	I	C
Aspirin/NSAIDs/colchicine and treatment of pericarditis is recommended when pericardial effusion is associated with systemic inflammation.	I	C
Pericardiocentesis, or cardiac surgery, is indicated for cardiac tamponade, or for symptomatic moderate to large pericardial effusions not responsive to medical therapy, and for suspicion of unknown bacterial or neoplastic aetiology.	I	C

NSAIDs = non-steroid anti-inflammatory drugs.

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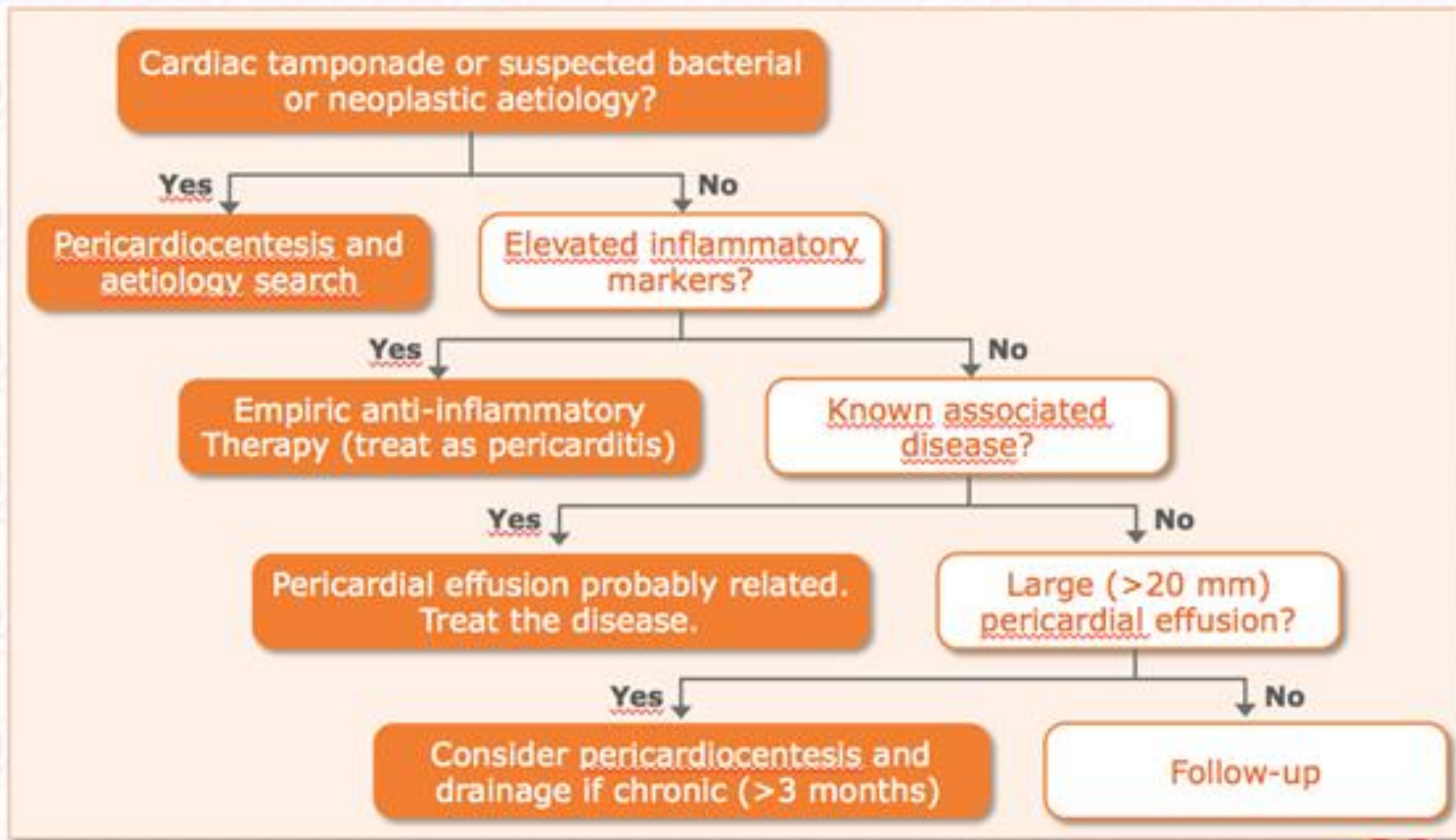
European Heart Journal (2015) - doi:10.1093/eurheartj/ehv318



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# A simplified algorithm for pericardial effusion triage and management



*Eur Heart J* 2013;34:1186-1197

[www.escardio.org](http://www.escardio.org)

*European Heart Journal* (2015) - doi:10.1093/eurheartj/ehv318



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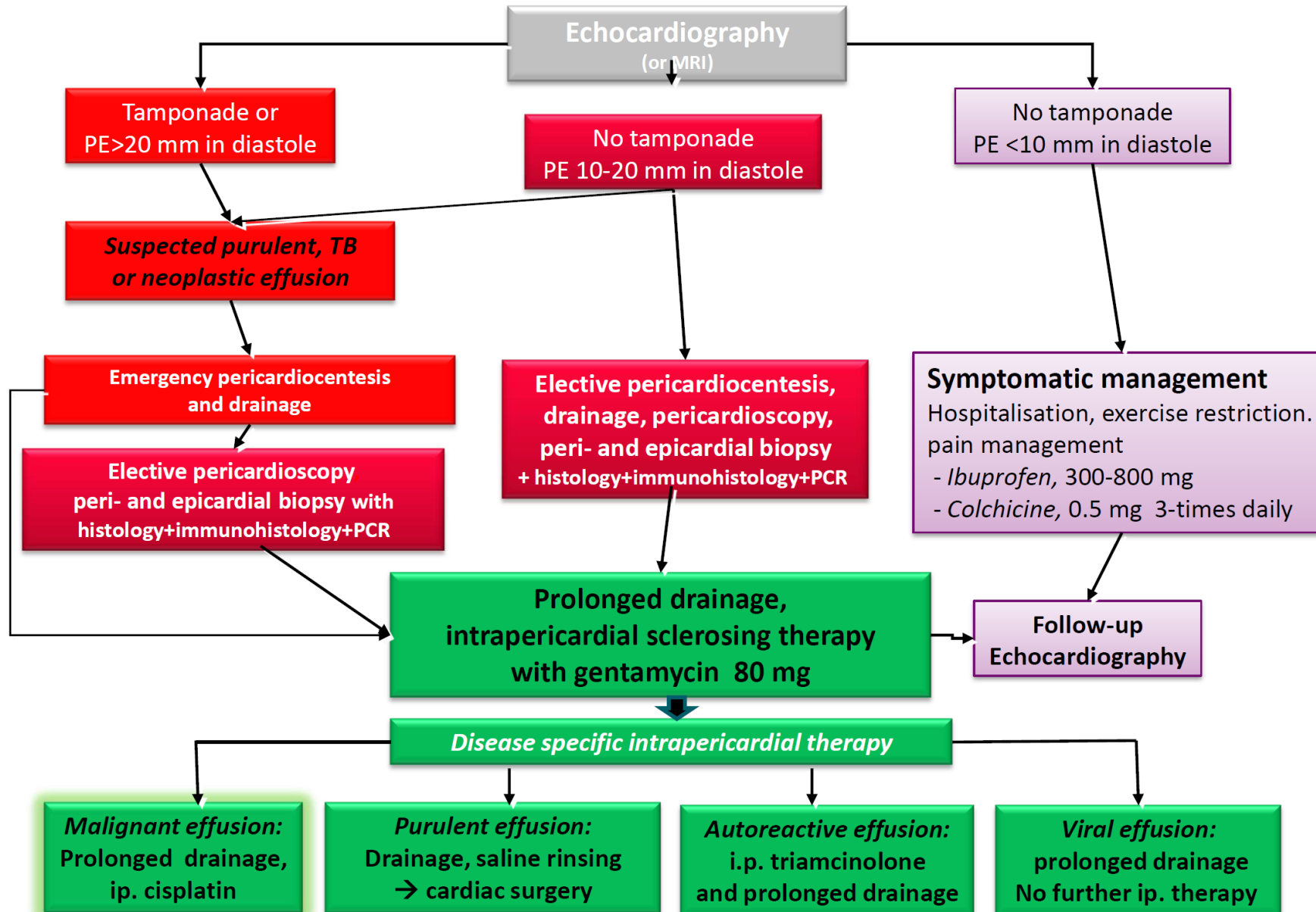
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## Pericardial involvement in neoplastic disease (1)

Recommendations	Class	Level
Pericardiocentesis is recommended for cardiac tamponade to relieve symptoms and establish the diagnosis of malignant pericardial effusion.	<b>I</b>	<b>B</b>
Cytological analyses of pericardial fluid are recommended for the confirmation of malignant pericardial disease.	<b>I</b>	<b>B</b>
Pericardial or epicardial biopsy should be considered for the confirmation of malignant pericardial disease.	<b>IIa</b>	<b>B</b>
Tumor marker testing should be considered for distinguishing malignant from benign effusions in pericardial fluid.	<b>IIa</b>	<b>B</b>
Systemic antineoplastic treatment is recommended in confirmed cases of neoplastic aetiology.	<b>I</b>	<b>B</b>
Extended pericardial drainage is recommended in patients with suspected or definite neoplastic pericardial effusion in order to prevent effusion recurrence and provide a way for intrapericardial therapy.	<b>I</b>	<b>B</b>

# Pericardial effusion: Diagnostic and therapeutic algorithms



Maisch B, Rupp H, Ristic A, Pankuweit S: Pericardioscopy ...in Heart Fail Rev 2013;18:317-328



# In conclusion

- Cardiac tamponade is clinical diagnosis which confirms by echocardiography
- Early RV diastolic collapse, RA and LA collapse, dilated IVC and Doppler features of “pulsus paradoxus” are echo features of tamponade
- Echo guided pericardiocentesis is a safe technique that can be done in bedside without the need of fluoroscopy
  - Agitated saline can confirm the needle in-situ at pericardial space (just like contrast)
- Prolonged pericardial drainage is recommended for malignancy related pericardial effusion to reduce future recurrence

