HEMODYNAMICS: CARDIOGENIC VS NON-CARDIOGENIC

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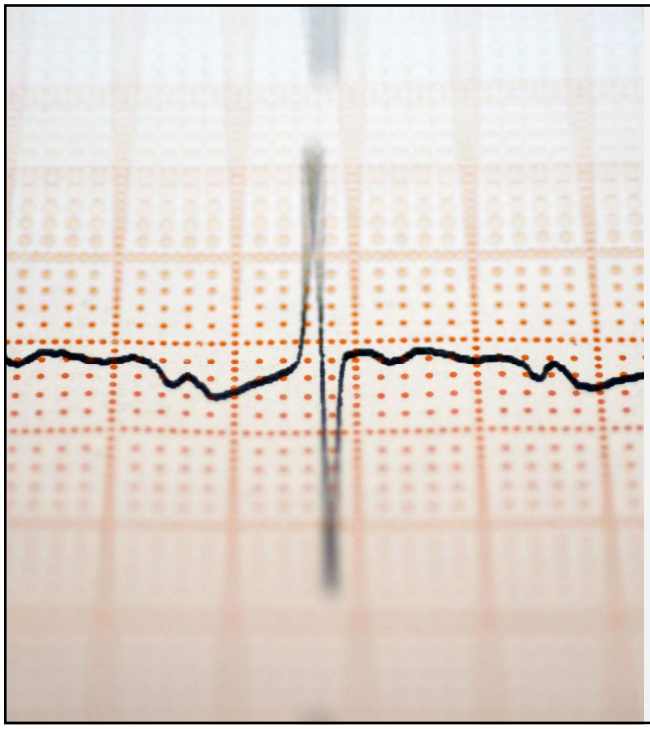

OBJECTIVES

- Review hemodynamics
- Relate cardiogenic conditions to hemodynamics
- Relate noncardiogenic conditions to hemodynamics
- ARDS – review hemodynamics and treatment
- CHF – review hemodynamics and treatment

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Knowing the difference between acute respiratory distress syndrome (ARDS) and congestive heart failure (CHF) hemodynamic values is crucial for accurate diagnosis and appropriate management of these conditions. ARDS and CHF are two distinct medical conditions with different underlying causes and treatment approaches. Hemodynamic values provide important information about the functioning of the cardiovascular system and can help differentiate between these conditions.

ARDS is a severe lung condition characterized by inflammation and fluid accumulation in the lungs, leading to respiratory failure. It is typically caused by direct lung injury (such as pneumonia or aspiration) or indirect injury (such as sepsis or trauma). In ARDS, hemodynamic values often show normal or low. On the other hand, CHF is a condition characterized by impaired cardiac function, leading to inadequate pumping of blood by the heart. It can result from various causes such as coronary artery disease, hypertension, or valvular heart disease. In CHF, the hemodynamic values often show an elevated PCWP, indicating increased left ventricular filling pressures.

Differentiating between ARDS and CHF based on hemodynamic values is important because the management approaches for these conditions differ significantly. Treatment of ARDS focuses on improving oxygenation, reducing lung inflammation, and providing supportive care. In contrast, managing CHF involves addressing the underlying cause, optimizing cardiac function, and often includes medications to improve cardiac output and reduce fluid overload. Misdiagnosis or confusion between these conditions can lead to inappropriate treatments and potential harm to the patient.

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GENERAL OVERVIEW

- It is important to understand that blood, well, goes. If the blood stops then we have bigger problems.
- Understanding blood flow can help to create an understanding of how certain hemodynamics are impacted by disease.

- What do we want? Homeostasis! When do want it? Forever!
- As we should know, a disruption in the flow of blood creates a cascade effect that ultimately impacts the whole body.
- SVC/IVC → RA → TRICUSPID → RV → PUL. SLV → PUL. ART. → LUNGS → PUL. V. → LA → BICUSPID → LV → ASLV → AORTA → ARTERIES → ARTIOLES → METARTERIOLES → CAPILLARIES → POSTCAPILLARIES → VENULES → VEINS → HEART

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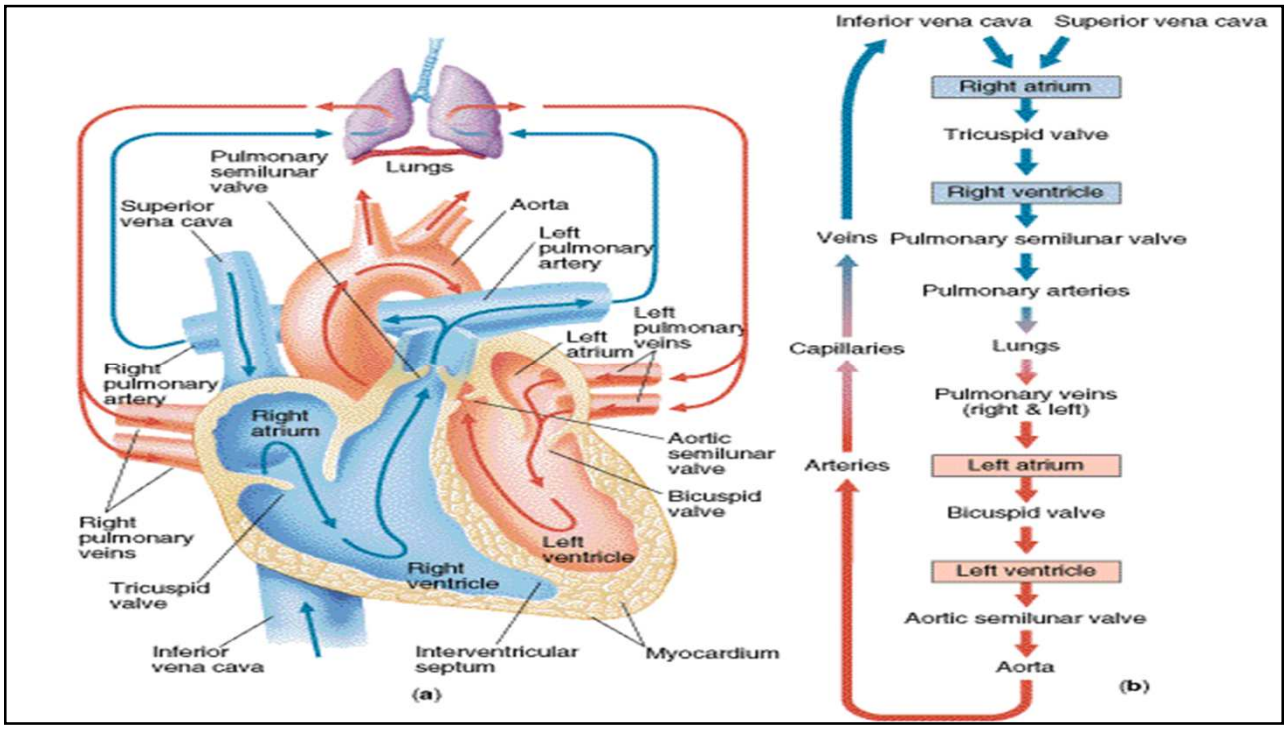

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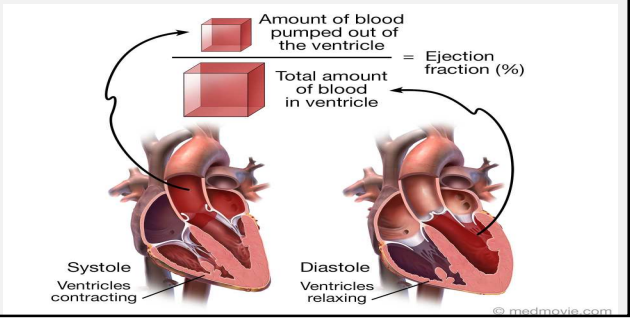
GENERAL OVERVIEW

- General Values
- Cardiac Output = (SV)(HR)
  - 4-8 L/min
- Stroke Volume is the amount of blood pumped in one contraction by either ventricle
- SV = CO/HR x 1000 60-120 ml/beat
- Blood Pressure*
- PVR – 50/100 – 250 dynes/sec/cm-5
- SVR – 800-1200 dynes/sec/cm-5

- MAP – think perfusion – roughly 70 –100 mmHg - >60 mmHg = organ perfusion
  - $systolic + diastolic(2)/3$
- Ejection Fraction 65 -75% - how much blood the left ventricle pumps out with each contraction.
- Pulse Pressure is the difference between systolic and diastolic – normal >40 mmHg, <30 and pulse is hard to find.



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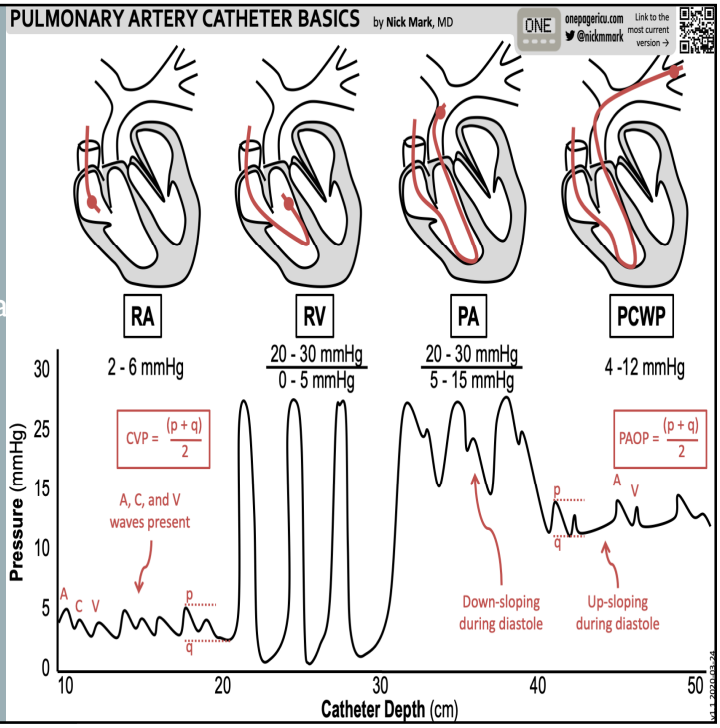
FOCUSED HEMODYNAMICS

- CVP: 2-6 mmHg
- Can obtain with a Swan-Ganz or sta alone CV line
- PAP: 25/8 mmHg
  - mPAP – mean in the teens
- PCWP: (4)/8-12 mmHg
- Need a Swan-Ganz



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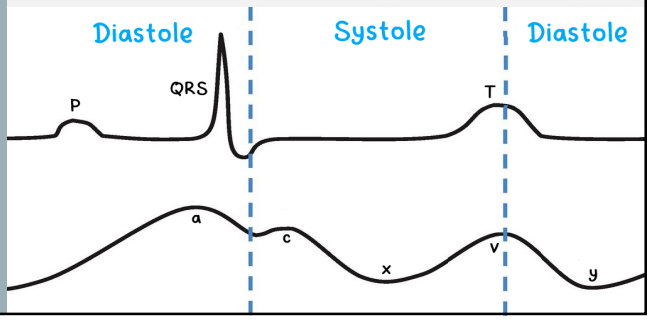
FOCUSED HEMODYNAMICS – CVP –

- Central Venous Pressure
- General measurement of right heart function
- Normal value is 2 – 6 mmHg
- Located in the right atria
- Right ventricular pressures can be obtained
- May be elevated with a number of hemodynamic abnormalities

- High CVP
  - Hypervolemia
  - Right heart failure
- Low CVP
  - Hypovolemia
  - Hemorrhage
  - Vasodilation (shock)



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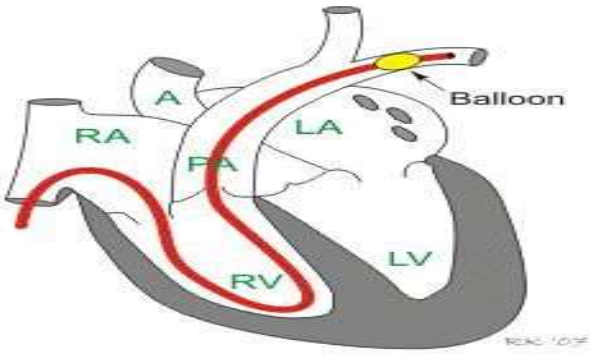
FOCUSED HEMODYNAMICS – PAP –

- Pulmonary Artery Pressure
- Has a systolic and diastolic value
- A mean value can be used for evaluation as well
- Normal value is 20 – 30 systolic and 5– 15 diastolic
- Mean in the teens 13 – 19 may indicate normality
- Balloon is not inflated



Balloon-tipped, Swan-Ganz catheter for measuring pulmonary capillary wedge pressure (PCWP).

- Remember: push proximal and draw distal
- Aspiration via the distal lumen is the best way to obtain mixed venous blood.
- Think about it – it is the very last place deoxygenated blood can be measured

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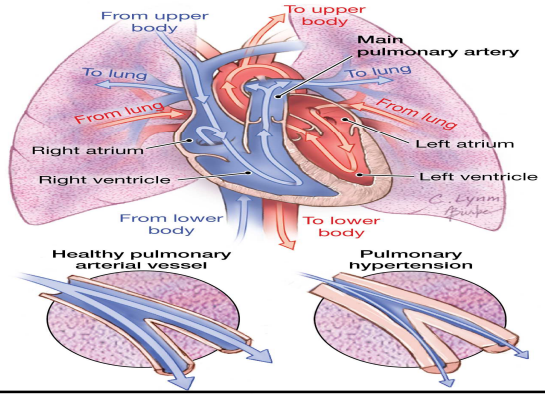
FOCUSED HEMODYNAMICS – PAP –

- Anything that will decrease blood flow *through* the heart will decrease PAP
  - RHF
  - Cor Pulmonale
  - Hypovolemia
- Increases in PAP will be seen lung disorders or left heart complications
  - COPD
  - Pulmonary Embolism
  - Pulmonary Hypertension

- Etiology
  - Idiopathic, drug induced, LHF, hypoxia, tumors, clots, etc.
- Treat the underlying factors and intubate if needed
  - Nitric oxide, prostacyclin (Flolan), phosphodiesterase inhibitors, fluid man.



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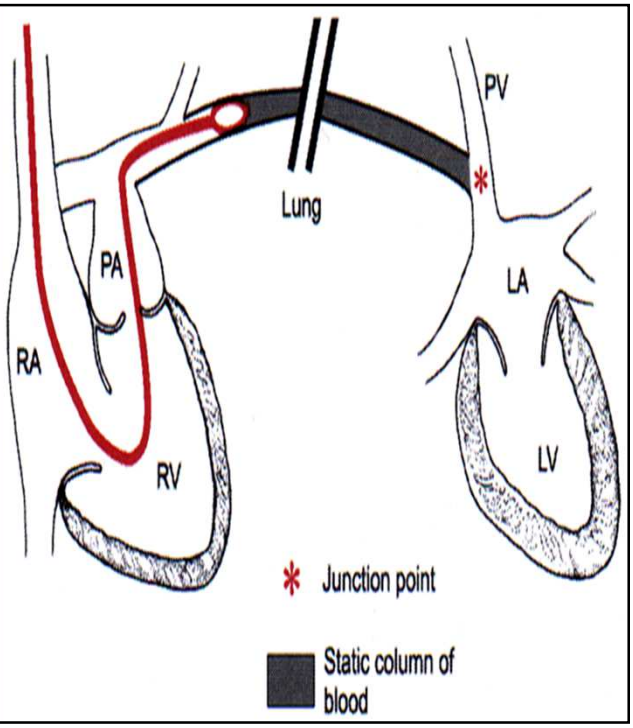
FOCUSED HEMODYNAMICS – PCWP –

- Balloon inflated no longer than 10-15s
- Blocks information from right side of heart
  - Like a mirror image
- Normal values: (4) 8-12 mmHg
- Increased with left heart dysfunction and hypervolemia
- Normal or decreased will nearly all other situations



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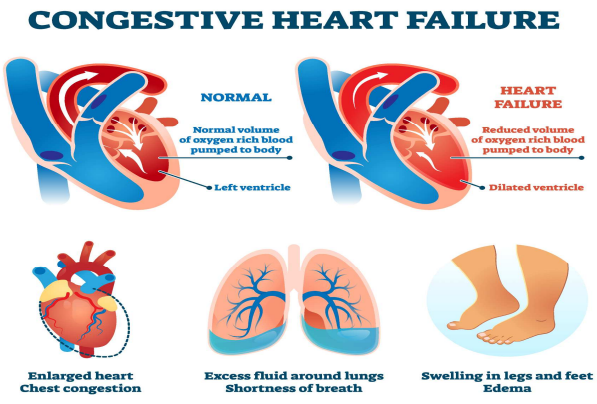
CHF

- Most common cause is CAD, HTN, and previous MI, lifestyle plays a huge part.
- Anything that may impede the outflow of blood to the body.
- Remember, the blood doesn't stop. If the pressure forward is greater than the pressure backwards then the fluids begin to back up, also following the path of least resistance – eventually flooding the lungs.

- Treatment:
  - O2 if hypoxic
  - CPAP or NPPV
  - Inotropes, beta, blockers, vasoactive
  - HOB elevated and manage other morbidities



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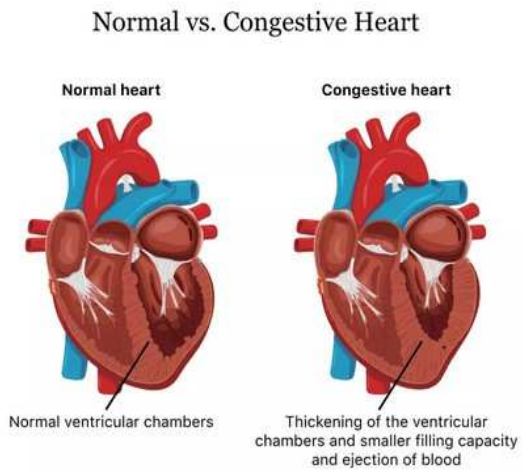
HEMODYNAMIC CORRELATION - CHF

- CVP – Normal or increased
  - PCWP – Increased
    - PAP – Increased
    - CO - Decreased

- Reduced left ventricular function that impedes or obstructs the normal flow of blood from the left ventricle to the rest of the body.



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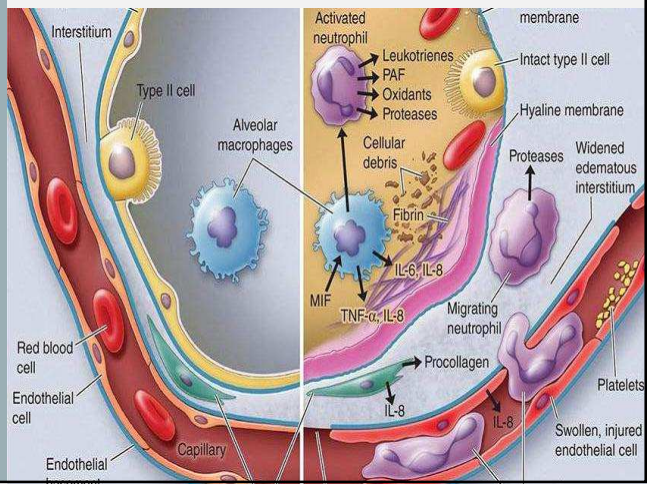
ARDS

- The most common cause of ARDS is SEPSIS
- 33% of patients that aspirate will develop ARDS
- Other causes are TRALI, pneumonia, trauma, or other infections
- In a nut shell: ARDS is massive pulmonary edema and atelectasis
- Three general stages: exudative (7-10), proliferative (10), and fibrotic

- Highly refractory to O2 therapy and generally requires more advanced therapies
- Treat underlying causes
- Sepsis is an indication for hemodynamic monitoring which can be used for targeted therapy



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HEMODYNAMIC CORRELATION - ARDS

CVP - increased or normal

PCWP - normal

PAP - increased

CO – normal or decreased

Can vary depending on severity

- How does pulmonary hypertension occur in ARDS?
  - Vessel obliteration, pulmonary vasoconstriction (hypoxemia), micro-thrombosis, hypercapnia, vasoactive mediator imbalances, other biochemical cascades
- Treatments – treat underlying condition
- Broad spectrum antibiotics or targeted
- O2 – MV – fluid management – ECMO in some cases – prophylactic or therapeutic anticoagulants – iNO – proning – etc.

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THE DIFFERENCE

- What exactly is the difference and what does it mean?
- When looking at the hemodynamic portions of these two diseases, it becomes very apparent how to differentiate between them
- Of course, these two diseases present with other obvious findings

- CHF vs ARDS
  - CHF
    - CVP – N or I
    - PAP – Increased
    - PCWP – Increased
    - CO - Decreased
  - ARDS
    - CVP – N or I
    - PAP - Increased
    - PCWP – N
    - CO – N or D

Where is the problem occurring?

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CASE REPORT

A patient has been mechanically ventilated for eight days post-CABG. Multiple weaning attempts have failed and the patient has required continuous sedation. Recent labs have indicated the need for prophylactic sepsis work up. The patient has required vasopressors and fluids on a number of occasions and so a Swan Ganz was placed.

- CVP – 6 mmHg
- PAP – 31/19 mmHg
- mPAP – 25 mmHg
- PCWP – 11 mmHg
- CO – 4.7 L/min
- CI – 2.3
- BP (arterial line) – 137/86
- PvO2 – 24 mmHg
- PVR - ~400 dynes/sec/cm-5
- SVR – ~1000 dynes/sec/cm-5
- After reviewing the monitor, the physician asks for thoughts and recommendations
  - What do you think the underlying problem is?
  - How did you come to that conclusion?
  - How would you approach fixing it?

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RECAP

1. Flow of Blood
2. Hemodynamic normal and treatment for abnormal
3. CHF and Hemodynamics
4. ARDS and Hemodynamics
5. The Difference

- 1. SVC/IVC → RA → TRICUSPID → RV → PUL. SLV → PUL. ART. → LUNGS → PUL. V. → LA → BICUSPID → LV → ASLV → AORTA → ARTERIES → ARTIOLES → METARTERIOLES → CAPILLARIES → POSTCAPILLARIES → VENULES → VEINS → HEART
- 2. CVP, PAP, PCWP, CO
- 3. CHF is LH failure (leads to RHF if not corrected);
- 4. ARDS begins in the lungs and manifests in the heart part of the lungs
- 5. The best hemodynamic value to look at to determine cardiogenic and non-cardiogenic is PCWP.

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