



# Cardiology: Diseases of the Pericardium for USMLE Step One

Part I: Overview and Acute Pericarditis

Part II: Tamponade and Constrictive Pericarditis

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# Cardiology: Diseases of the Pericardium for USMLE Step One



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# The Language of Pericardial Disorders

Acute  
Pericarditis

(Cardiac)  
Tamponade  
Physiology

Constrictive  
Pericarditis

- Virtually all patients will be described with positional chest pain
- '3-phase' friction rub

- Shock
- Pulsus Paradoxus

- Pericardial Knock/Pericardial Calcification
- Predisposing condition (e.g. Radiation Therapy)
- Kussmaul's Sign

# Cardiac Tamponade

- When to suspect?
  - **Pulsus Paradoxus** (JVD, hypotension = Beck's Triad)
  - Transmural AWTMI (days 5-10)
  - Aortic dissection/Trauma
  - Infection/Neoplasm

Hemopericardium

# Cardiac Tamponade

- When to suspect?
  - Pulsus Paradoxus (JVD, hypotension = Beck's Triad)
  - **Transmural AWTMI** (days 5-10)
    - Macrophage Phase
  - **Aortic dissection/Trauma**
    - Hemopericardium
  - Infection/Neoplasm

Neoplasm may slowly accumulate fluid in contrast to dissection or trauma.

# Cardiac Tamponade

- When to suspect?
  - Pulsus Paradoxus

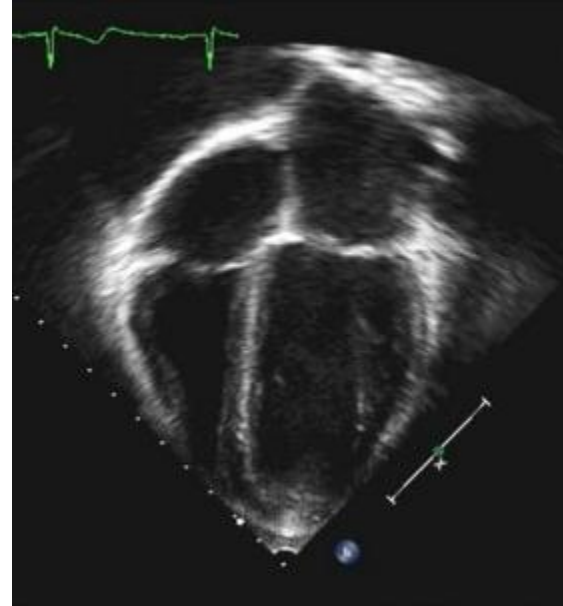
Definition: a drop in systolic BP of  $> 10$  mmHg with inspiration

Implied: there is some degree of BP drop associated with inspiration (increased venous return) at baseline.

To understand why this happens, is to understand tamponade?

# Cardiac Tamponade

- Pericardial Sac
  - Fibroelastic tissue
    - Distensible
  - < 50 ml of serous fluid
  - Intrapericardial Pressure
    - +5 to minus 5 mmHg



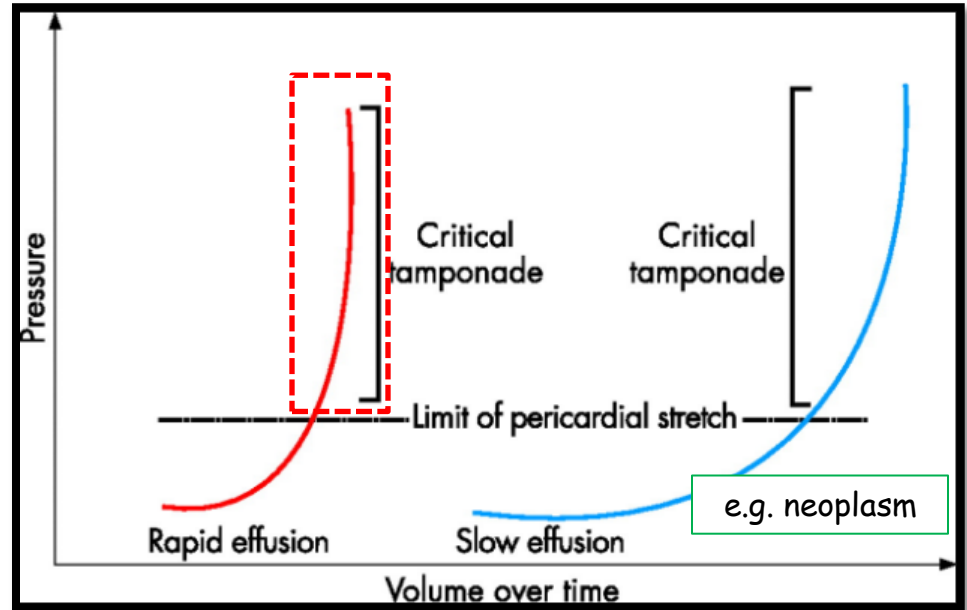
Normal Pressure Volume Relationship

# Cardiac Tamponade

- Pericardial Sac
  - Fibroelastic tissue
    - Distensible
  - < 50 ml of serous fluid
  - Intrapericardial Pressure
    - 5 to minus 5 mmHg

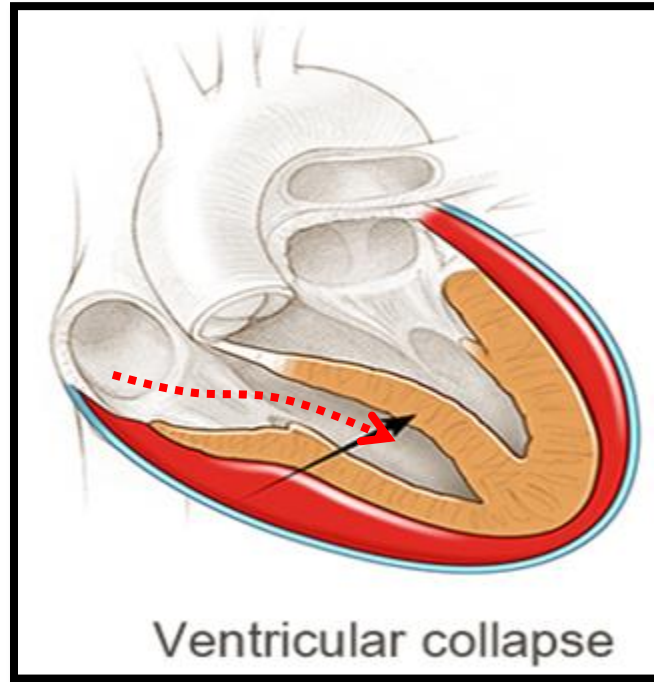
What happens if fluid accumulates in that fibroelastic sac and exceeds the limits of pericardial stretch?

FYI: this does depend on speed of fluid accumulation





# Cardiac Tamponade

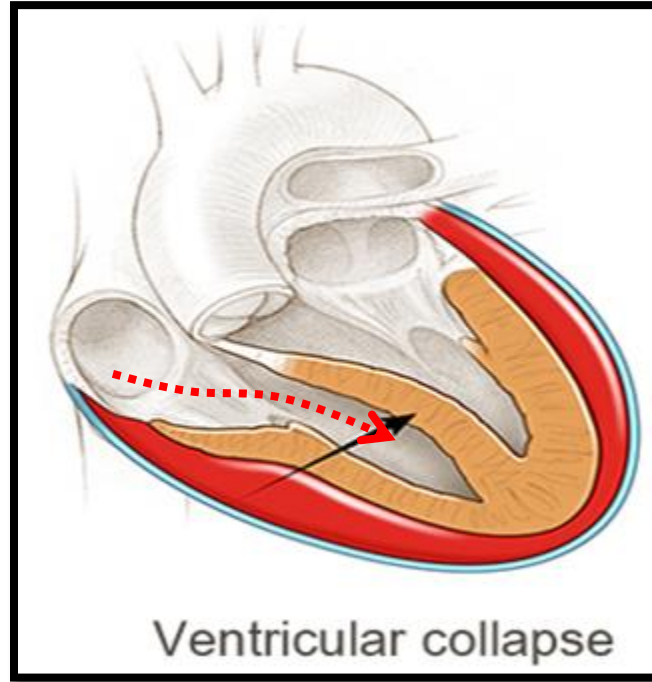


Pulsus Paradoxus: results from a direct competition between the right and left sides of the heart for limited space.

# Cardiac Tamponade

1. All cardiac chambers are compressed to some extent

2. For the right heart to fill more (during inspiration), the left heart must fill less.



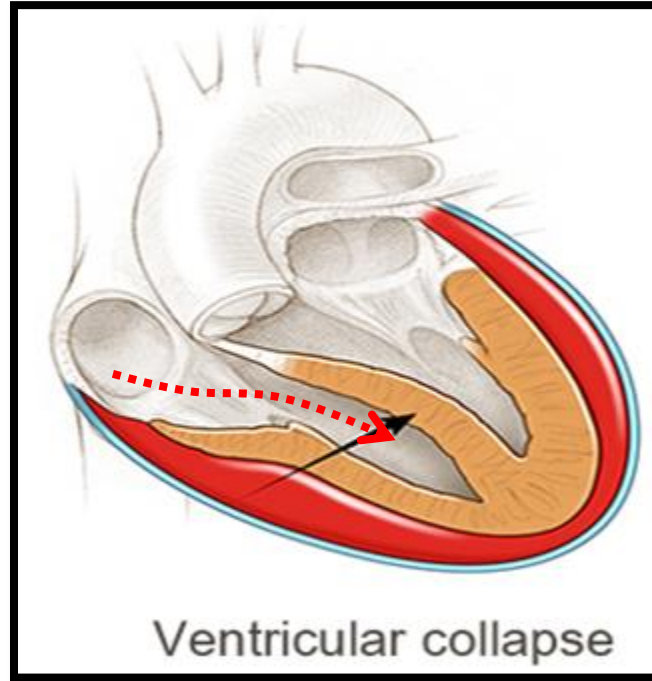
Pericardial pressures exceed diastolic pressures

# Cardiac Tamponade

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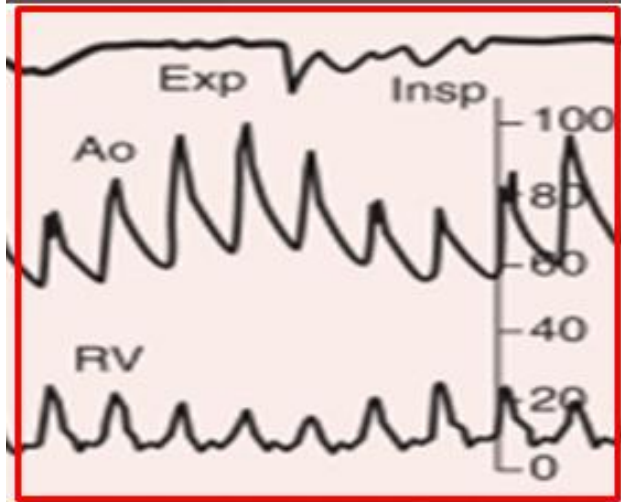
3. Since the free wall of the RV cannot distend (into the pericardial space), the interventricular septum must bulge into the left chamber.



## Result:

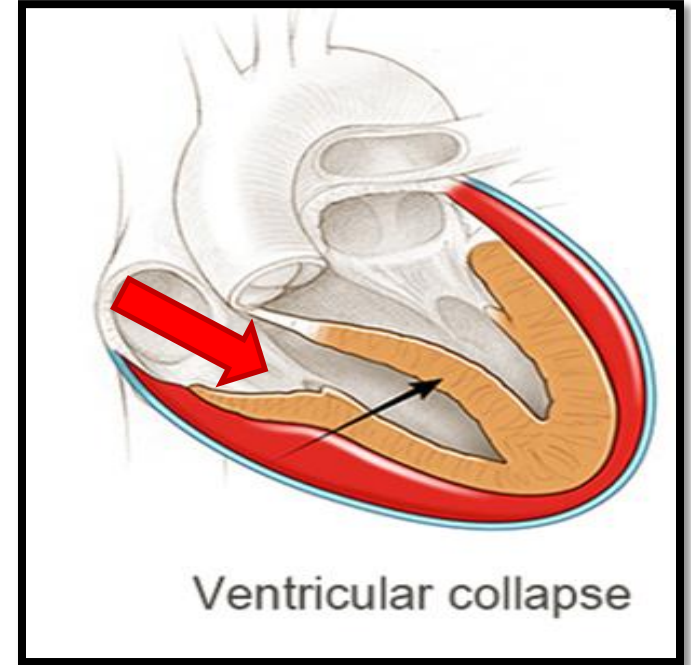
Functional collapse of the LV chamber with decrease in CO during inspiration - clinically translated as **pulsus paradoxus**

# Cardiac Tamponade



Physiologic correlate of pulsus paradoxus

↑ VR → ↑ RA/RV pressure → ↓ LV CO  
(decreased LVEDV → ↓ SV)



# Cardiac Tamponade

- When to suspect?
  - Pulsus Paradoxus: **the Language of Tamponade**

Definition: a drop in systolic BP of  $> 10$  mmHg with inspiration

**How will this be described in vignettes?**

The BP cuff is inflated to 120 mmHg and then slowly decreased. At 100 mm Hg Korotkoff sounds are only heard during expiration. At 80 mm Hg, they are heard throughout the respiratory cycle.

The pulse becomes undetectable during inspiration

# Cardiac Tamponade

The BP cuff is inflated to 120 mmHg and then slowly decreased. At 100 mm Hg Korotkoff sounds are only heard during expiration. At 80 mm Hg, they are heard throughout the respiratory cycle.

The pulse becomes undetectable during inspiration

What was the most likely cause of this finding?

SLE  
Coxsackie  
LV rupture

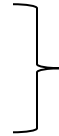
What is the most likely diagnosis?

Effusion  
Pericarditis  
Tamponade

# Cardiac Tamponade

- Physical Exam

- Pulsus paradoxus/Hypotension
- JVD present
- Kussmaul's sign is absent

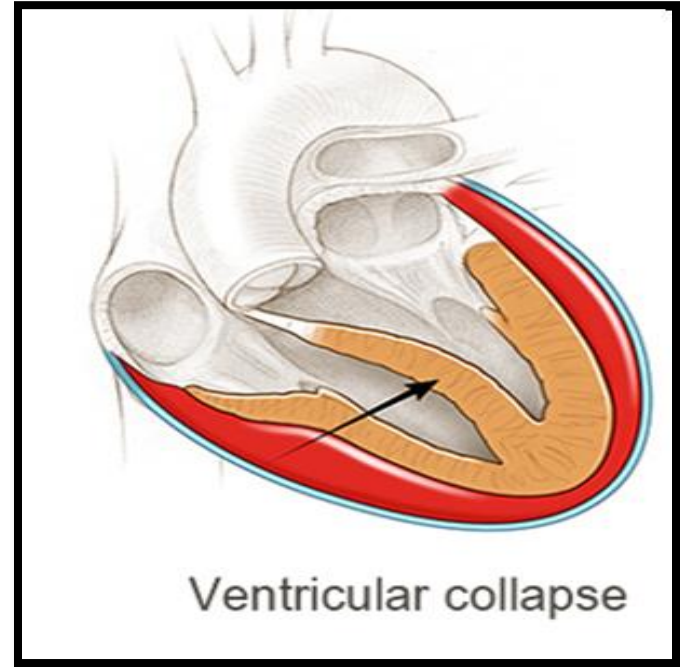


Beck's Triad

# Cardiac Tamponade

- Pericardial Sac
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  - Intrapericardial Pressure
    - +5 to minus 5 mmHg

Intrapericardial Pressure mirrors the normal swings in intrathoracic pressures during respiration





# Cardiac Tamponade

- Physical Exam

- Pulsus paradoxus/Hypotension

- JVD present

- **Kussmaul's sign is absent**

- Inspiration decreases the intrapericardial pressure

Beck's Triad

# Cardiac Tamponade

- Physical Exam

- Pulsus paradoxus/Hypotension
- JVD present
- Kussmaul's sign is absent
  - Inspiration decreases the intrapericardial pressure
- Distant/Muffled Heart Sounds
  - Friction rub (if tamponade complicates acute pericarditis)

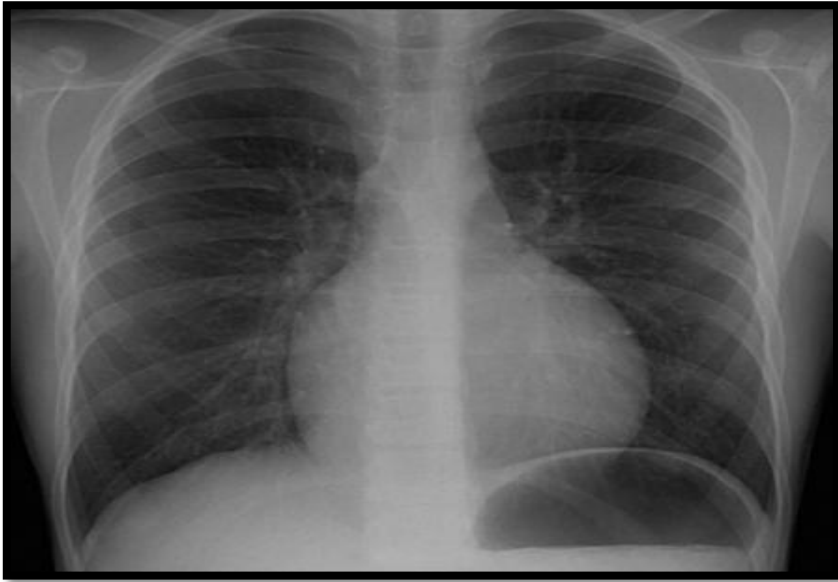
Beck's Triad

# Cardiac Tamponade

- Data
  - CXR
  - EKG
  - Echocardiogram - effusion plus...
    - RA collapse: sensitive
    - RV/LV collapse: specific

# Cardiac Tamponade

- Data: CXR (depends on speed of accumulation)

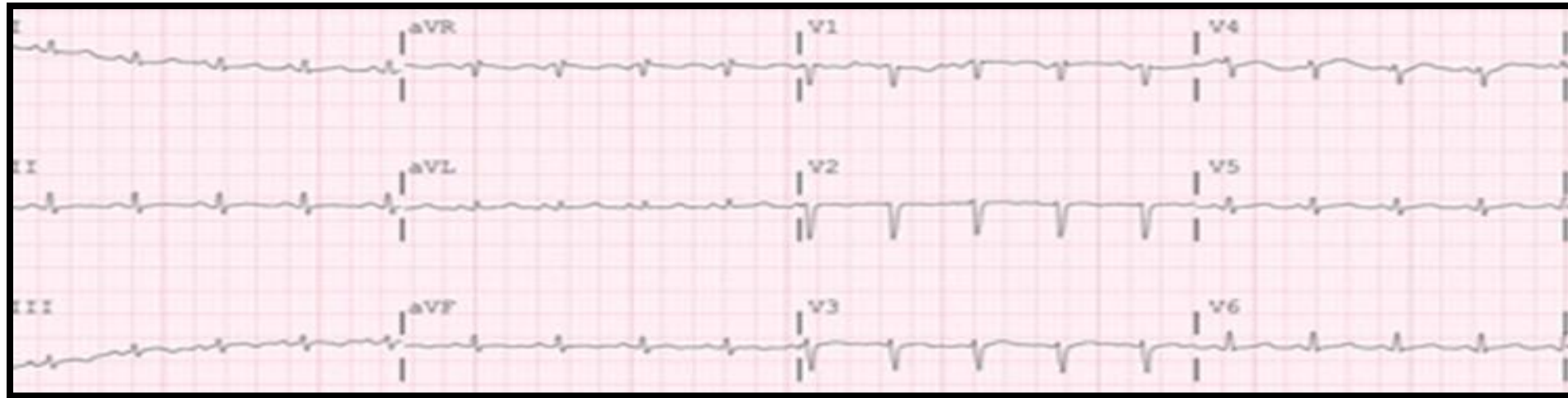


Globular



Water Bottle

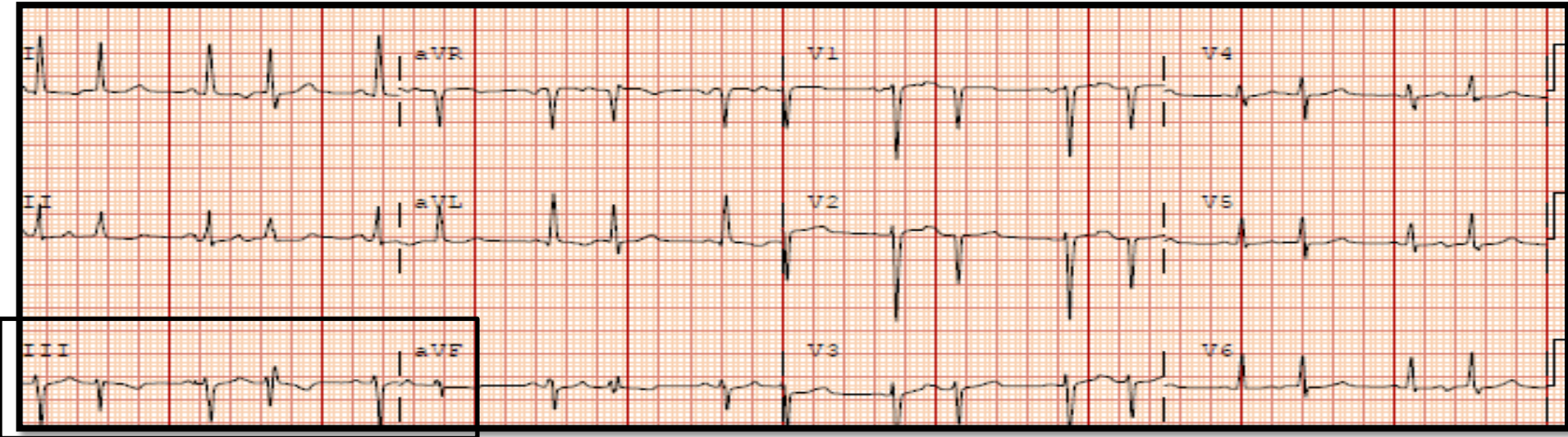
# Cardiac Tamponade: EKG



## Low Voltage

- < 5 mm limb leads
- < 10 mm precordial leads

# Cardiac Tamponade: EKG



Electrical alternans  
Varying QRS amplitude between beats  
Swinging of the heart

# Cardiac Tamponade

- When to suspect?
  - Pulsus Paradoxus (JVD, hypotension = Beck's Triad)
  - Transmural AWTMI (days 5-10)
  - Aortic dissection/Trauma
  - Infection/Neoplasm
- Do Not Confuse (Pulsus Paradoxus):
  - Asthma/Respiratory Distress
    - Correlates with degree of airway obstruction/lung hyperinflation
  - Constrictive Pericarditis

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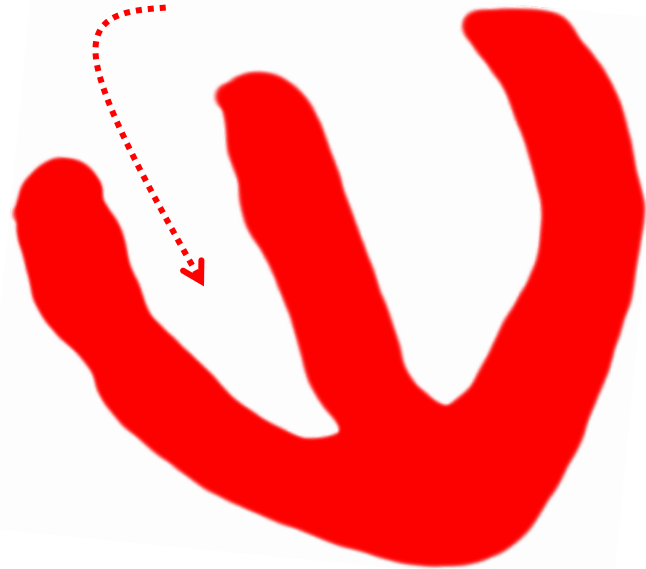


# Constrictive Pericarditis

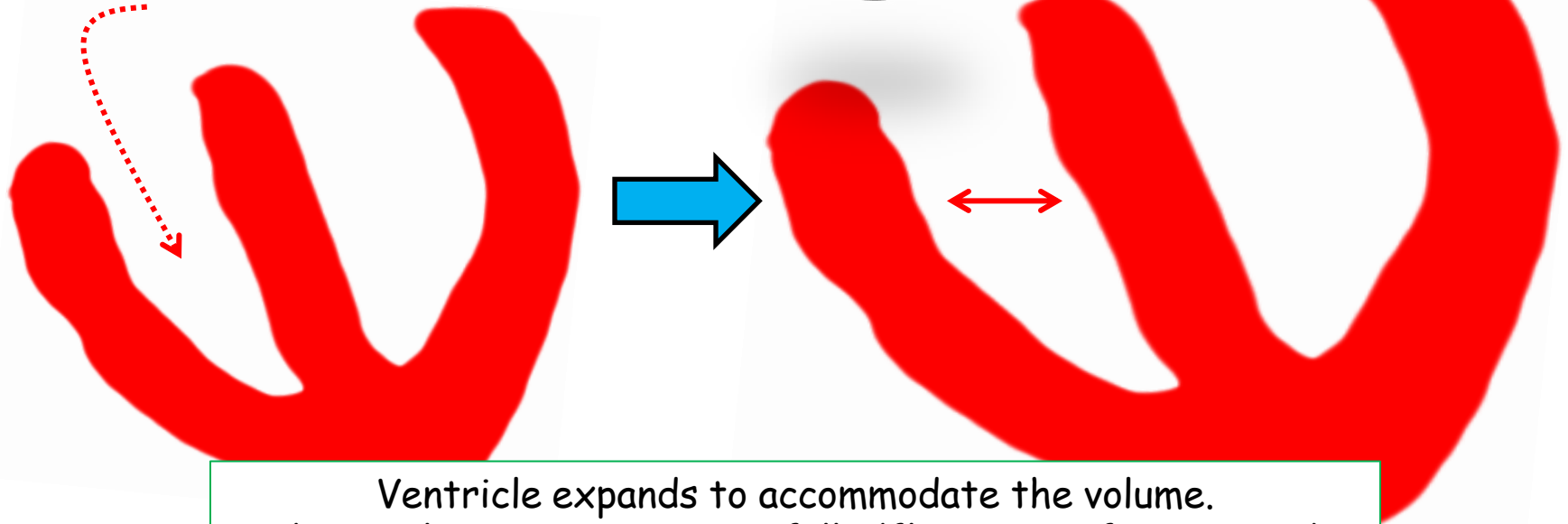


Kussmaul's Sign

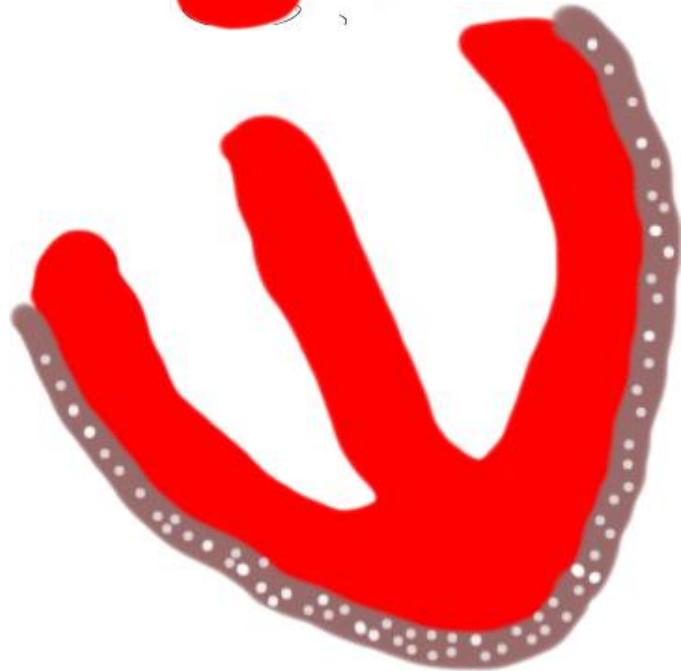
Paradoxical increase in the jugular venous pulse during inspiration



Normal Physiologic Response to Inspiration:  
↓ Intrathoracic mm Hg → ↑ Venous Return

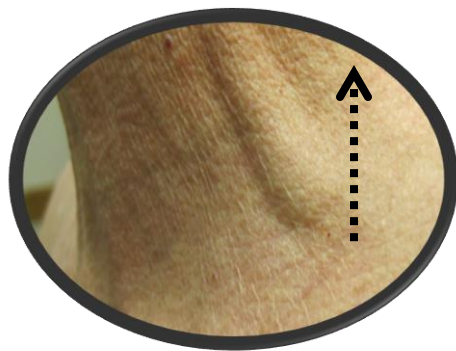


Ventricle expands to accommodate the volume.  
The jugular venous pressure falls (flattening of neck veins)

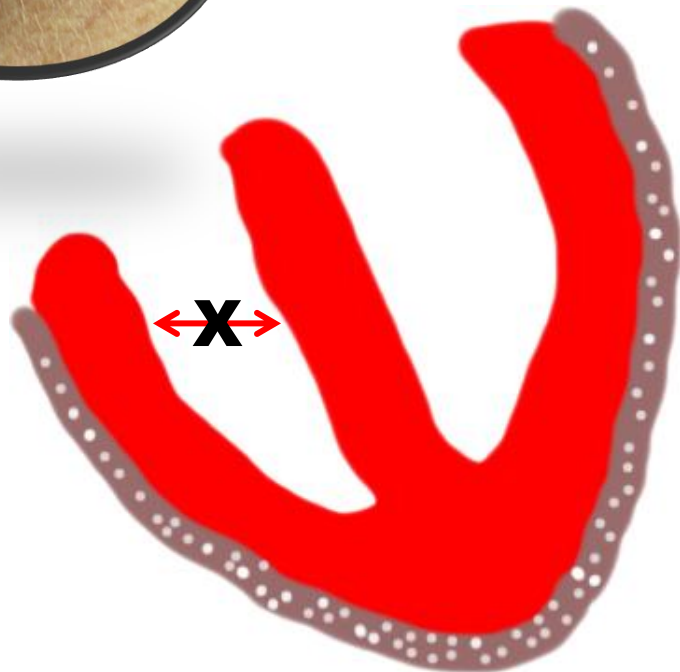
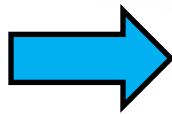


What happens if I encase the heart in a very stiff, inelastic, fibrocalcific shell...

...and the ventricles cannot expand to accommodate the increased volume generated during inspiration?

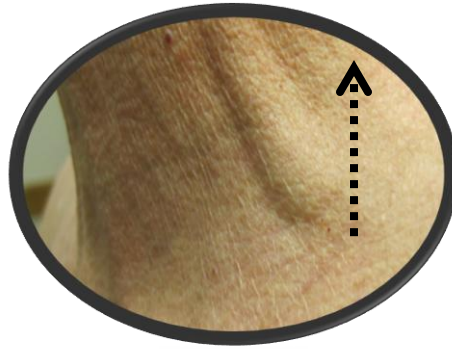


Kussmaul's sign

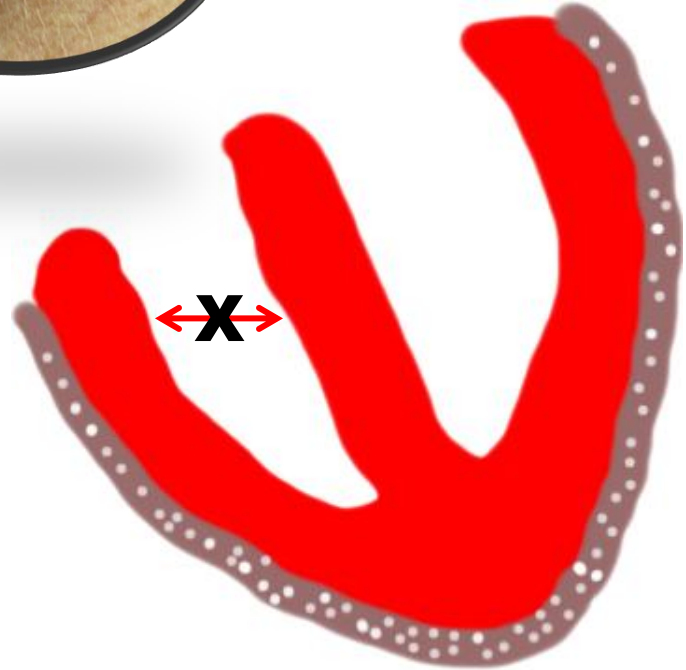


Constrictive Pericarditis

Not a pumping problem  
It is a ventricular **filling** problem



Kussmaul's sign

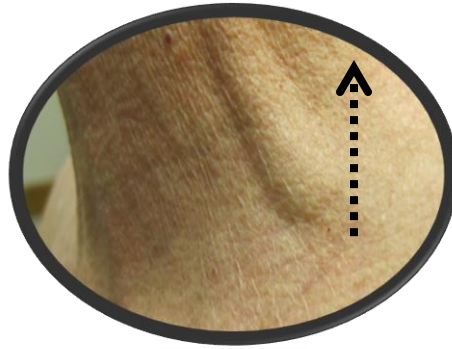


## Constrictive Pericarditis

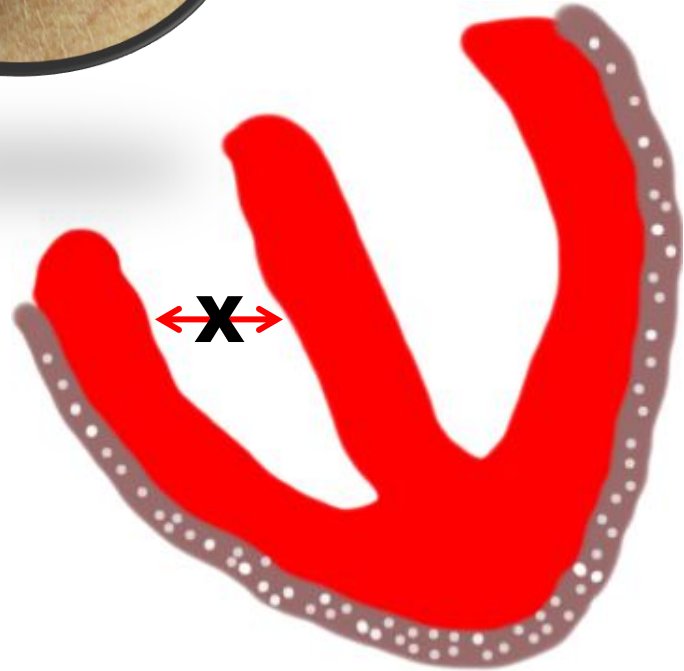
**Not** a pumping problem  
It is a ventricular **filling** problem

### Derivative One:

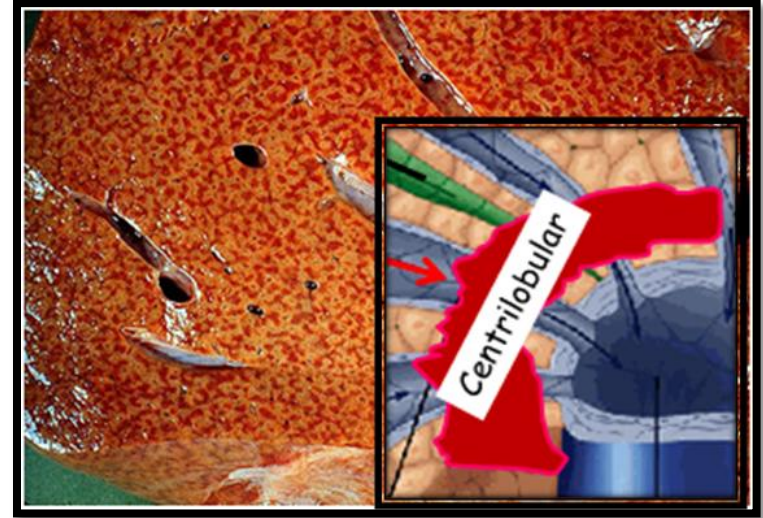
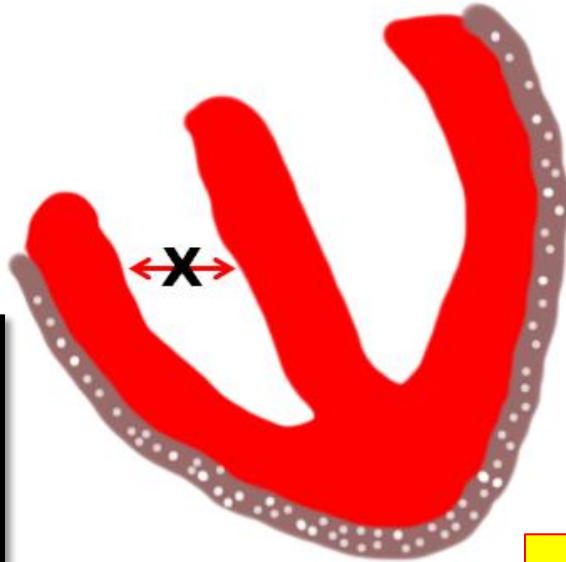
If you can't fill the ventricle  
and blood backs up to the  
jugular vein, where else  
might this be manifest?



Kussmaul's sign



## Constrictive Pericarditis: a ventricular filling problem



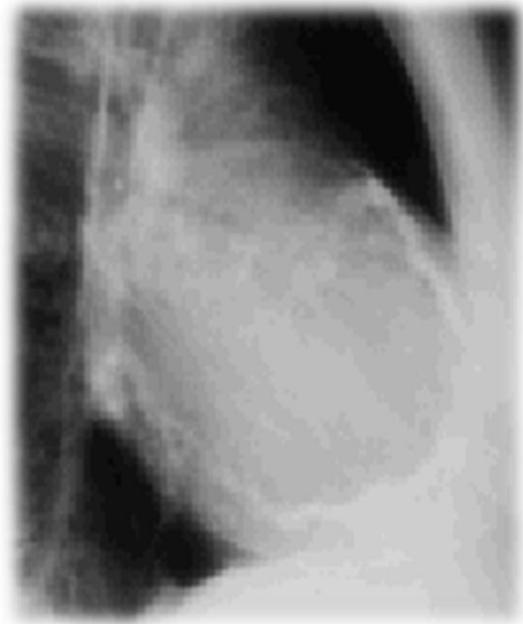
### Congestive Hepatopathy (aka 'nutmeg liver')

- Manifestation of right-sided heart failure
- The 'nutmeg' pattern is results from centrilobular hemorrhagic necrosis



# Constrictive Pericarditis

- Etiologies:
  - Uremia, Tuberculosis
  - Post-Cardiotomy Syndrome
  - Radiation Therapy



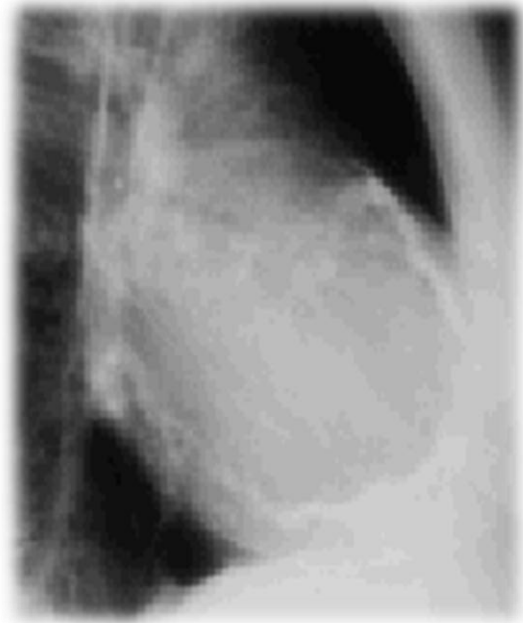
Pathologic Description:  
Dense, thick, fibrocalcific scar

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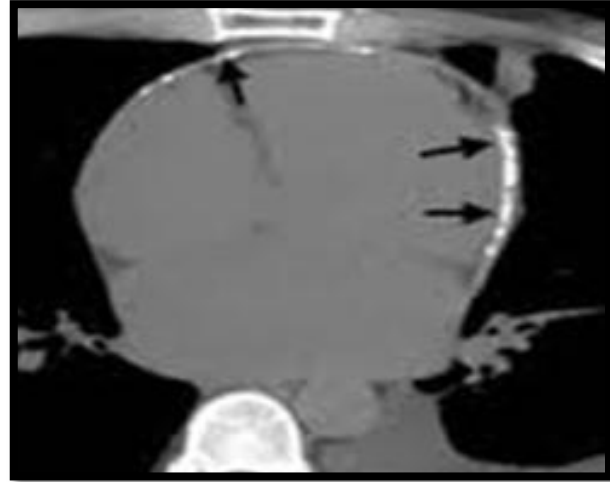
Reed-Sternberg Cell



Pathologic Description:  
Dense, thick, fibrocalcific scar

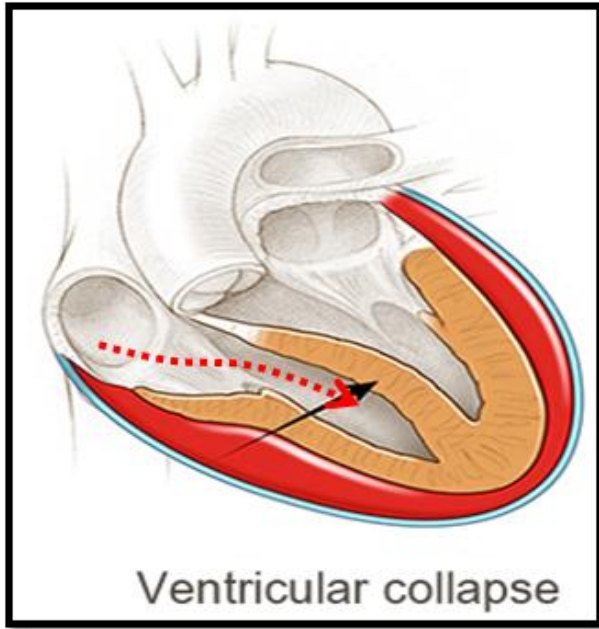
# Constrictive Pericarditis

- Physical Exam
  - Pericardial knock
  - Kussmaul's sign
  - +/- Pulsus Paradoxus



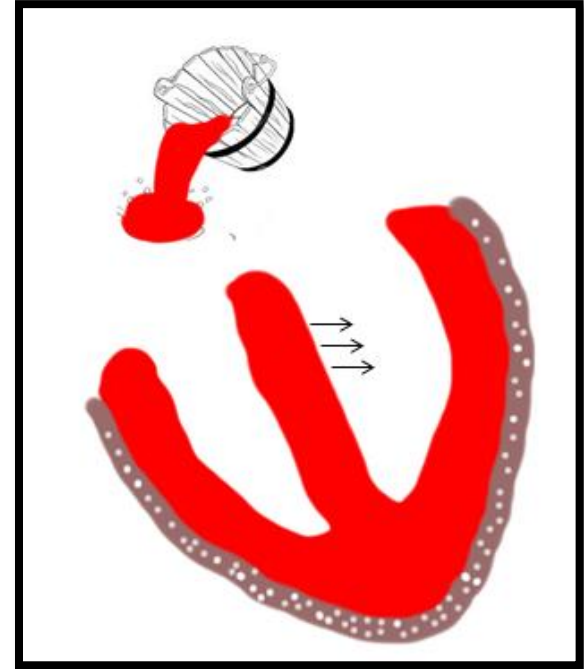
Pericardial Knock:  
Sound made by ventricle 'banging  
into' the calcified pericardium

# Cardiac Tamponade



Kussmaul's Negative  
Pulsus Paradoxus (+)

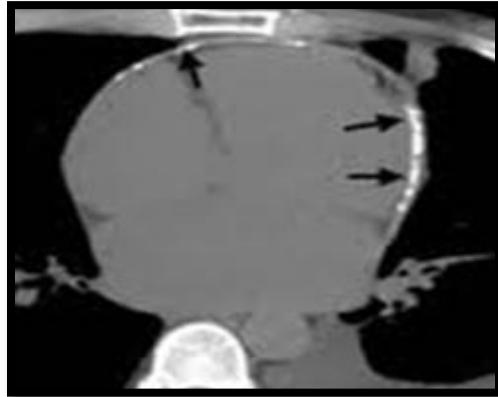
# Constrictive Pericarditis



Kussmaul's Positive  
Pulsus Paradoxus (+/-)

# Constrictive Pericarditis

- Do Not Confuse:
  - Ventricular Filling Problems due to Impaired Relaxation
    - Restrictive Heart Disease: Amyloid is prototype
    - Diastolic Heart Failure (HFpEF)



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- Shock
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