

## Hemodynamics and the Evaluation of Shock

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## Objectives

- To review basic circulatory system physiology
- To relate types of shock to hemodynamics
- To pass your PBA!

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## Shock

- Abnormal perfusion
- Low blood pressure
- Multiple causes
  - Etiology often unclear
  - Therapies directed at causes
- Diagnostics important

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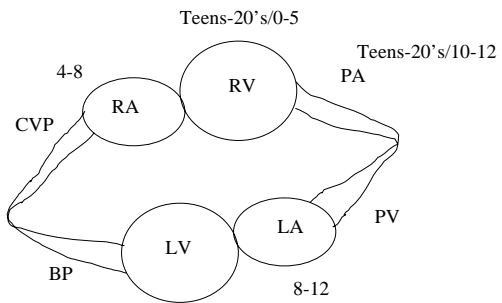
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# My View of the Circulatory System




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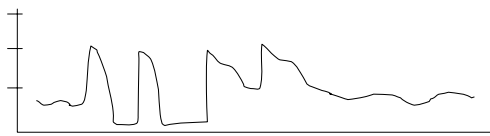
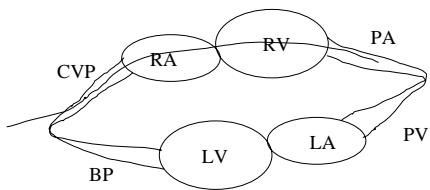
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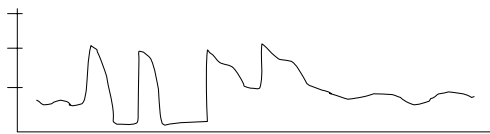
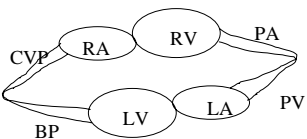
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Why Can I Reliably Measure Left Atrial Pressure From the Right Side?

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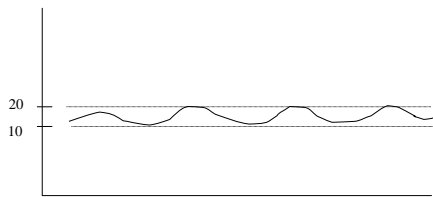
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Measure Wedge at End-Expiration



Spontaneous Breathing: Top of the Curve  
Mechanical Ventilator: Bottom of the Curve

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### Tracings

- Remember the jugular venous pulse?
- The same thing happens in the wedge position; however this time we are seeing left atrial waveforms
- Abnormalities need to be recognized

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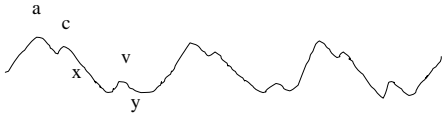
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PAOP (Wedge) With Same Characteristics as the Jugular Venous Pulse



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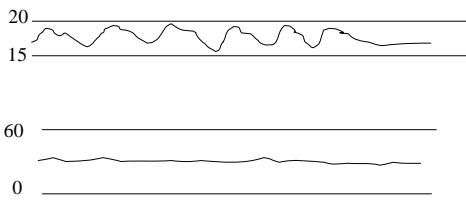
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Wedge Tracing Varies Depending on the Scale Used



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Waveforms often change in pathologic states



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## Cardiac Output

- Thermodilution Method
- Area Under the Curve
  - Calculus
- Cardiac Output (Normal 5 Liters/min)
- Cardiac Index = CO/BSA
  - “Pound for pound” assessment
  - Normal > 2.5

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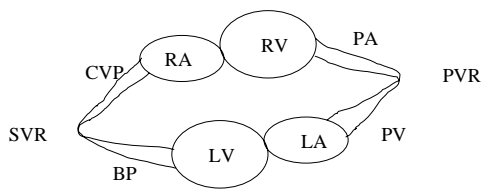
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General Formula for Resistance?  $\frac{\Delta \text{ Pressure}}{\Delta \text{ Flow}}$

Systemic Vascular Resistance  $\frac{\text{MAP-CVP}}{\text{CO}} \times 80$

It's A Fraction!!!!

(WU) Dyn/sec/cm<sup>5</sup>

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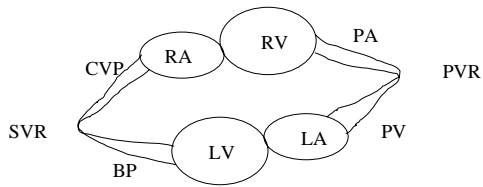
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General Formula for Resistance?  $\frac{\Delta \text{ Pressure}}{\Delta \text{ Flow}}$

Pulmonary Vascular Resistance  $\frac{\text{MPAP-PAOP}}{\text{CO}} \times 80$

(WU) Dyn/sec/cm<sup>5</sup>

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### What is This?

CVP	RV	PA	PAOP	CI	BP	SVR
4	24/3	22/12	11	3.5	110/70	--

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### Shock Eval with PA Catheter

- Start at the left atrium and work backward
- Make sure the numbers make sense
  - PAP 30/15; PAOP 25 cannot happen
- Make your hemodynamic diagnosis, then relate it to the clinical scenario
- Look at tracings carefully
- Where pressures go from low to high is usually where the problem is

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### What is This?

CVP	RV	PA	PAOP	CI	BP	SVR
2	10/1	12/3	2	1.6	60/40	--

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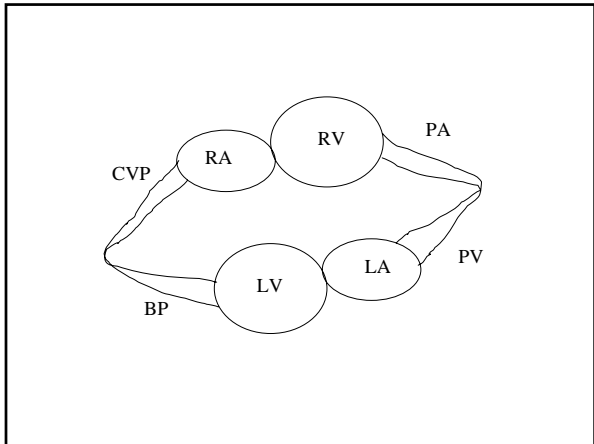
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**What is This?**

CVP	RV	PA	PAOP	CI	BP	SVR
16	40/6	40/25	24	1.6	60/40	--

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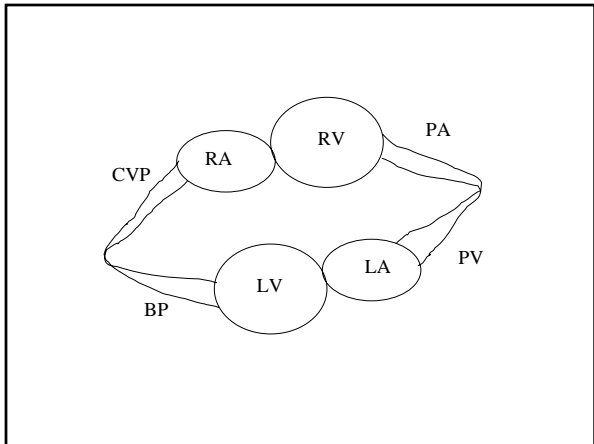
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What is This?

CVP	RV	PA	PAOP	CI	BP	SVR
3	40/8	40/25	4	1.6	60/40	--

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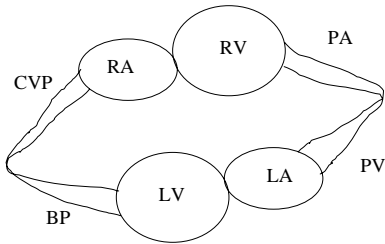
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What is This?

CVP	RV	PA	PAOP	CI	BP	SVR
16	45/10	12/4	4	1.6	60/40	--

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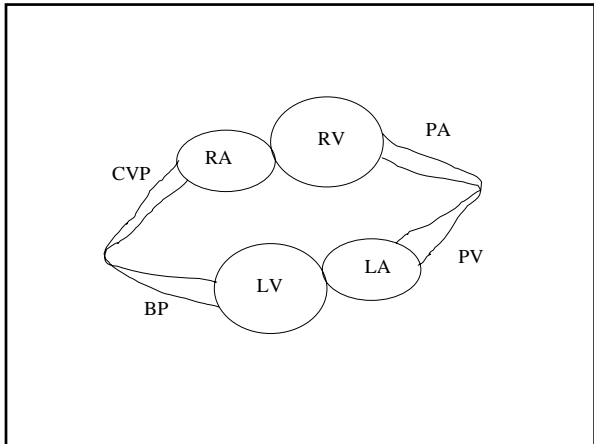
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**What is This?**

CVP	RV	PA	PAOP	CI	BP	SVR
17	40/18	35/17	18	1.6	60/40	--

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What is This?

CVP	RV	PA	PAOP	CI	BP	SVR
18	10/4	10/5	5	1.6	60/40	--

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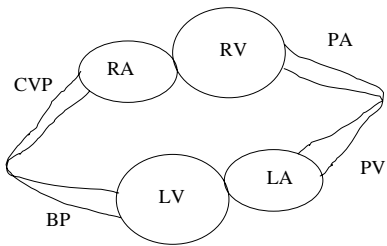
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What is this?

CVP	RV	PA	PAOP	CI	BP	SVR
10	30/5	30/14	14	4.3	60/40	--

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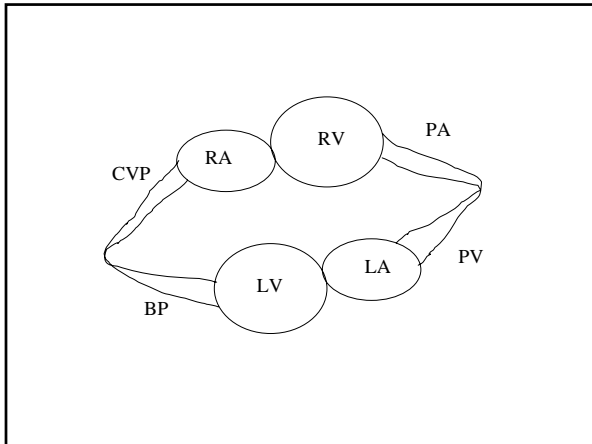
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### Hemodynamic Summary

	RA	RV	PA	WP	CI	BP	SVR
Hypovol	↓	↓	↓	↓	↓	↓	--
Cardiogen	↑	↑	↑	↑	↓	↓	--
PA Obst	↑	↑	↑	↓	↓	↓	--
RV Obst	↑	↑	↓	↓	↓	↓	--
Tamp	Var	Var	Var	Var	↓	↓	--
RA Obst		↓	↓	↓	↓	↓	--
Distrib	Var	Var	Var	Var	↓	↓	↓

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- ### Types of Shock
- I. Hypovolemic
    - Bleeding
    - Dehydration
    - Etc.
  - II. Cardiogenic
    - ACS
    - Valvular
    - Cardiomyopathy
    - Etc.
  - III. Extracardiac Obstructive
    - Pulm Embolism
    - Cardiac Tamponade
  - IV. Distributive
    - Sepsis
    - Etc.

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## Causes of Distributive Physiology

- Sepsis
- Trauma
- Burns
- Aspiration
- Pancreatitis
- Inhalation Injury
- Neuro Trauma
- Cirrhosis
- Paget's Disease
- Beri-Beri
- Thyroid Storm
- Toxodromes
- Ovarian Hyperstim

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## Summary

- Diagnose early!
  - Clinical judgment is important
- Early goal-directed therapy
- For PA Cath
  - Start at left atrium and work backward
  - Remember the bra analogy
- Good Luck With Your PBA!

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