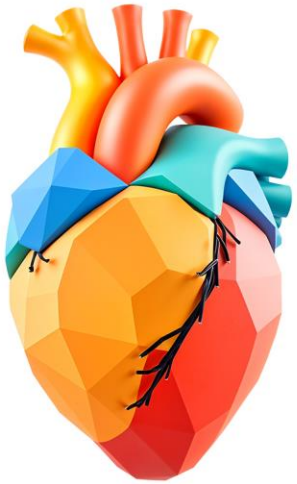

بسم الله الرحمن الرحیم



Critical Cardiovascular Care

دانشگاه علوم پزشکی و خدمات بهداشتی درمانی تهران

مرکز قلب تهران

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دوازدهمین کنگره سالیانه مرکز قلب تهران

2025

۲۵ و ۲۶ بهمن ماه ۱۴۰۳

13 & 14 February

Tehran Heart Center

Tehran, Iran

Echo's Pivotal Role in Diagnosing and Managing Acute Cardiac Tamponade Engaging Case based Discussion

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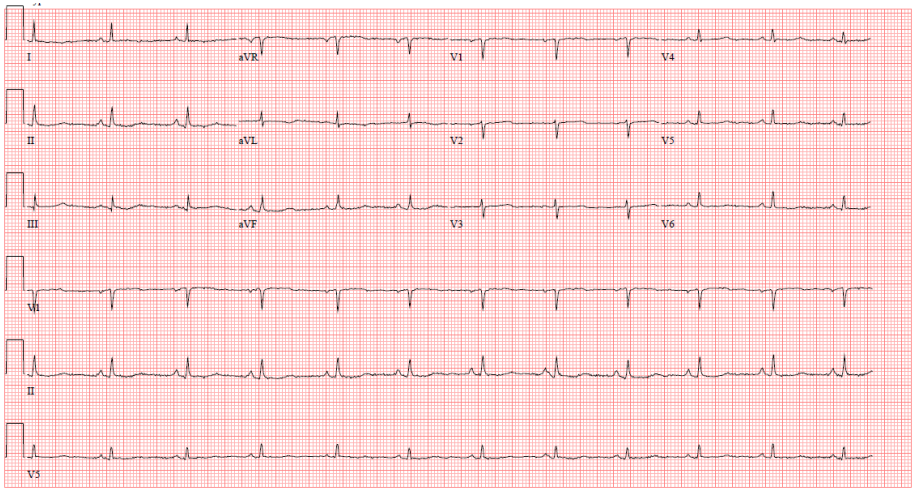
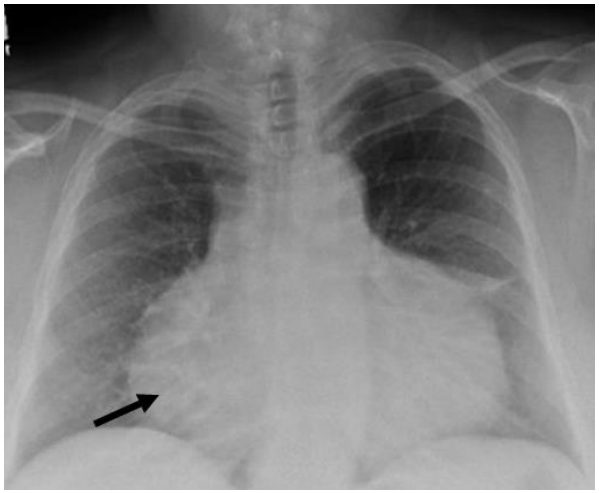
To Drain or Not to Drain, That is the Question

- A 57-year-old woman with a past medical history relevant for hypertension, obesity (BMI 32 kg/m2), tobacco abuse (20 pack years) and left hip osteoarthritis was admitted for a large asymptomatic pericardial effusion.
- The patient was scheduled to have a hip replacement for osteoarthritis and preoperative testing revealed she had low voltage on the preoperative electrocardiogram (EKG) and a "water bottle sign" on chest X ray.





- An echocardiogram was also performed which showed a posterior pericardial effusion adjacent to the left ventricle measuring 1.3 cm and anterior pericardial effusion adjacent to the right ventricle measuring 2.5 cm.
- The inferior vena cava was dilated at 2.7 cm, but compressibility could not be assessed due to suboptimal subcostal images.
- However, there were no other signs of tamponade. Specifically, there was no overt chamber collapse, and respiratory inflow variation across the mitral valve was 17.6% and across the tricuspid valve was 54%.

- Based on these findings, she was sent to the emergency department for further evaluation and management.
- The patient denied any chest pain, shortness of breath, palpitations, recent trauma, thoracic radiation, recent cardiac intervention, personal history of cancer or autoimmune diseases but reported 30 kg weight gain in the preceding 5 months.
- She was not very active recently due to her left hip pain and she spent most of the day in a wheelchair.
- Her temperature was 37 degrees Celsius, pulse was 78 beats per minute, respiratory rate was 18 breaths per minute and blood pressure was 136/85 mmHg.

- Her physical exam showed obesity, point of maximal impulse could not be palpated, regular heart rate and rhythm, normal S1 and S2 without a pericardial rub and no jugular venous distention, pulsus paradoxus, lower limb edema, thyromegaly or thyroid mass.
- She had normal kidney function, negative cardiac enzymes, hemoglobin of 15.1 g/dL, platelets of 405 k/uL, international normalized ratio of 1.0 (normal range: 0.8 - 1.2), ESR of 27 mm/hour (normal range: 0 - 20 mm/hour), thyroid stimulating hormone (TSH) of 104 uU/mL (normal range: 0.4 - 5.5 uU/mL) and a free thyroxine (T4) of 0.2 ng/dL (normal range: 0.9 - 1.7 ng/dL).

Which of the following is the best approach to the management of the patient's large pericardial effusion?

A Therapeutic pericardiocentesis is indicated at this stage because a large pericardial effusion can unpredictably cause clinical pericardial tamponade.

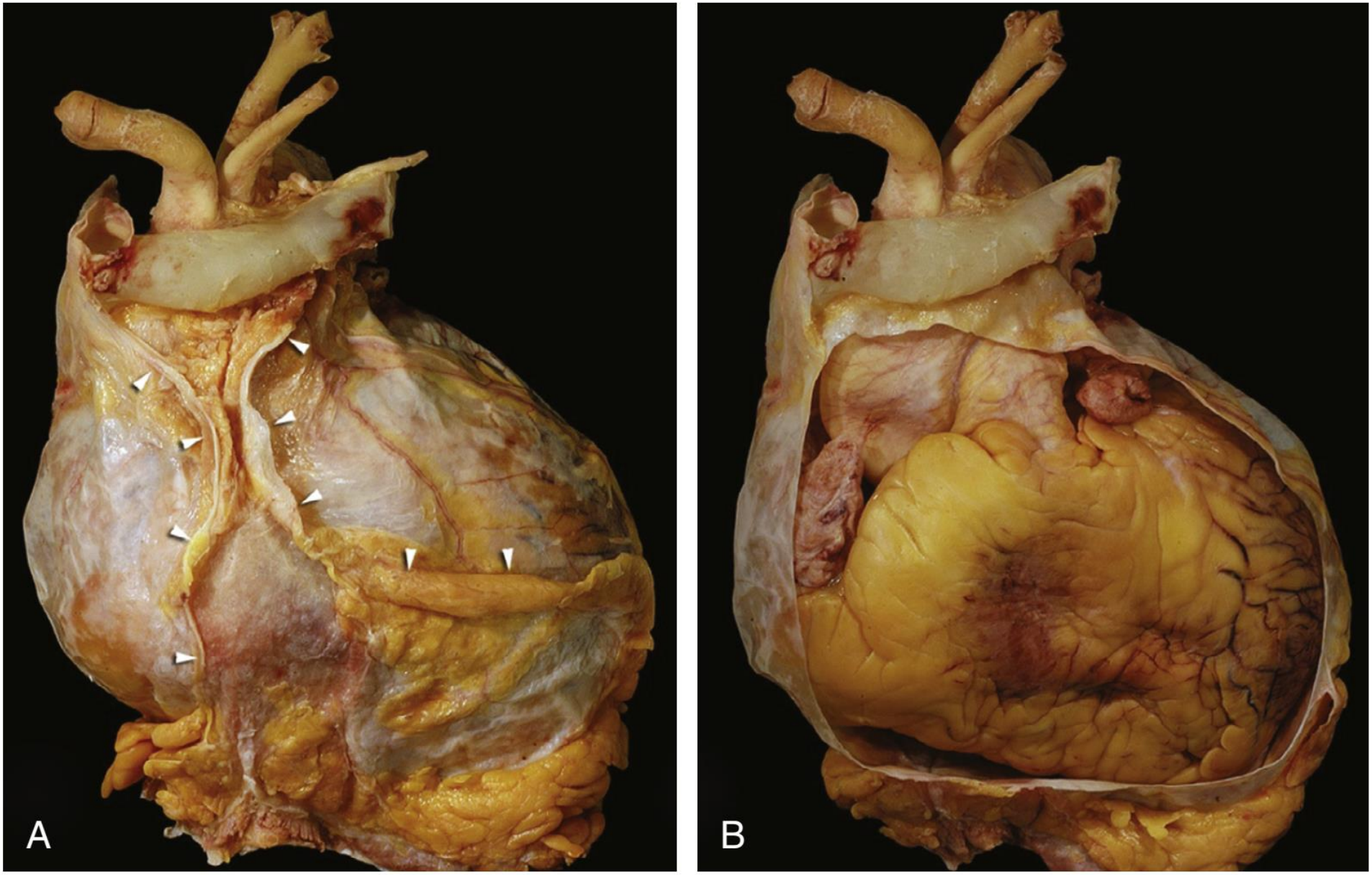
B This patient has a pericardial effusion secondary to an underlying known disease, therefore pericardiocentesis can be deferred and the underlying condition should be treated.

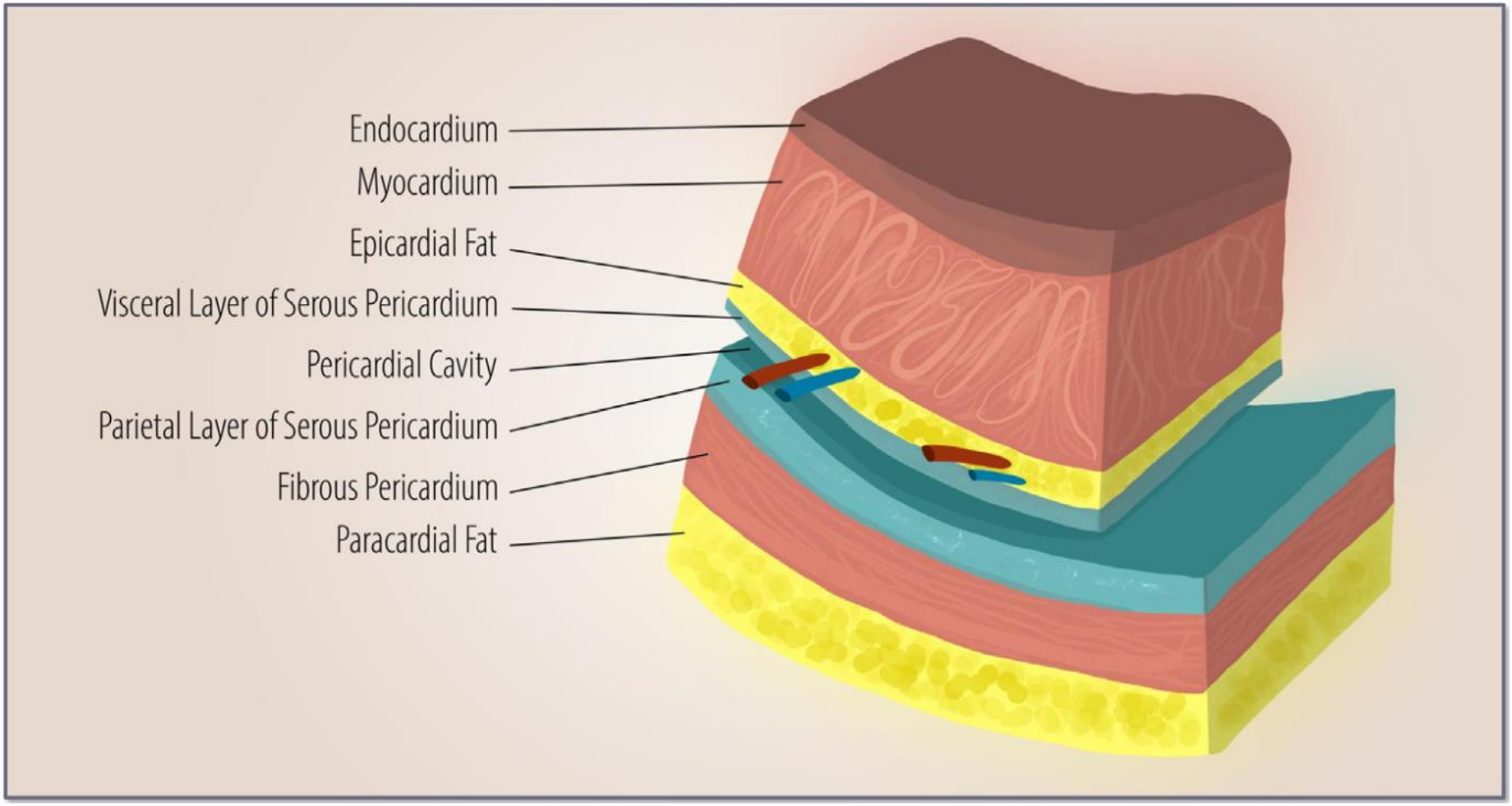
C Diagnostic pericardiocentesis should be done the next day if low risk and easily accessible percutaneously.

D Surgical drainage with pericardial window is indicated given the large effusion and risk for recurrence.

E A non-steroidal anti-inflammatory drug with colchicine should be trialed first in a large pericardial effusion.

Pericardium
Pericardial Effusion
Tamponade


A
B


Endocardium
Myocardium
Epicardial Fat
Visceral Layer of Serous Pericardium
Pericardial Cavity
Parietal Layer of Serous Pericardium
Fibrous Pericardium
Paracardial Fat

- The normal pericardial sac contains **10–50 ml** of pericardial fluid as a plasma ultrafiltrate that acts as a lubricant between the pericardial layers.
- Any pathological process usually causes an **inflammation** with the possibility of increased production of pericardial fluid **(exudate).**
- An alternative mechanism of accumulation of pericardial fluid may be **decreased reabsorption** due to a general increase in systemic venous pressure as a result of **congestive heart failure or pulmonary hypertension (transudate).**

- A significant proportion of patients with pericardial effusion are asymptomatic.
- Large idiopathic chronic effusions (>3 months) have a 30–35% risk of progression to cardiac tamponade.

- Etiology in developed countries:
  - Idiopathic: up to 50%
  - Cancer: 10–25%
  - Infections: 15–30%
  - Iatrogenic: 15–20%
  - Connective tissue diseases: 5–15%

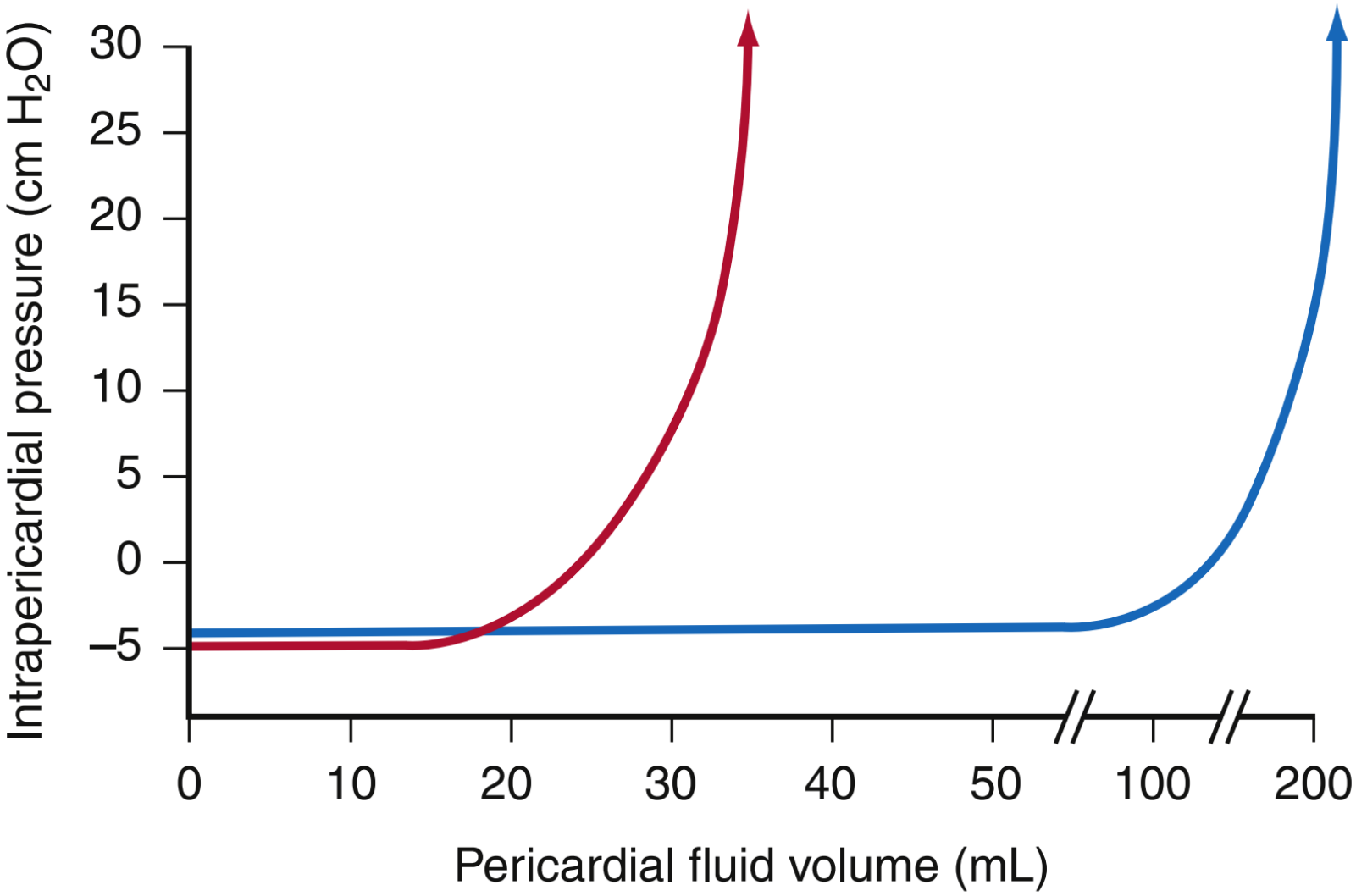
- Etiology in developing countries endemic for TB:
  - TB: 60%

Classification of pericardial effusion

Onset	**Acute (< 1 week)** **Subacute (1 week – 3 months)** **Chronic (>3 months)**
Size	**Trivial <5mm (<10mm only in systole)** **Mild <10 mm** **Moderate 10–20mm** **Large >20 mm** **Very large >25mm**
Distribution	**Circumferential** **Loculated**
Composition	**Transudate** **Exudate** **Blood**
Hemodynamic impact	**None** **cardiac tamponade** **effusive-constrictive**

Tamponade

- **2 components**
  - **Pericardial effusion**
  - **Impairment of cardiac filling because of pericardial effusion pressure on cardiac chambers**


Intrapericardial pressure (cm H_2O)
30
25
20
15
10
5
0
–5
0
10
20
30
40
50
100
200
Pericardial fluid volume (mL)

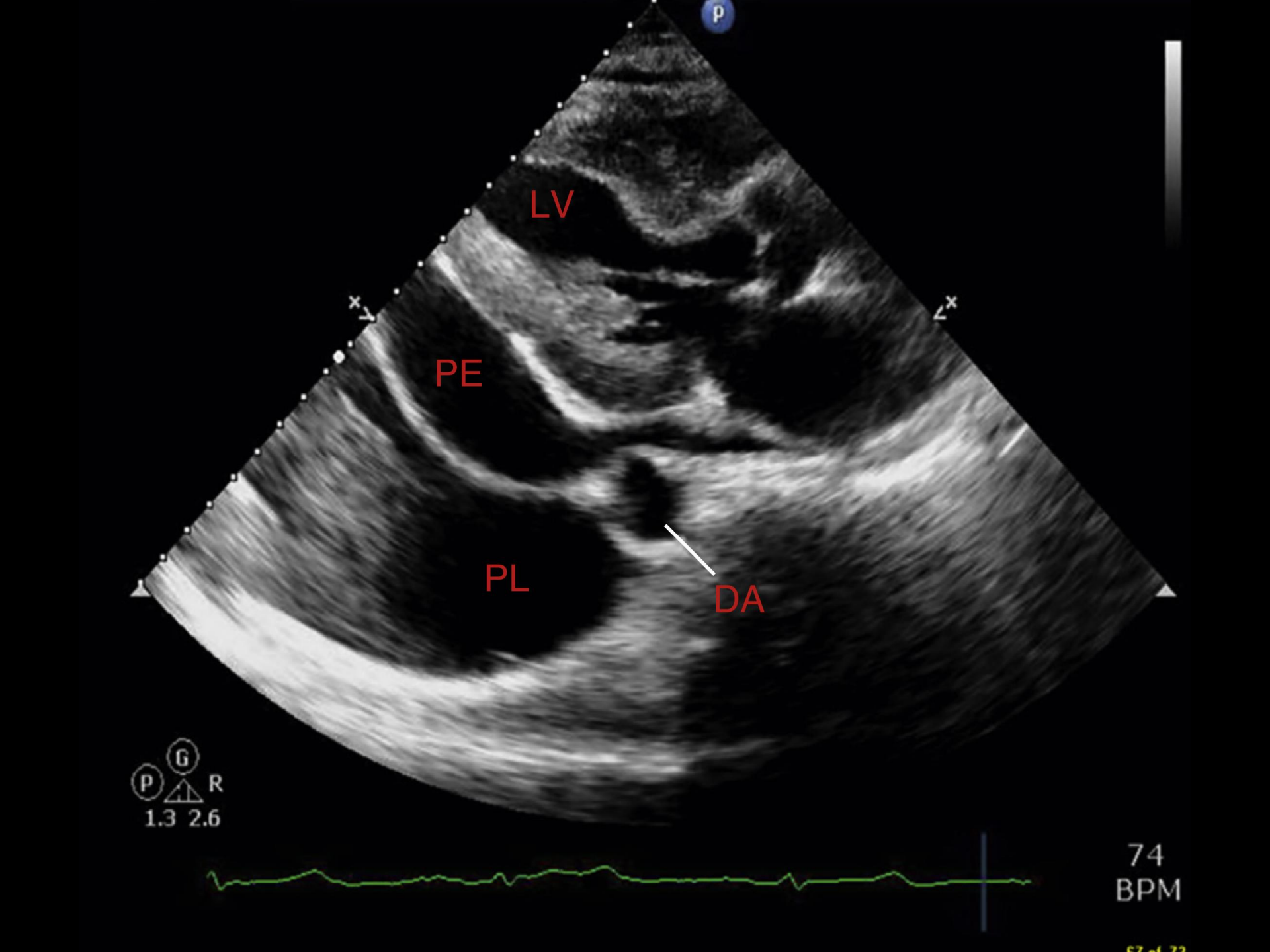
Echocardiography

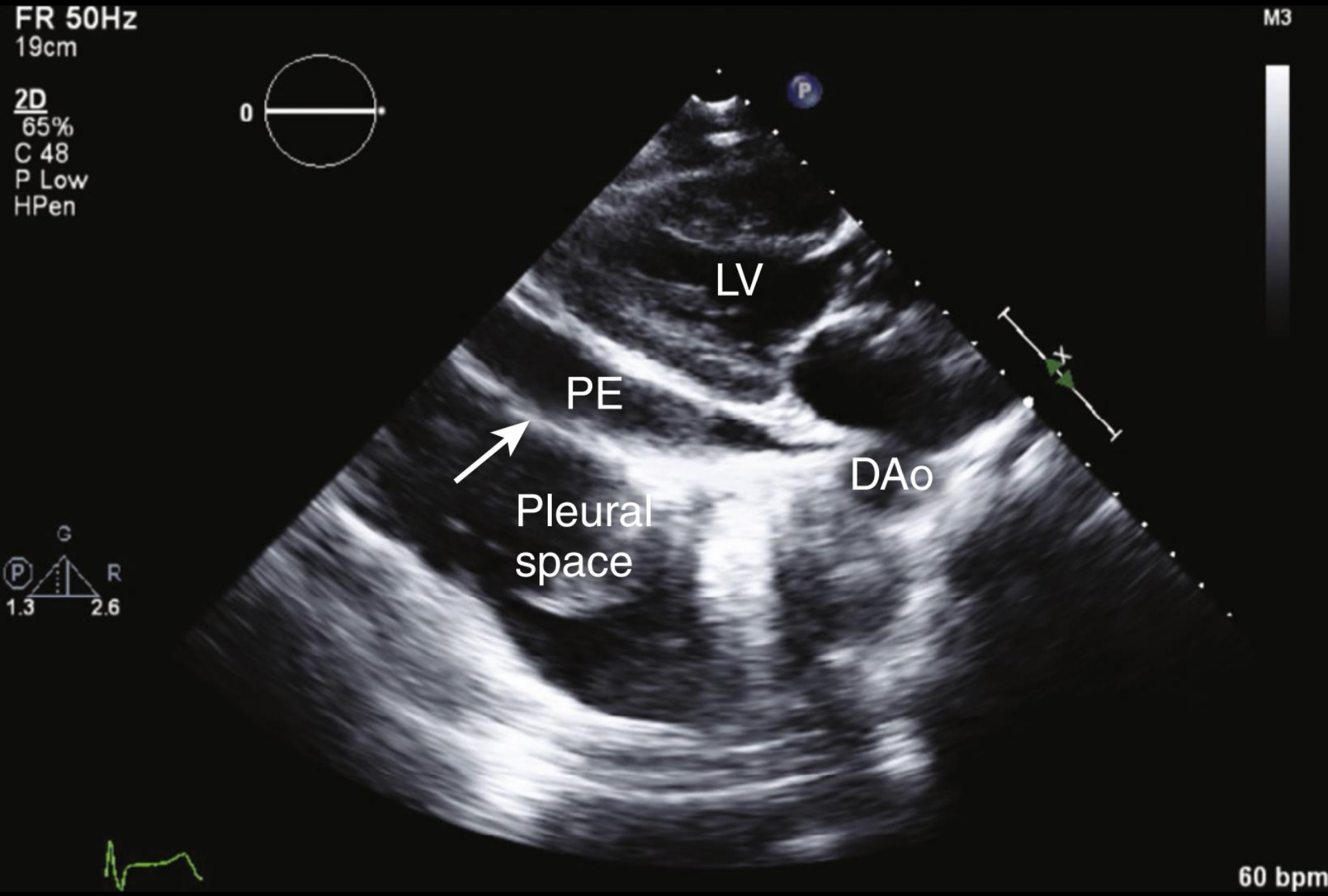
Pericardial effusion

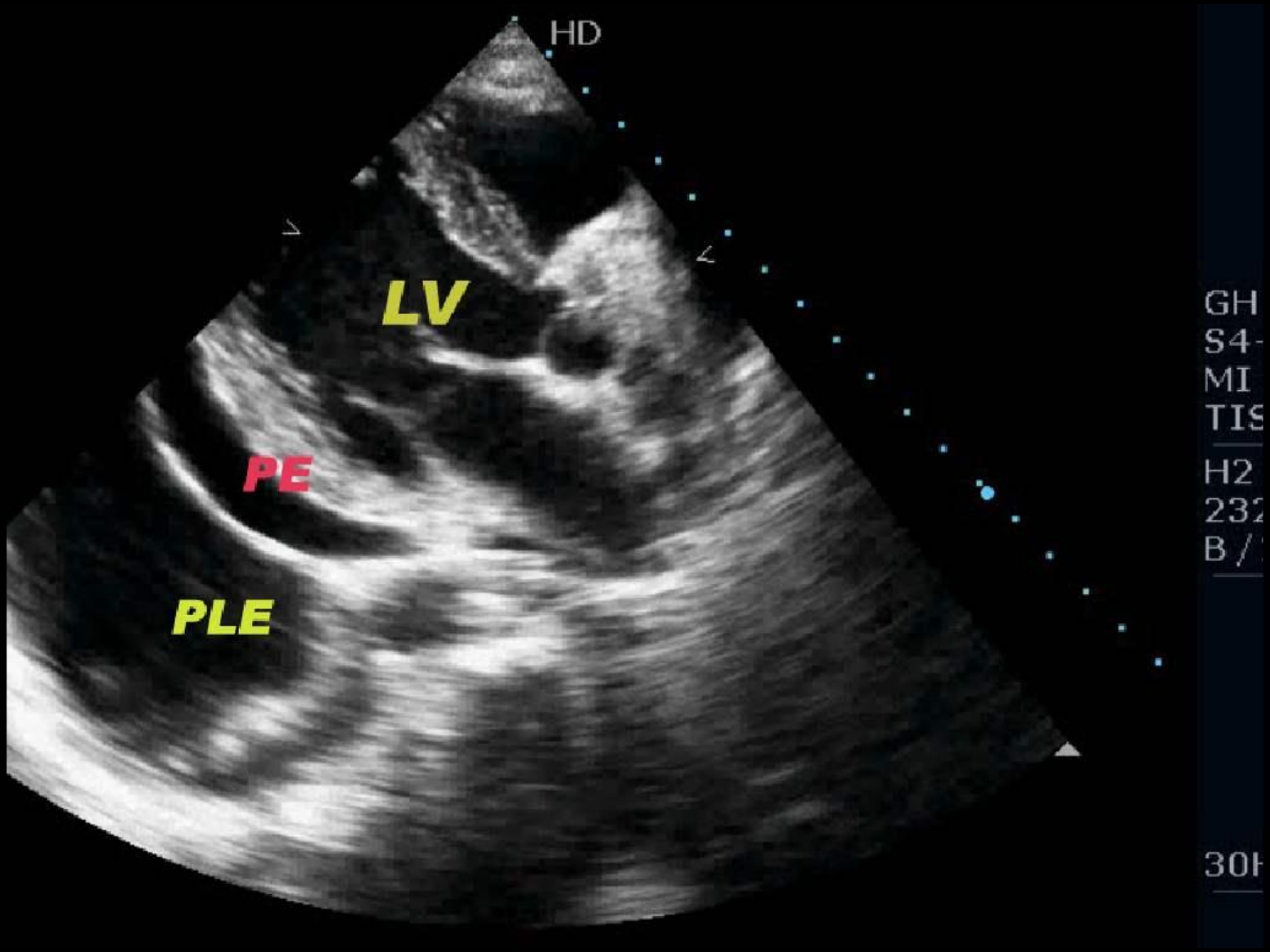
- A pericardial effusion appears as an echo-lucent space between the epicardium and parietal pericardium.
- When evident only in systole, a physiologic or trivial amount of fluid is present.
- When evident throughout the cardiac cycle, a greater than physiologic (>50 mL) amount of fluid is present.
-

Differential diagnosis of pericardial effusion

- **Left pleural effusion:**
- **May mimic a posterior pericardial effusion.**
- **The key to differentiation: relationship of the fluid to the descending thoracic aorta from the parasternal imaging window**
- **Pericardial fluid tracks anterior to the aorta, whereas pleural fluid does not**

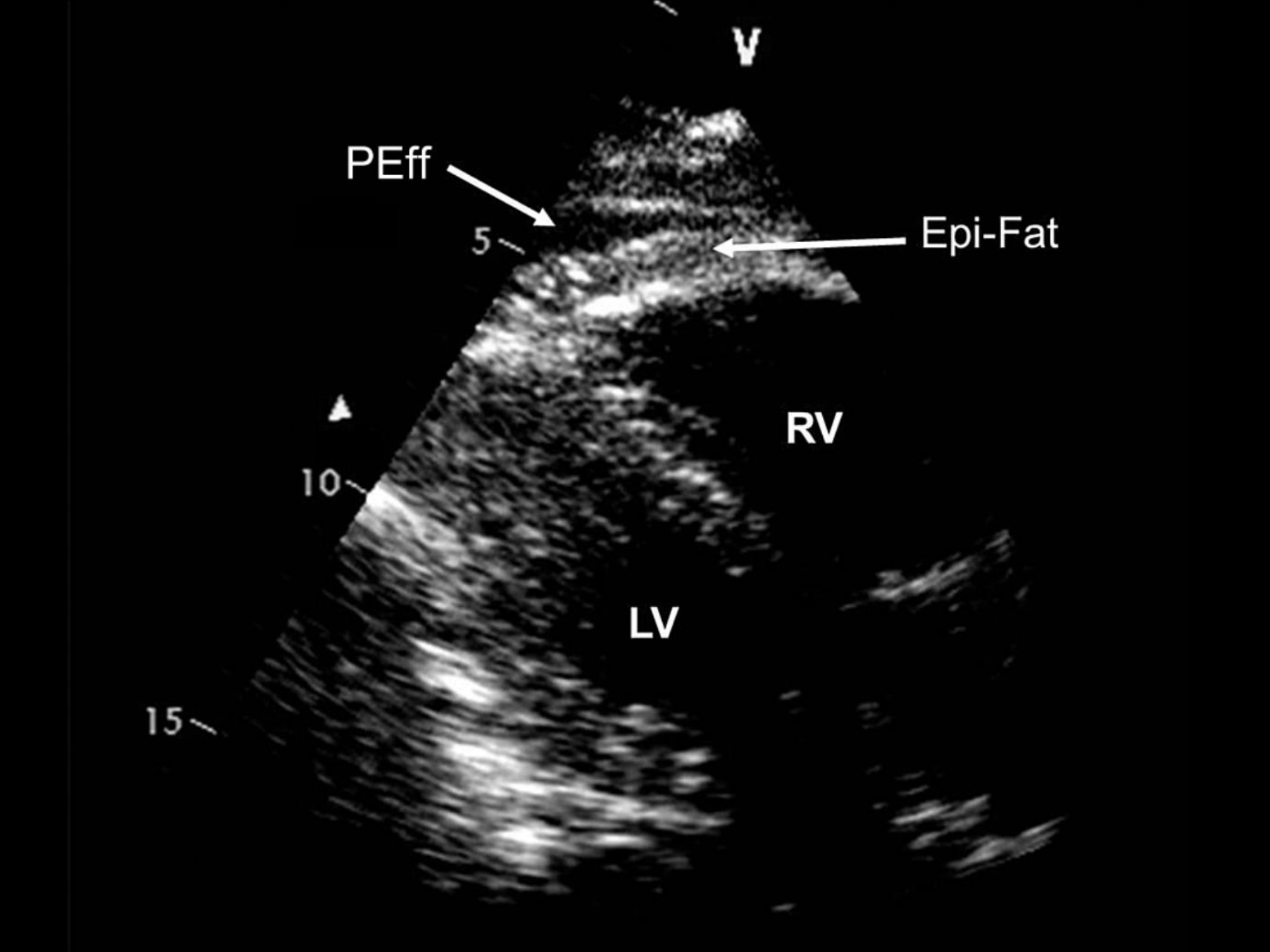

LV
PE
PL
DA
P
G
P
R
1.3 2.6
74
BPM


FR 50Hz
19cm
2D
65%
C 48
P Low
HPen
M3
LV
PE
Pleural
space
DAo
1.3
2.6
60 bpm


HD
LV
PE
PLE

Differential diagnosis of pericardial effusion

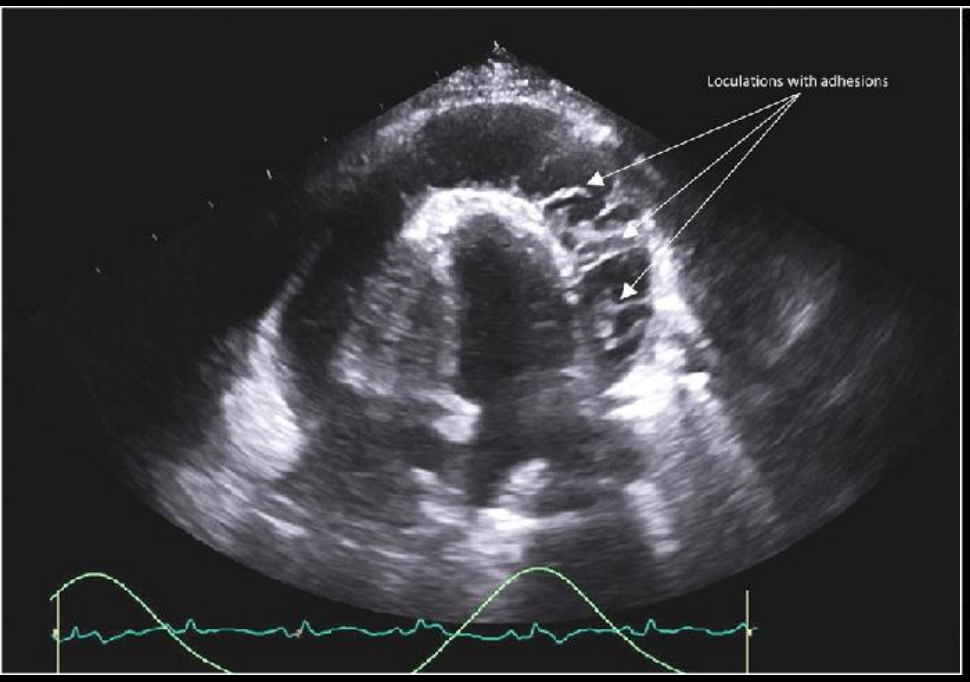
- **Epicardial fat:**
- **Echo-bright appearance**
- **Movement in concert with the myocardium**
- **Uniform in thickness**
- **Mostly seen in anterior side in PLAX view**

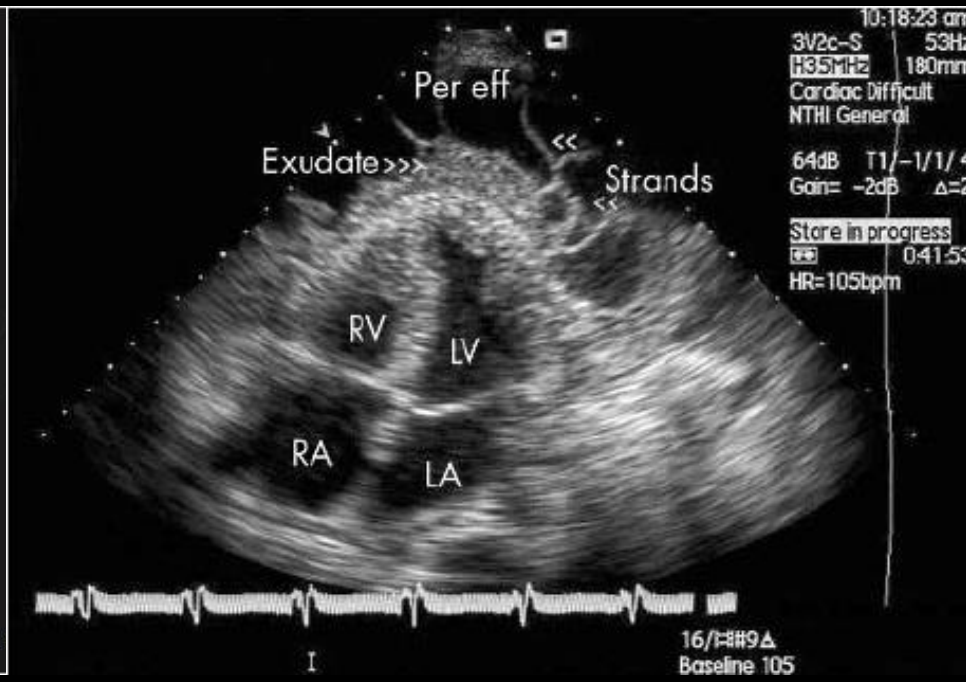

PEff
Epi-Fat
RV
LV
5
10
15

Exudative Vs. Transudative PE

- **Transudative pericardial effusion:** Echo-lucent appearance

- **Exudative Pericardial effusion:** Mostly contains strands or adhesions
  - Echo-lucent appearance does not rule out exudative PE

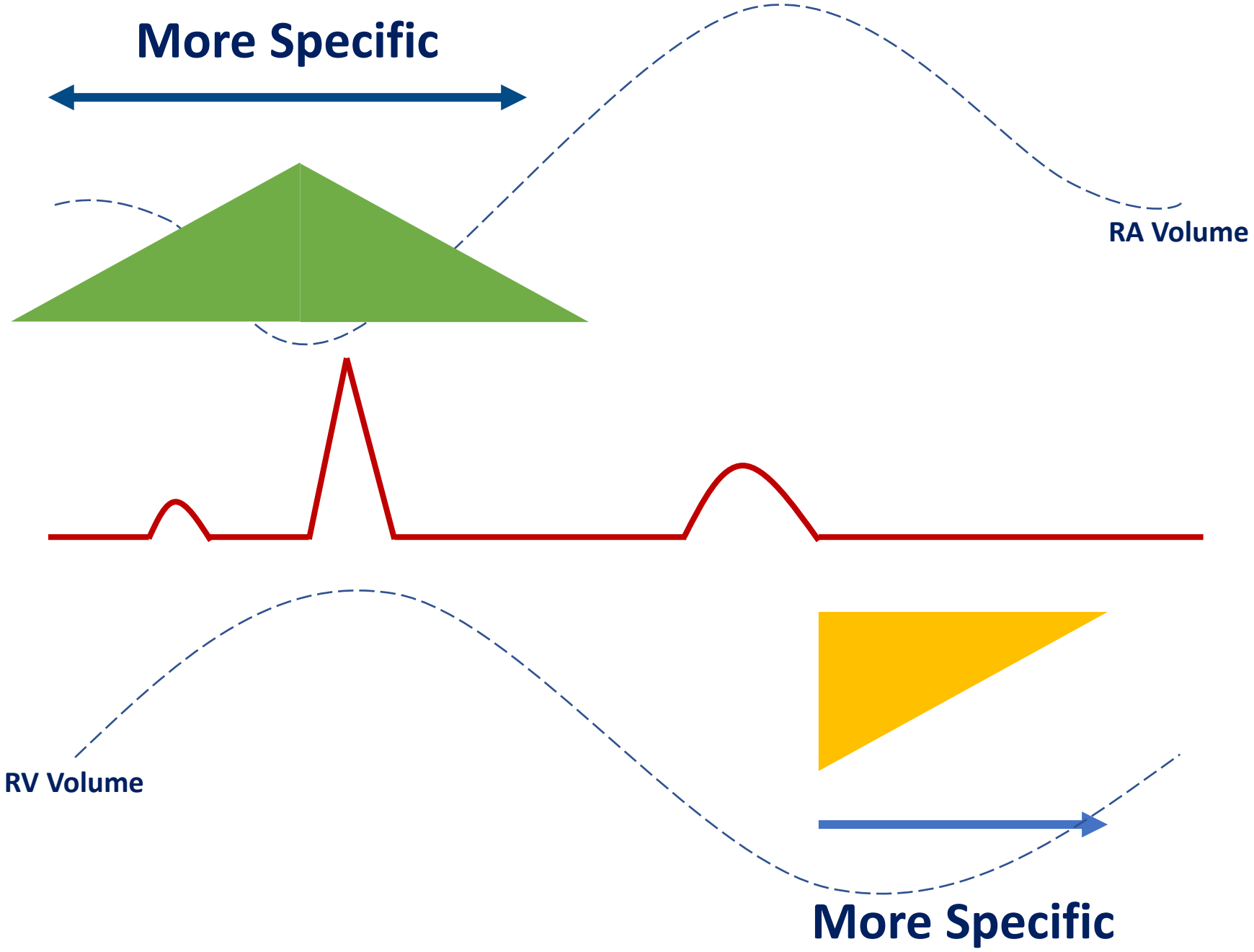

Loculations with adhesions


Per eff
Exudate>>>
Strands
RV
LV
RA
LA
3V2c-S
Cardiac Difficult
NTHI General
Store in progress
HR=105bpm
Baseline 105

Tamponade

Chamber Collapse (Compression, Inversion)

- **Collapse occurs when the chamber pressure is in lower than pericardial fluid pressure.**


More Specific
RA Volume
RV Volume
More Specific

RA collapse:

- More than $^{1}/_{3}$ of cardiac cycle
  - Sensitivity: 94%
  - Specificity: 100%

- Decrease reliability:
  - RA hypertension
  - Ventricular pacing

RV collapse:

- Less sensitive, more specific than RA collapse

- Initially most evident during expiration
- It can be observed throughout the respiratory cycle as tamponade becomes more severe

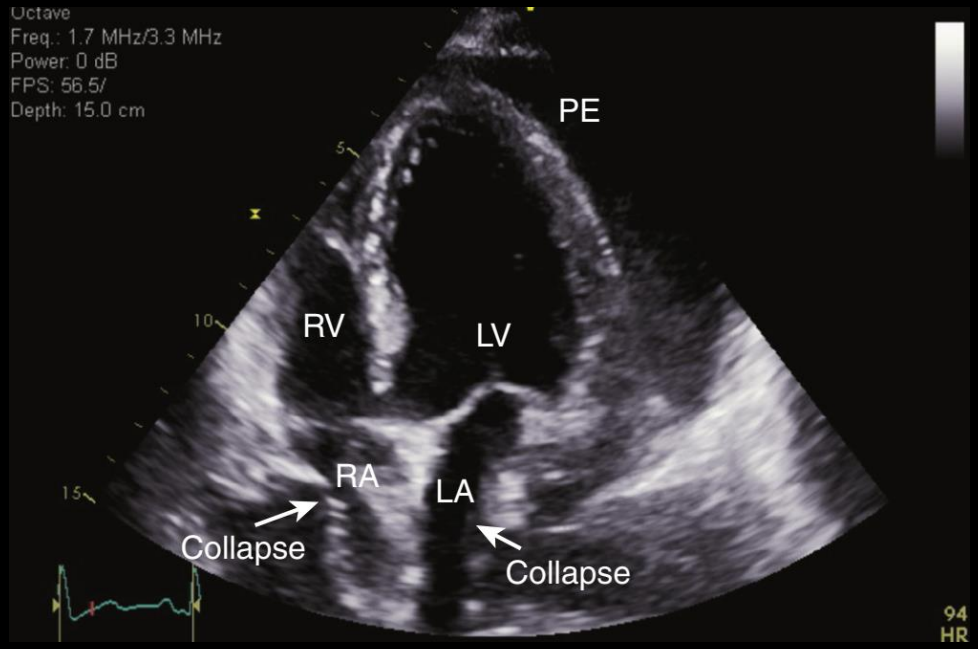
- Decrease reliability:
  - RV pressure overload (PH)
  - RV volume overload (ASD)

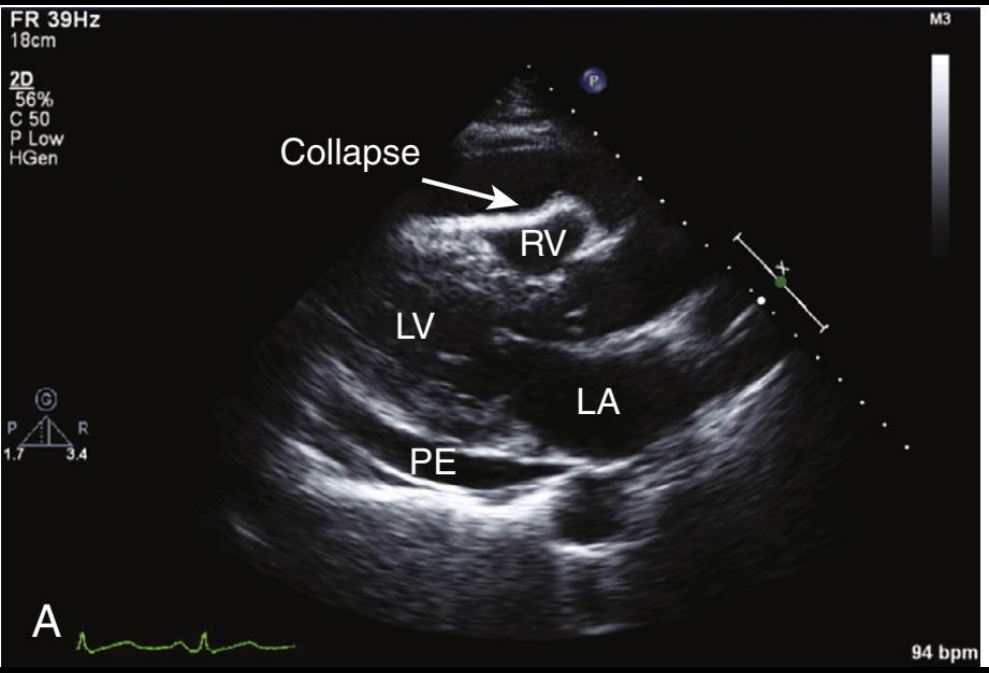
LA collapse:

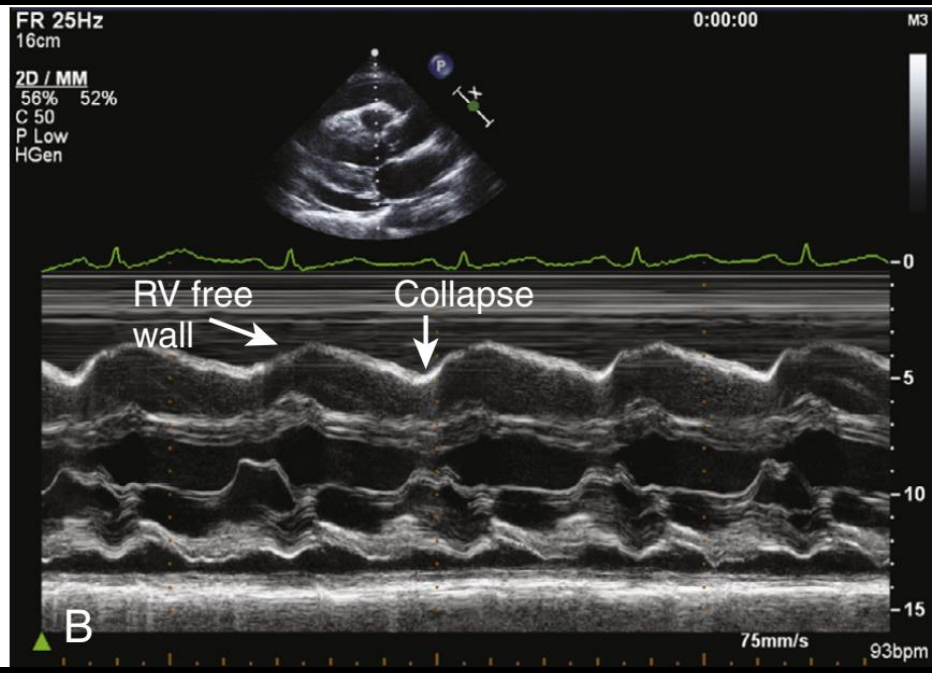
- Less sensitive, more specific than RA collapse
- The only chamber collapse evident in cases of tamponade with pulmonary hypertension
- Regional tamponade after trauma or cardiac surgery.

LV collapse:

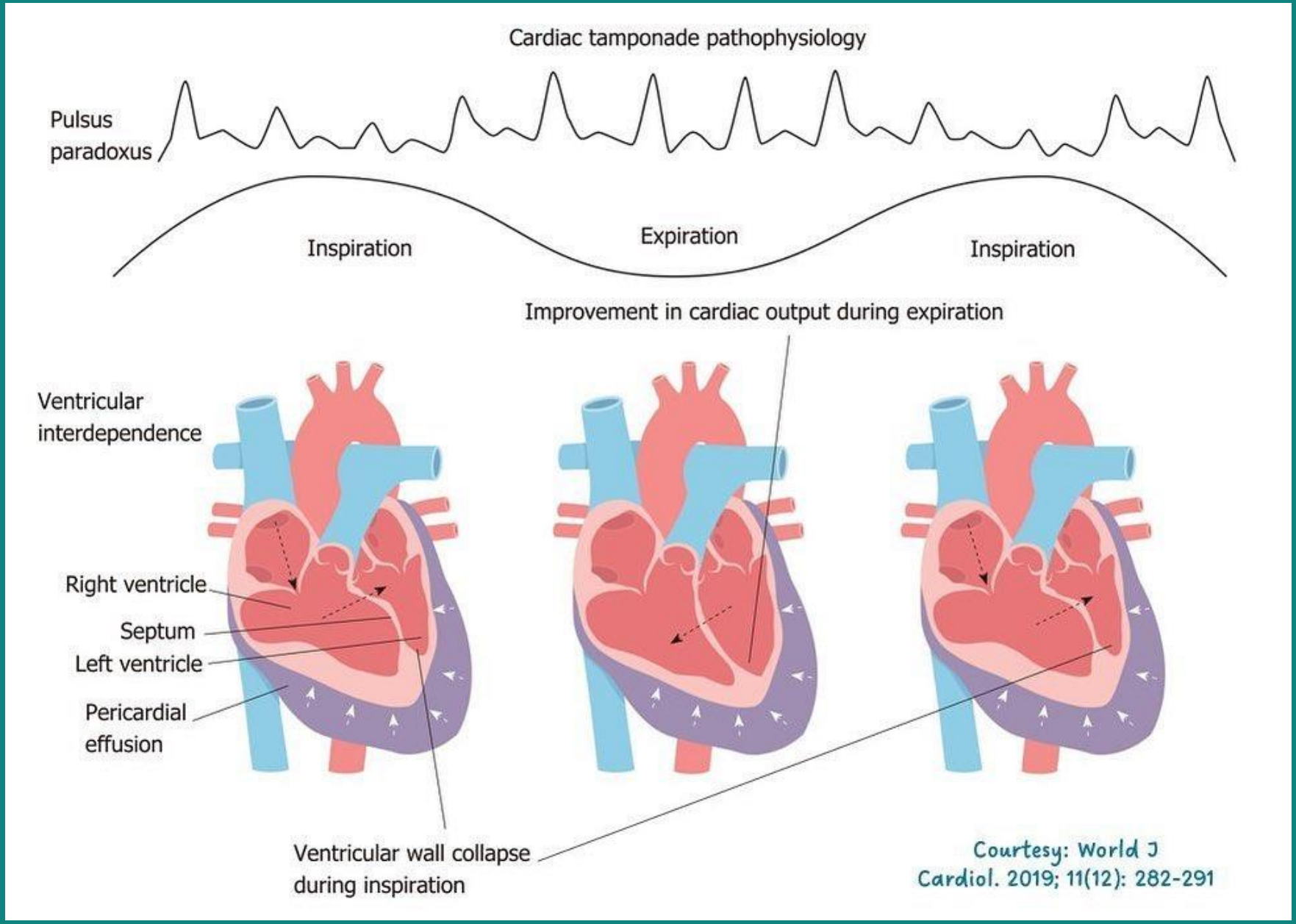
- Regional tamponade after trauma or cardiac surgery.


Octave
Freq.: 1.7 MHz/3.3 MHz
Power: 0 dB
FPS: 56.5/
Depth: 15.0 cm
PE
RV
LV
RA
LA
Collapse
Collapse
94
HR

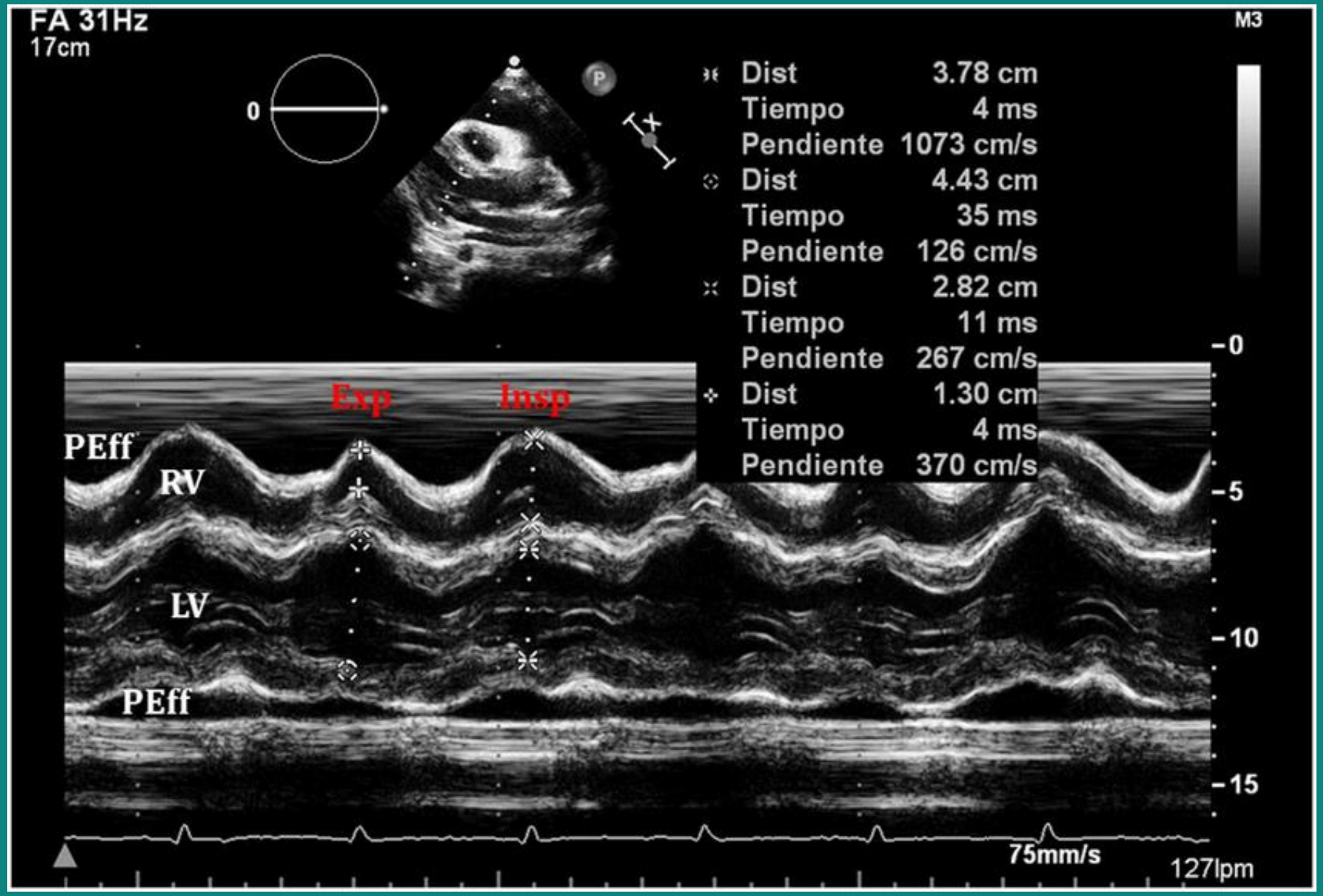

FR 39Hz
18cm
M3
2D
56%
C 50
P Low
HGen
Collapse
RV
LV
LA
PE
A
94 bpm


FR 25Hz
16cm
0:00:00
M3
2D / MM
56% 52%
C 50
P Low
HGen
RV free wall
Collapse
0
5
10
15
B
75mm/s
93bpm

Increased ventricular interdependence (enhanced ventricular interaction)


Cardiac tamponade pathophysiology
Pulsus paradoxus
Inspiration
Expiration
Inspiration
Improvement in cardiac output during expiration
Ventricular interdependence
Right ventricle
Septum
Left ventricle
Pericardial effusion
Ventricular wall collapse during inspiration
Courtesy: World J Cardiol. 2019; 11(12): 282-291

	Inspiration	Expiration
RV size		
LV size		
TV flow		
MV flow		


FA 31Hz
17cm
M3
0
P
Dist 3.78 cm
Tiempo 4 ms
Pendiente 1073 cm/s
Dist 4.43 cm
Tiempo 35 ms
Pendiente 126 cm/s
Dist 2.82 cm
Tiempo 11 ms
Pendiente 267 cm/s
Dist 1.30 cm
Tiempo 4 ms
Pendiente 370 cm/s
Exp
Insp
PEff
RV
LV
PEff
0
5
10
15
75mm/s
127lpm

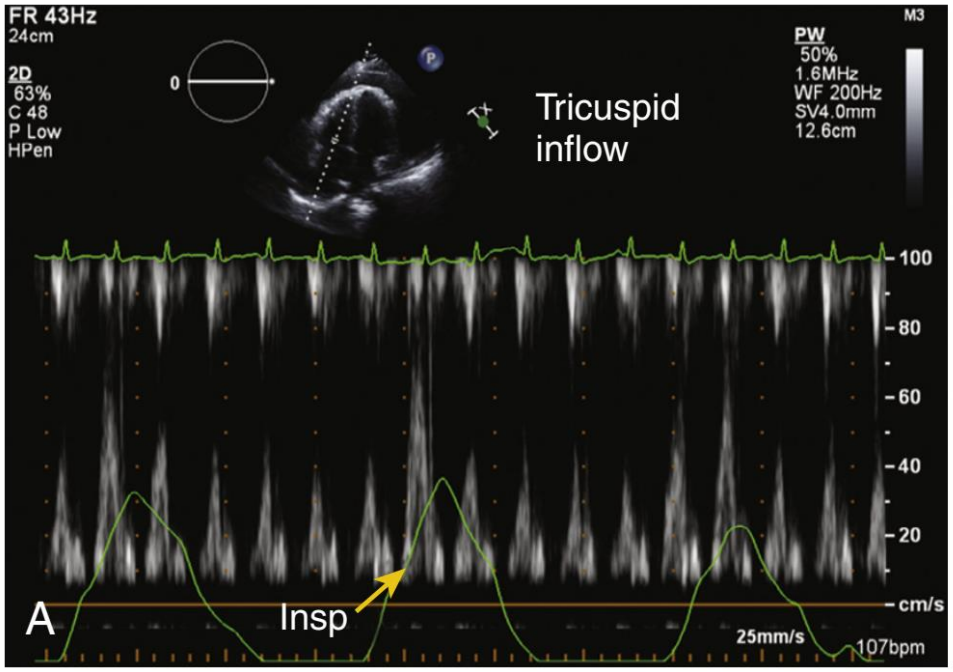
Increased respiratory variation in MV and TV

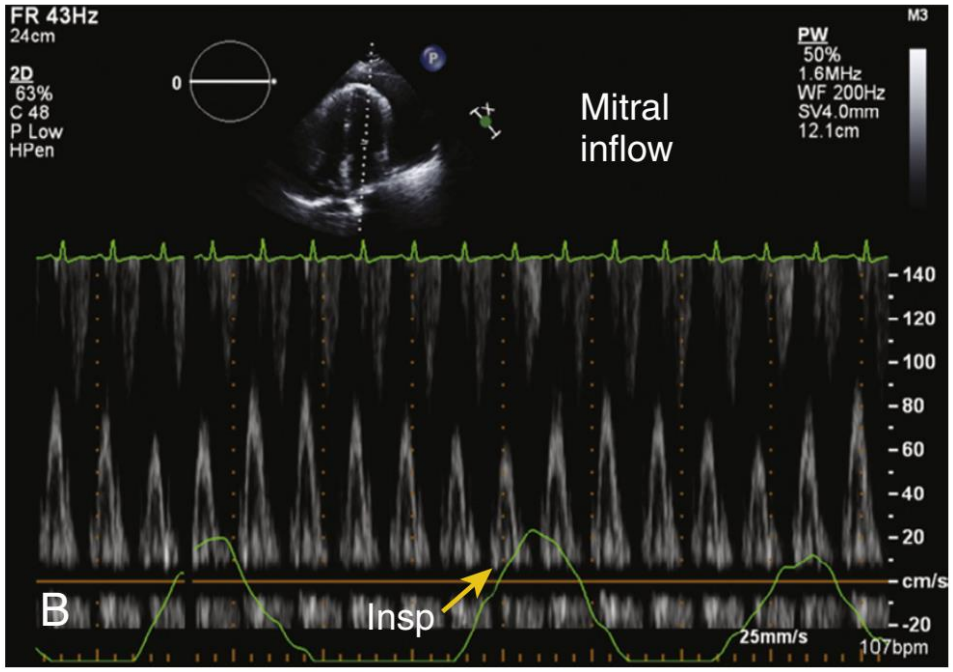
(expiratory velocity – inspiratory velocity)/ expiratory velocity × 100

Significant change for:

TV > 60% **MV > 30%**

- The first beats of expiration and inspiration should be considered

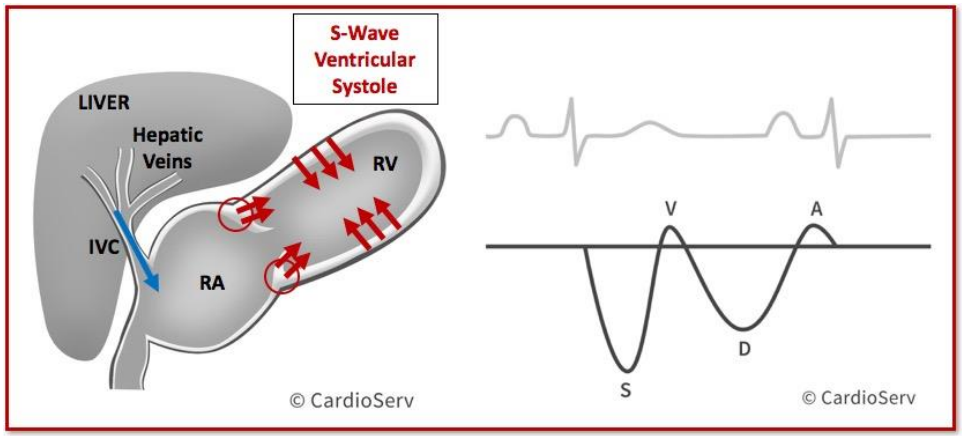

FR 43Hz
24cm
2D
63%
C 48
P Low
HPen
PW
50%
1.6MHz
WF 200Hz
SV4.0mm
12.6cm
M3
Tricuspid inflow
100
80
60
40
20
cm/s
A
Insp
25mm/s
107bpm

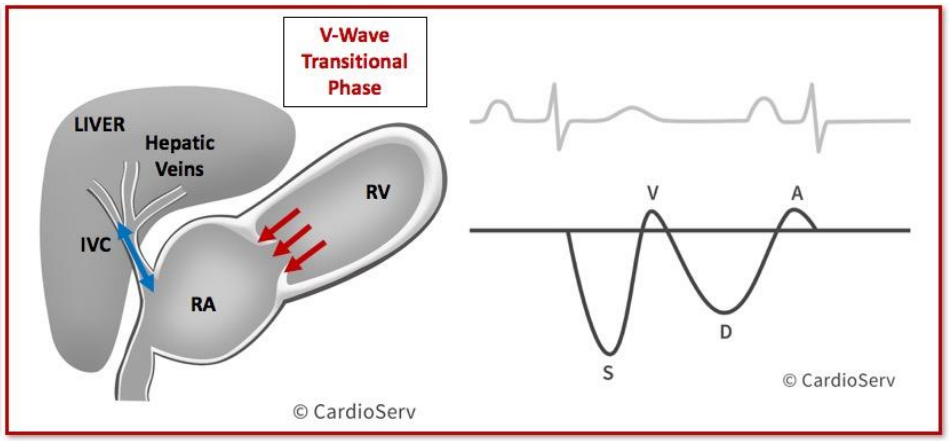

FR 43Hz
24cm
2D
63%
C 48
P Low
HPen
PW
50%
1.6MHz
WF 200Hz
SV4.0mm
12.1cm
M3
Mitral inflow
140
120
100
80
60
40
20
cm/s
-20
B
Insp
25mm/s
107bpm

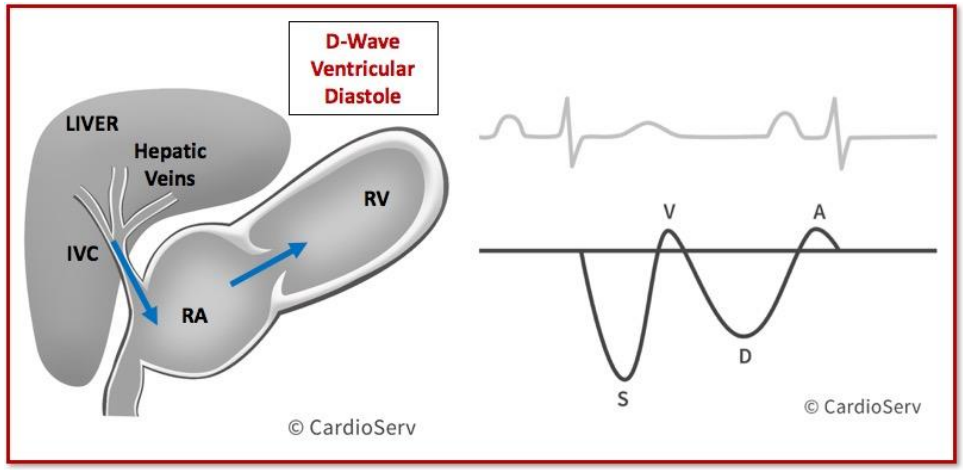
IVC plethora

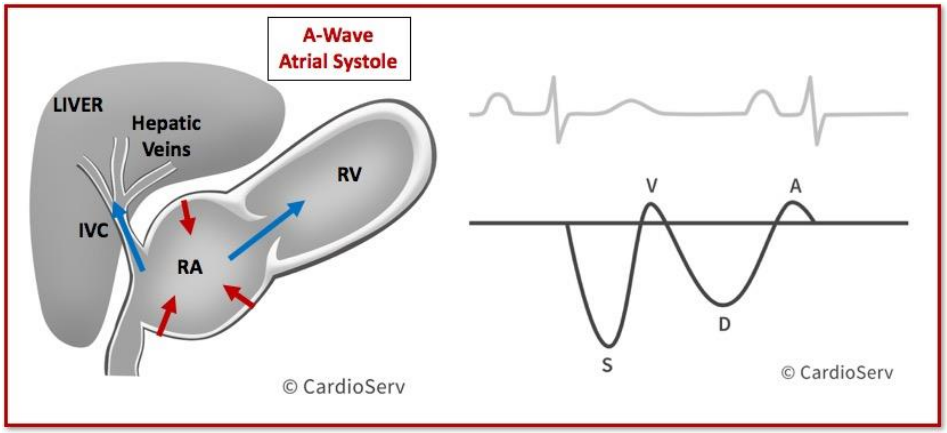
- Highly sensitive (97%) for tamponade
- No specific for tamponade

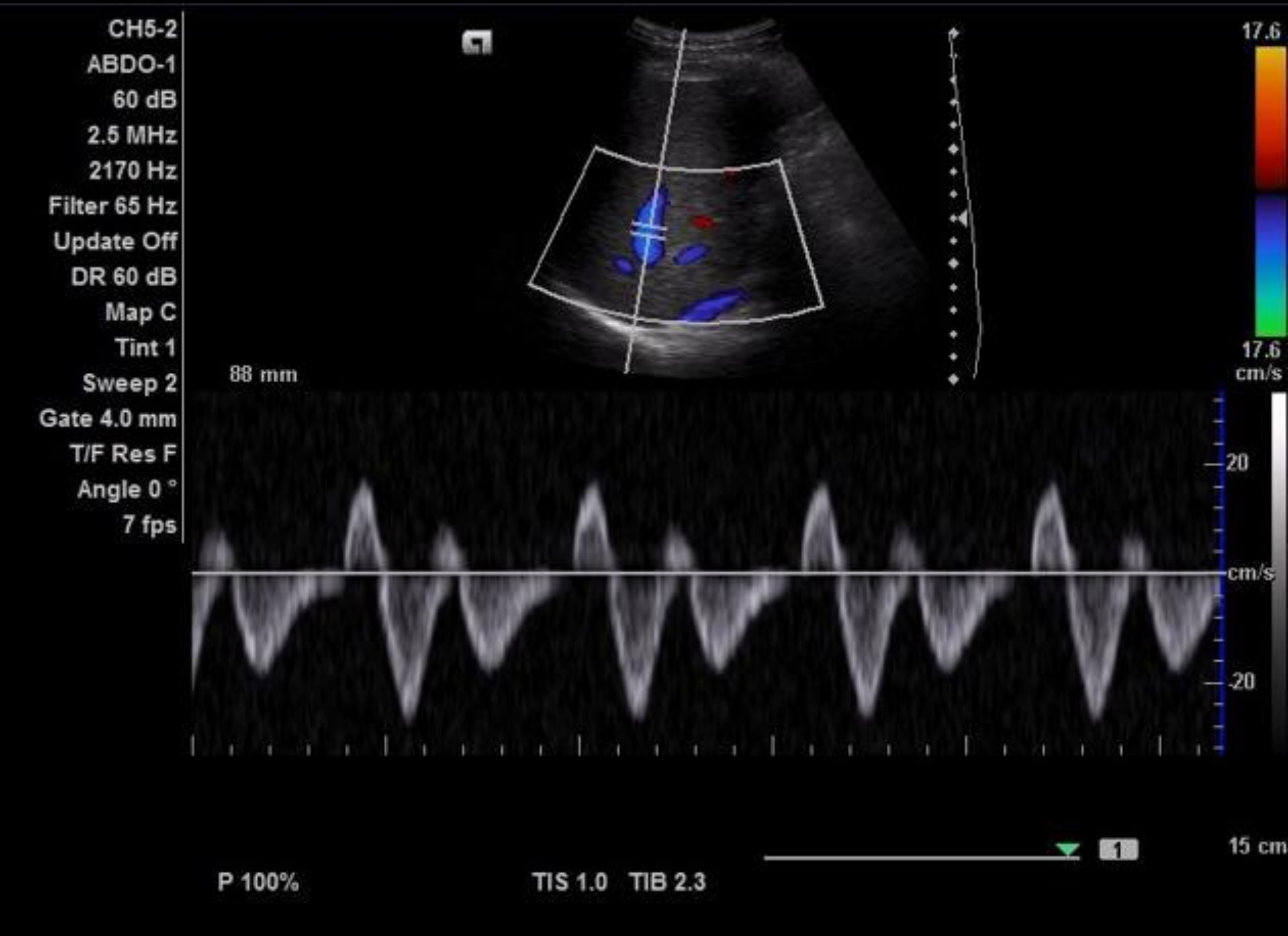
Hepatic vein flow pattern


S-Wave
Ventricular
Systole
LIVER
Hepatic
Veins
RV
IVC
RA
V
A
D
S
© CardioServ
© CardioServ


V-Wave
Transitional
Phase
LIVER
Hepatic
Veins
RV
IVC
RA
V
A
D
S
© CardioServ
© CardioServ


D-Wave
Ventricular
Diastole
LIVER
Hepatic
Veins
RV
IVC
RA
V
A
D
S
© CardioServ
© CardioServ


A-Wave
Atrial Systole
LIVER
Hepatic
Veins
RV
IVC
RA
V
A
D
S
© CardioServ
© CardioServ


CH5-2
ABDO-1
60 dB
2.5 MHz
2170 Hz
Filter 65 Hz
Update Off
DR 60 dB
Map C
Tint 1
Sweep 2
Gate 4.0 mm
T/F Res F
Angle 0 °
7 fps
88 mm
17.6
17.6
cm/s
20
cm/s
-20
1
15 cm
P 100%
TIS 1.0 TIB 2.3

- Systolic hepatic vein forward flow is predominant.
- Tamponade progression: hepatic vein diastolic forward flow diminishes and ultimately becomes undetectable by Doppler.
- With the onset of expiration, when left heart filling is favored at the expense of the right, hepatic vein diastolic forward flow markedly decreases or reverses.

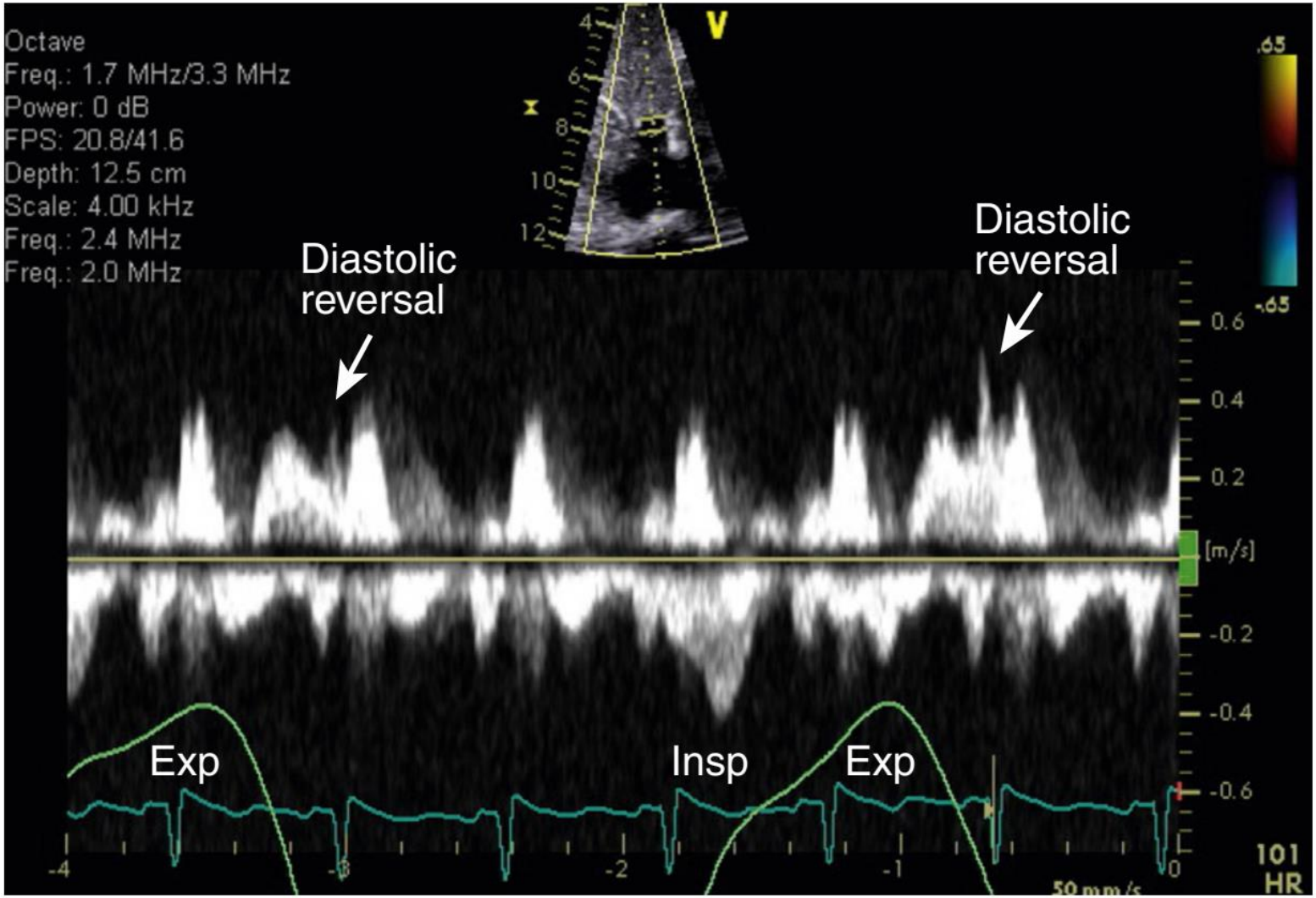


Fig. 17.20 Hepatic venous Doppler profile in tamponade. Inspiration *(Insp)* leads to augmentation of hepatic vein forward velocity. With the onset of expiration *(Exp)*, when left heart filling is favored at the expense of the right, hepatic vein diastolic forward flow reverses as indicated.

TABLE 17.4 Test Performance Characteristics for Echocardiographic Findings in Tamponade.

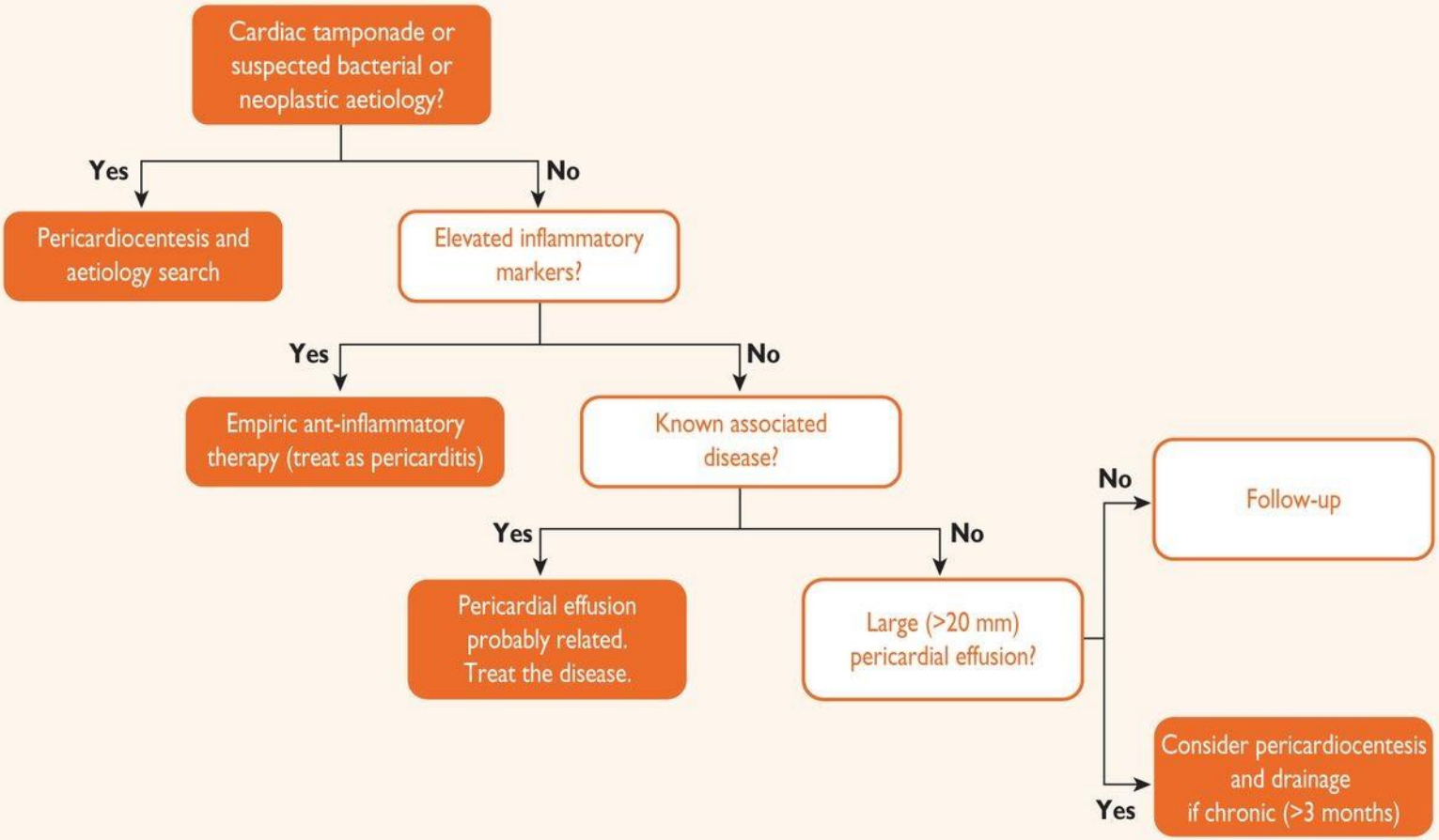
Characteristic	*Sensitivity (%)*	*Specificity (%)*
Any collapse	90	65
RA collapse	68	66
RV collapse	60	90
RA + RV collapse	45	92
Abnormal venous flow[a]	75	91
Abnormal venous flow + 1 collapse	67	91
Abnormal venous flow + 2 collapses	37	98

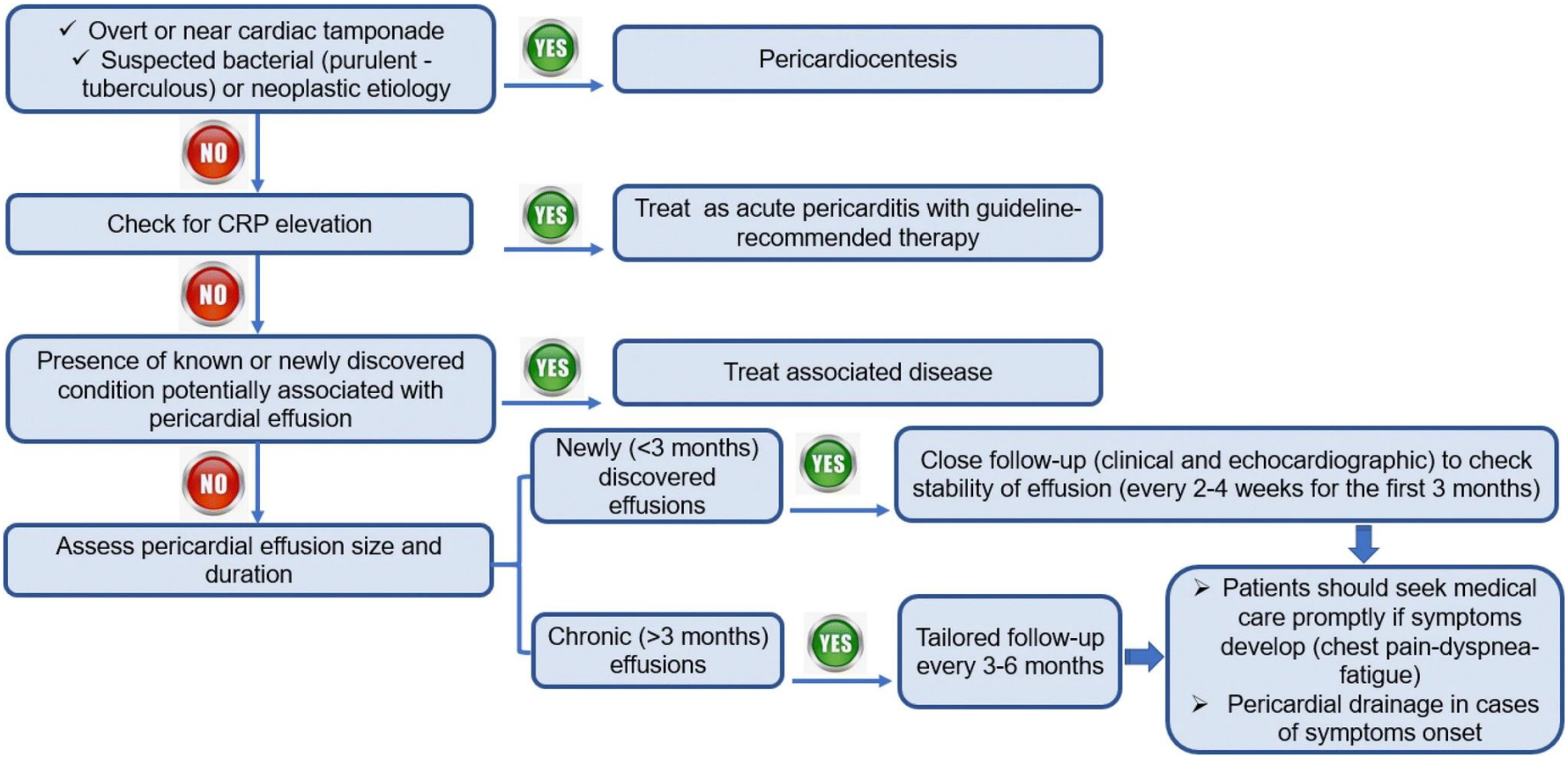
[a]Abnormal venous (hepatic vein or superior vena cava) flow defined as marked systolic over diastolic component, expiratory accentuation of this difference, and expiratory reversal of diastolic flow.

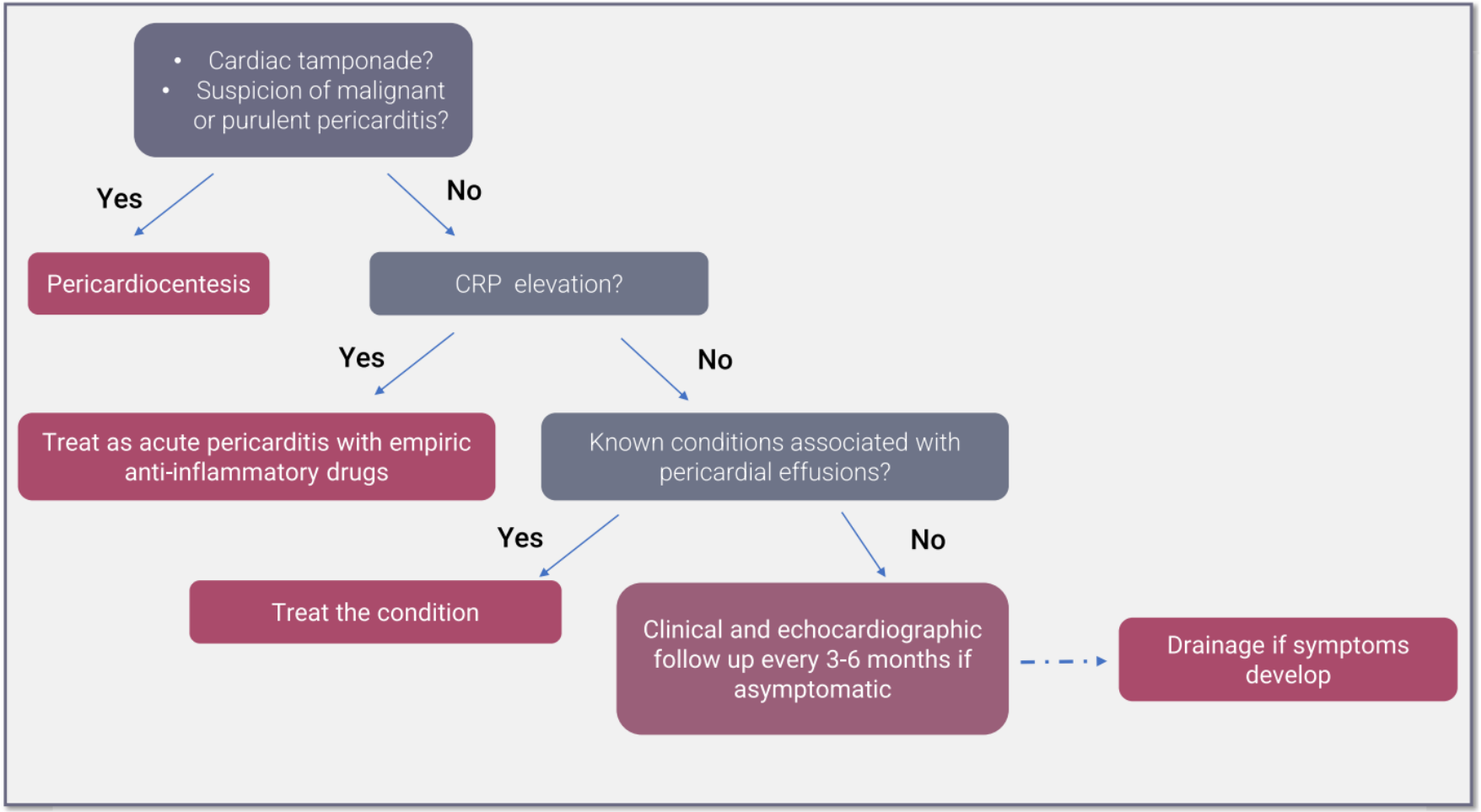
REGIONAL TAMPONADE

- Most likely occur after cardiac surgery.
- Typical clinical and echocardiographic findings may be absent.
- A high index of clinical suspicion is essential.

Empiric anti-inflammatory therapies should be considered if a missed diagnosis of pericarditis is presumed.




✓ Overt or near cardiac tamponade
✓ Suspected bacterial (purulent - tuberculous) or neoplastic etiology
YES
Pericardiocentesis
NO
Check for CRP elevation
YES
Treat as acute pericarditis with guideline-recommended therapy
NO
Presence of known or newly discovered condition potentially associated with pericardial effusion
YES
Treat associated disease
NO
Assess pericardial effusion size and duration
Newly (<3 months) discovered effusions
YES
Close follow-up (clinical and echocardiographic) to check stability of effusion (every 2-4 weeks for the first 3 months)
Chronic (>3 months) effusions
YES
Tailored follow-up every 3-6 months
➢ Patients should seek medical care promptly if symptoms develop (chest pain-dyspnea-fatigue)
➢ Pericardial drainage in cases of symptoms onset


• Cardiac tamponade?
• Suspicion of malignant or purulent pericarditis?
Yes
No
Pericardiocentesis
CRP elevation?
Yes
No
Treat as acute pericarditis with empiric anti-inflammatory drugs
Known conditions associated with pericardial effusions?
Yes
No
Treat the condition
Clinical and echocardiographic follow up every 3-6 months if asymptomatic
Drainage if symptoms develop

EVIDENCE OF CARDIAC TAMPONADE

STEP 1
SCORE THE ETIOLOGY

1. Malignant disease	2
2. Tuberculosis[1]	2
3. Recent radiotherapy[2]	1
4. Recent viral infection	1
5. Recurrent PE, previous pericardiocentesis	1
6. Chronic terminal renal failure[3]	1
7. Immunodeficiency or immunosupression	1
8. Hypo- or hyperthyroidism	-1
9. Systemic autoimmune disease	-1

+

STEP 2
SCORE THE CLINICAL PRESENTATION

1. Dyspnea / Tachypnea	1
2. Orthopnea (NO rales on lung auscultation)	3
3. Hypotension (SBP<95 mmHg)	0.5
4. Progressive sinus tachycardia (in the absence of medications afecting HR, hypothyreosis and uremia)	1
5. Oliguria	1
6. Pulsus paradoxus >10 mmHg	2
7. Pericardial chest pain	0.5
8. Pericardial friction rub	0.5
9. Rapid worsening of symptoms	2
10. Slow evolution of the disease	-1

+

STEP 3
SCORE THE IMAGING

1. Cardiomegaly on chest x-ray	1
2. Electrical alternans on ECG	0.5
3. Microvoltage in ECG	1
4. Circumferential PE (>2 cm in diastole)[4]	3
5. Moderate PE (1-2 cm in diastole)	1
6. Small PE (<1 cm in diastole), no trauma	-1
7. Right atrial collapse >1/3 of cardiac cycle	1
8. IVC >2.5 cm, <50% inspiratory collapse	1.5
9. Right ventricular collapse	1.5
10. Left atrial collapse	2
11. Mitral/tricuspid respiratory flow variations	1
12. Swinging heart	1

Σ

CALCULATE THE CUMULATIVE SCORE (SUM OF SCORES FROM STEPS 1+2+3)

URGENT SURGICAL MANAGEMENT (REGARDLESS OF THE SCORE)
1. Type A aortic dissection
2. Ventricular free wall rupture after acute myocardial infarction[5]
3. Severe recent chest trauma
4. Iatrogenic hemopericardium when the bleeding cannot be controlled percutaneously

SCORE ≥6

<6

URGENT PERICARDIOCENTESIS
(IMMEDIATELY AFTER CONTRAINDICATIONS[6] ARE RULED-OUT)

PERICARDIOCENTESIS CAN BE POSTPONED
(for up to 12/48h)

EVIDENCE OF CARDIAC TAMPONADE

STEP 1
SCORE THE ETIOLOGY

1. Malignant disease	2
2. Tuberculosis[1]	2
3. Recent radiotherapy[2]	1
4. Recent viral infection	1
5. Recurrent PE, previous pericardiocentesis	1
6. Chronic terminal renal failure[3]	1
7. Immunodeficiency or immunosupression	1
8. Hypo- or hyperthyroidism	-1
9. Systemic autoimmune disease	-1

+

STEP 2
SCORE THE CLINICAL PRESENTATION

1. Dyspnea / Tachypnea	1
2. Orthopnea (NO rales on lung auscultation)	3
3. Hypotension (SBP<95 mmHg)	0.5
4. Progressive sinus tachycardia (in the absence of medications afecting HR, hypothyreosis and uremia)	1
5. Oliguria	1
6. Pulsus paradoxus >10 mmHg	2
7. Pericardial chest pain	0.5
8. Pericardial friction rub	0.5
9. Rapid worsening of symptoms	2
10. Slow evolution of the disease	-1

+

STEP 3

SCORE THE IMAGING

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Σ

CALCULATE THE CUMULATIVE SCORE (SUM OF SCORES FROM STEPS 1+2+3)

URGENT SURGICAL MANAGEMENT (REGARDLESS OF THE SCORE)

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URGENT PERICARDIOCENTESIS

(IMMEDIATELY AFTER CONTRAINDICATIONS[6] ARE RULED-OUT)

PERICARDIOCENTESIS CAN BE POSTPONED

(for up to 12/48h)

Which of the following is the best approach to the management of the patient's large pericardial effusion?

A Therapeutic pericardiocentesis is indicated at this stage because a large pericardial effusion can unpredictably cause clinical pericardial tamponade.

B This patient has a pericardial effusion secondary to an underlying known disease, therefore pericardiocentesis can be deferred and the underlying condition should be treated.

C Diagnostic pericardiocentesis should be done the next day if low risk and easily accessible percutaneously.

D Surgical drainage with pericardial window is indicated given the large effusion and risk for recurrence.

E A non-steroidal anti-inflammatory drug with colchicine should be trialed first in a large pericardial effusion.

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Thanks for your Attention