SHOCK

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Defining Shock

Shock is not just hypotension

- A state of widespread cellular and tissue hypoxia due to:
  - Less oxygen delivery
  - More oxygen consumption
  - Poor oxygen utilization
- USUALLY patients are hypotensive.
- Shock is life-threatening circulatory failure.
- Shock is initially reversible, but rapidly progresses to multiorgan failure.

Indicators of Shock

Mean arterial pressure (MAP) is an estimator of tissue perfusion.

Good: easy to check and monitor.

Bad: unreliable in special patients.

- Absolute (<65)
- Relative (drop > 40)
- Profound (medication-dependent)

Lactate is produced by hypoxic tissue. Evidence of poor perfusion.

Good: elevated in every type of shock. Early indicator of shock and mortality.

Bad: performed only when shock is already suspected. Not specific to shock.

Compensatory features

- Tachycardia (↑ HR)
- Tachypnea (↑ RR)
- Oliguria (low urine output)
- Mental status change
- Cool clammy skin

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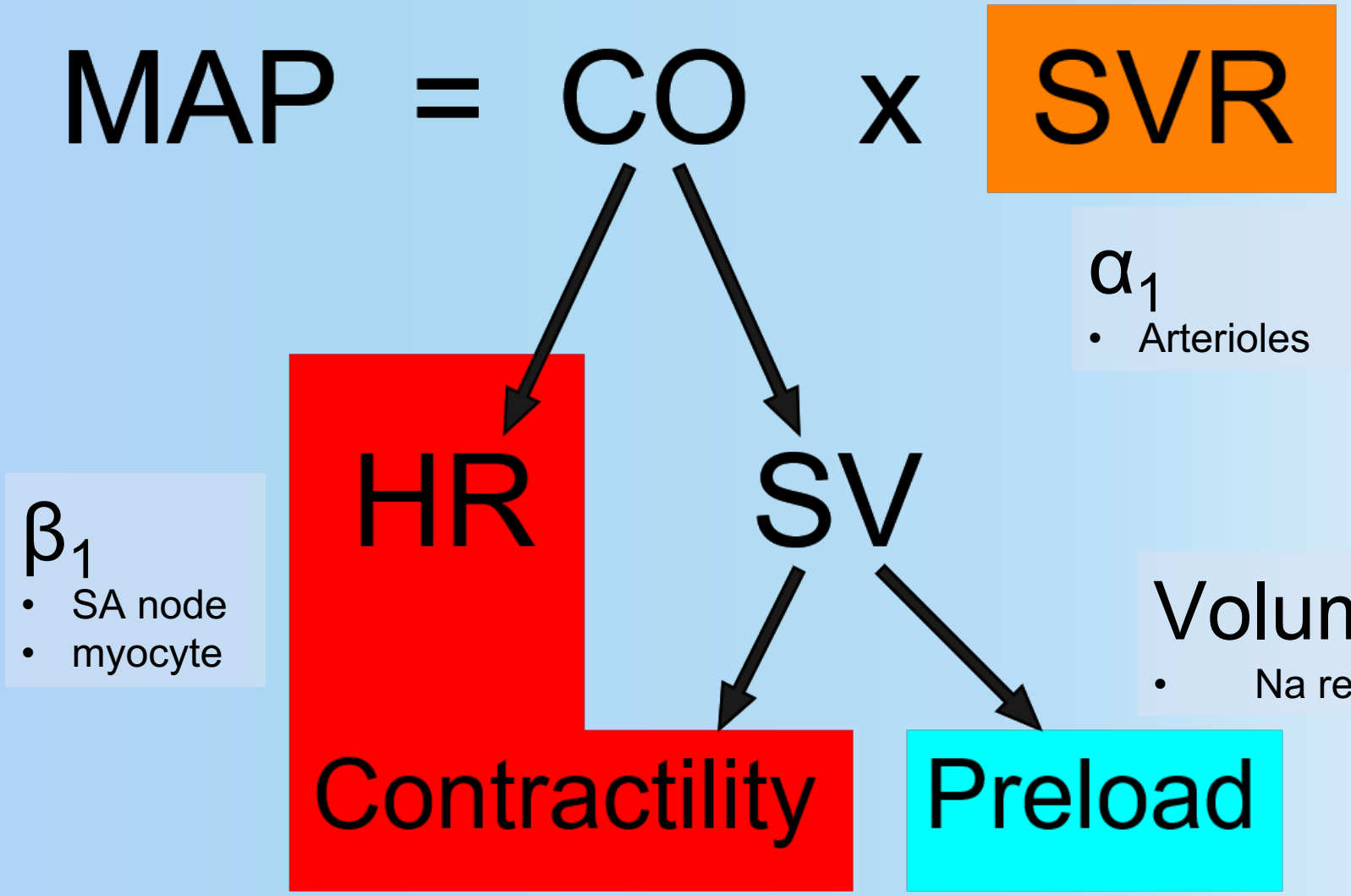
Hemodynamic Refresher

Autonomic regulation occurs in the span of seconds to minutes



α_1
- Arterioles

β_1
- SA node
- myocyte

Volume
- Na reabsorption

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Regulation of BP and Perfusion

Mechanism	Location	Trigger	Response	Effector	Hemodynamic change
Baroreceptors (quick)	• Carotid sinus • Aortic arch	↓ BP (decreased stretch)	SANS stimulated PANS inhibited (NE and E)	Cardiomyocytes SA node Arterioles	↑ HR ↑ contractility ↑ SVR
Regional/ Arteriolar (quick)	• Arterioles	• ↑ CO_2 • ↓ pH • ↓ O_2	Vasodilation	Arteriole	↓ SVR
RAAS (slow)	Macula densa of the kidney	↓ renal plasma flow	Renin release → AT II → aldosterone	• Arterioles • Renal tubules (reabsorption)	↑ SVR ↑ preload

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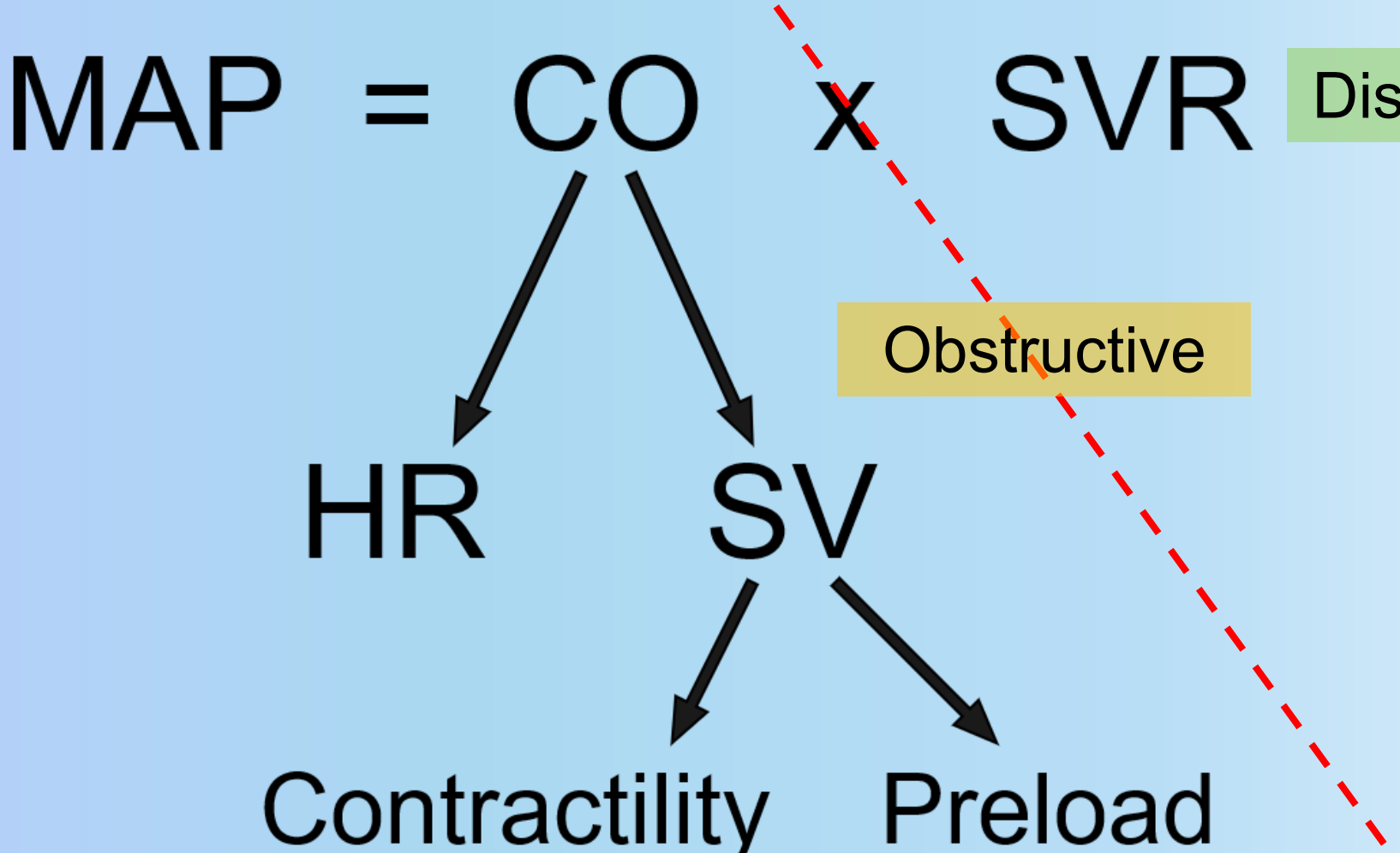
Types of Shock

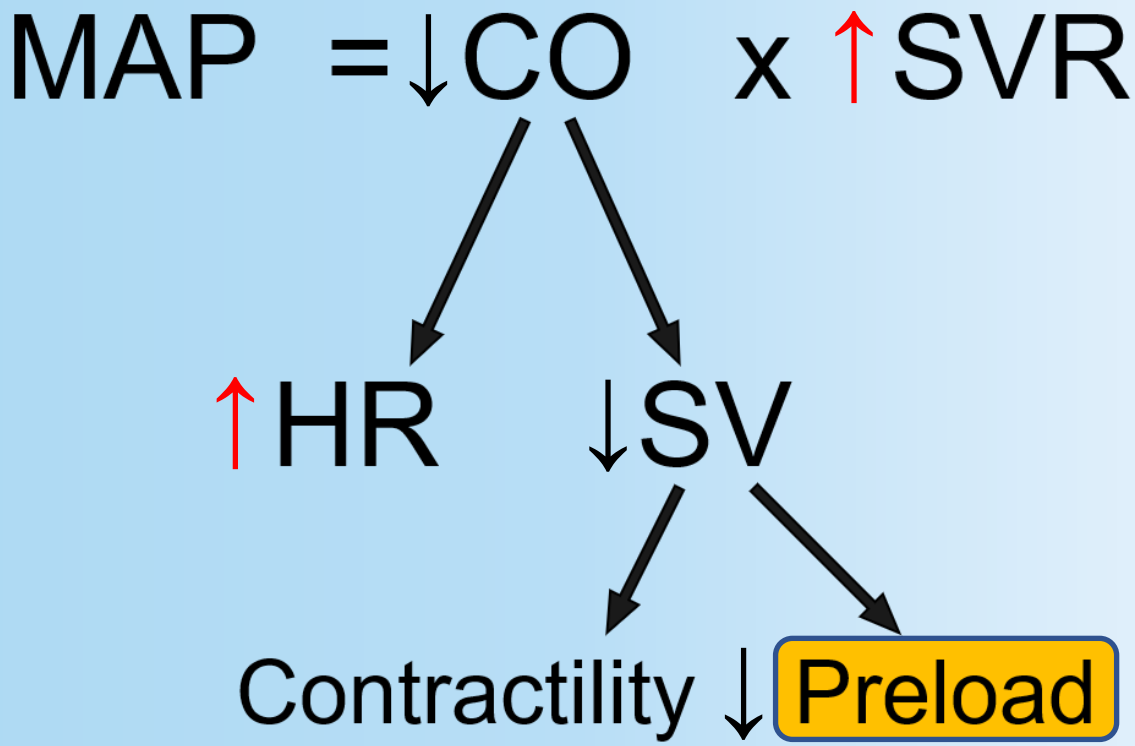


Hypovolemic Shock

A 26 year old man arrives in the ER presenting with impaired consciousness and multiple lacerations to the face. Paramedics tell you the patient was in a motor vehicle collision.

Blood pressure is 60/30. He is sweating and his skin is pale and cold. His pulse is 150/min, but your attending calls it thready.

MAP = 40



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Causes of Hypovolemic Shock

Hemorrhagic

- Trauma
- Upper GI bleeds (peptic ulcer, variceal hemorrhage)
- Lower GI bleeds (diverticular)
- Ruptured aorta
- Iatrogenic (surgical)

Nonhemorrhagic

- GI losses (diarrhea, vomiting)
- Skin losses (heat stroke, severe burns)
- Renal losses (diabetes insipidus)
- Third spacing (pancreatitis)

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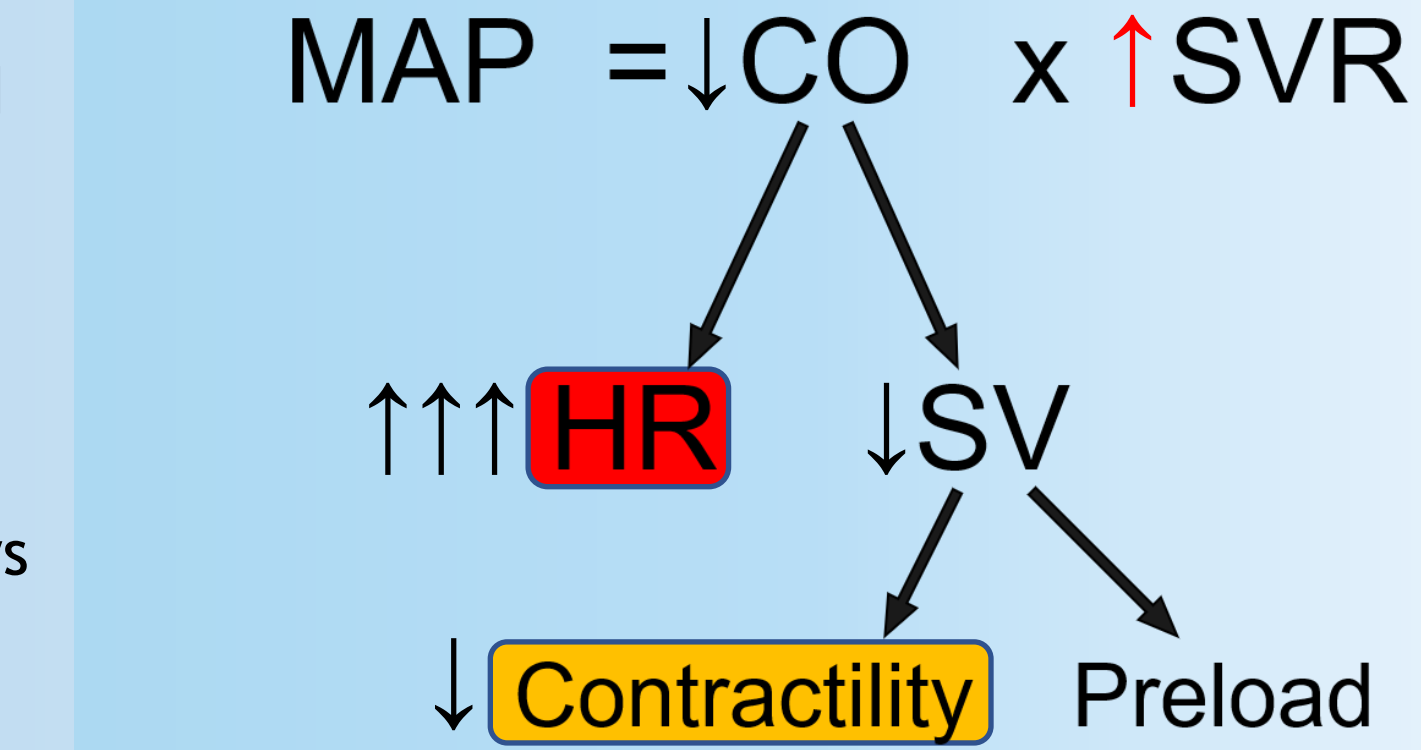
Cardiogenic Shock

Cardiogenic shock is “pump failure”

A 60 YO woman was admitted to the cardiology ward after receiving PCI for a confirmed myocardial infarction.

3 days after admission the patient reports sudden palpitations and soon loses consciousness. Her ECG shows ventricular tachycardia; you cannot detect a radial pulse.



Causes of Cardiogenic Shock

Cardiomyopathic

- Myocardial infarction
- Dilated cardiomyopathy
- Myocarditis
- Drug-induced (beta blocker)

Arrhythmogenic

- Tachyarrhythmia (A-fib, V-fib, V-tach)
- Bradyarrhythmia (2^{nd} or 3^{rd} degree heart block)

Mechanical

- Valve insufficiency or failure
- Valve stenosis
- Ruptured ventricular wall

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Obstructive Shock

- Due to extracardiac causes of pump failure.
  - Must be divided into two categories:

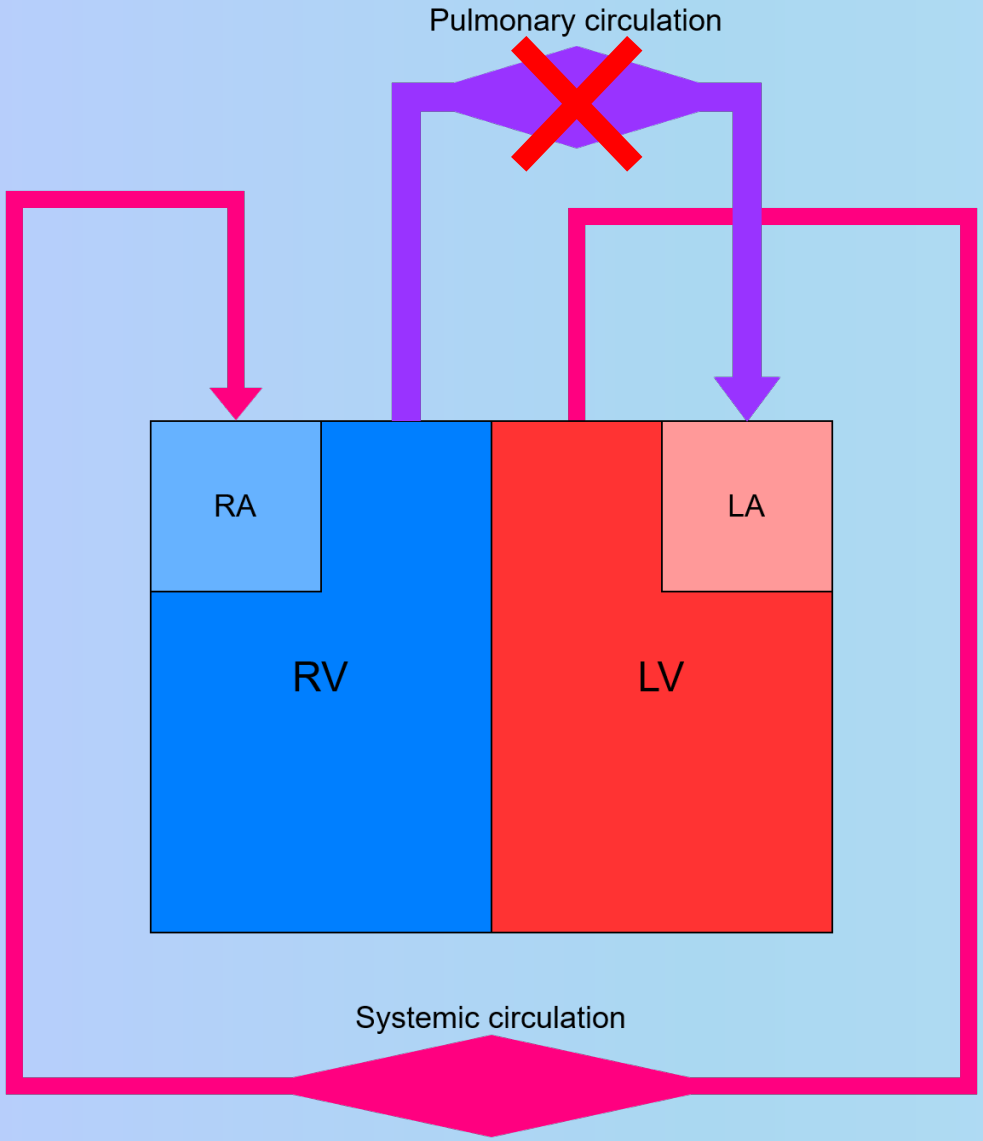
Pulmonary Vascular

- Massive pulmonary embolism or severe pulmonary hypertension.
- The RV cannot overcome the high pulmonary vascular resistance.
- Venous return to the left heart decreases.

Mechanical

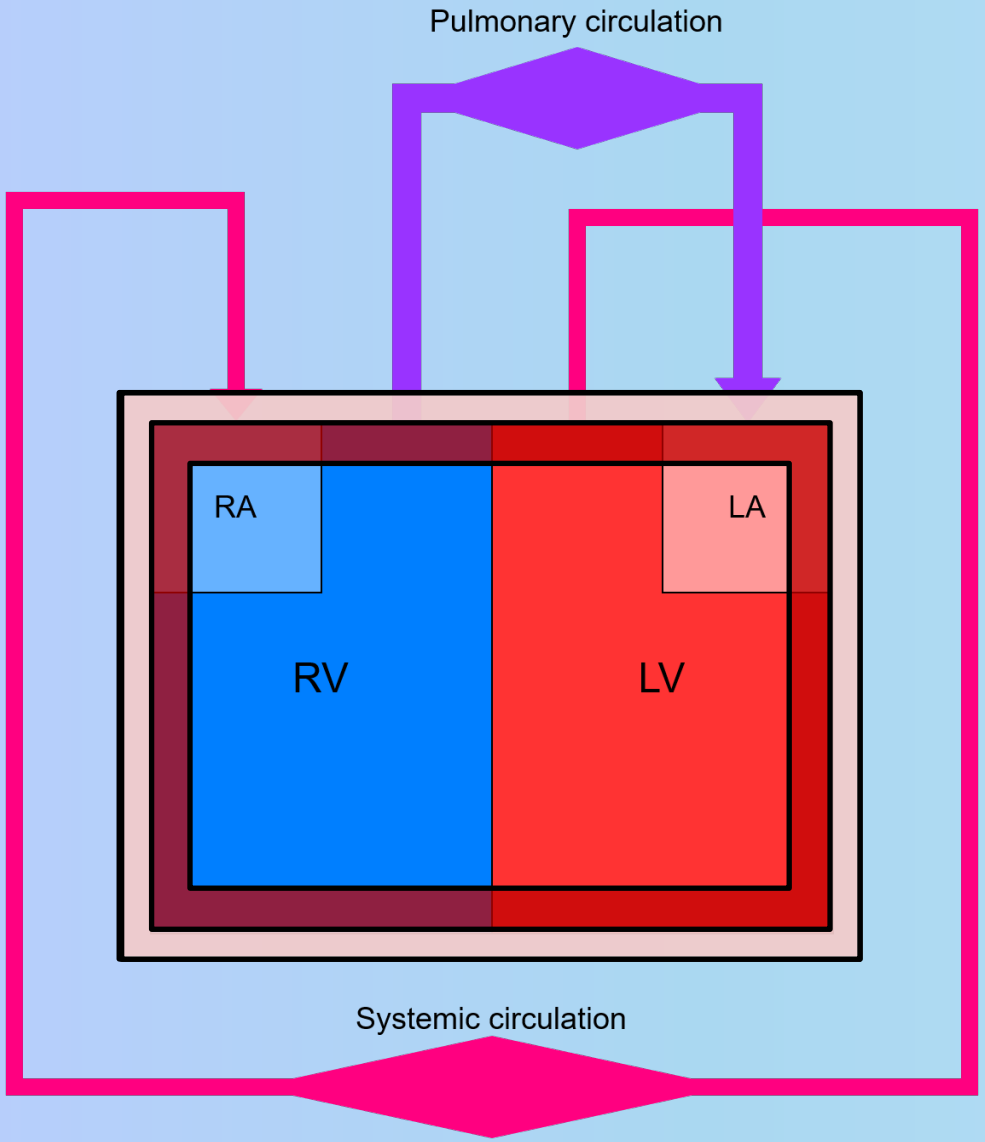
- The space that the heart can expand into is limited.
- Presents like hypovolemic shock, because preload cannot overcome the external pressure.
- Pericardial tamponade, tension pneumothorax.

Pulmonary Embolism



- The obstruction lies in a large pulmonary artery → ↑↑ PVR
- Preload in the LV decreases because no blood is passing through the pulmonary circulation.
- Afterload and HR increase to compensate for low BP.
- Patients do not typically present with shock at onset. Pulmonary symptoms are most common (dyspnea, chest pain, cough).

Pericardial Tamponade



- **Bleeding into the pericardial space until the elastic potential of the pericardium is reached.**
- End diastolic volume is low → stroke volume is low.
- Pulse pressure is lower.
- Beck triad: hypotension, jugular venous distension, distant heart sounds.

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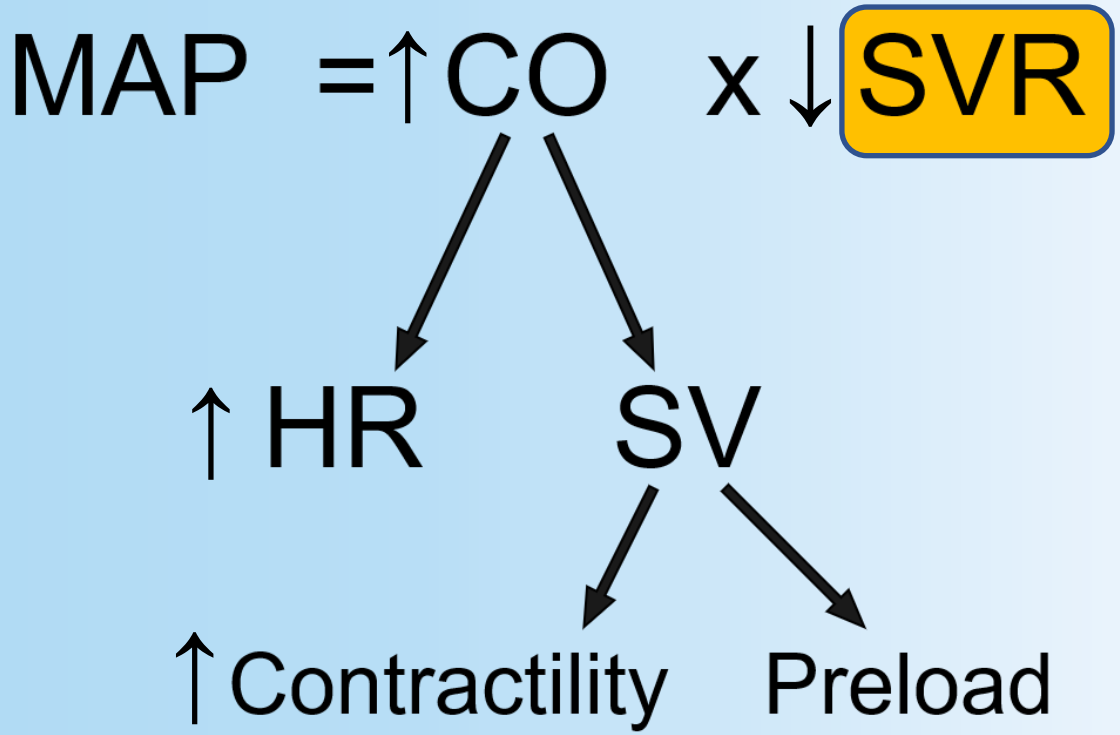
Distributive Shock

A 20 year old man is brought to the ER by paramedics with labored breathing and impaired consciousness. His skin is red and warm to the touch. HR is 150bpm.

The paramedics tell you the man was found in bed wearing a condom. His girlfriend reports he felt unwell before fainting on the way to the bathroom.



Flushed skin is a sign of distributive shock

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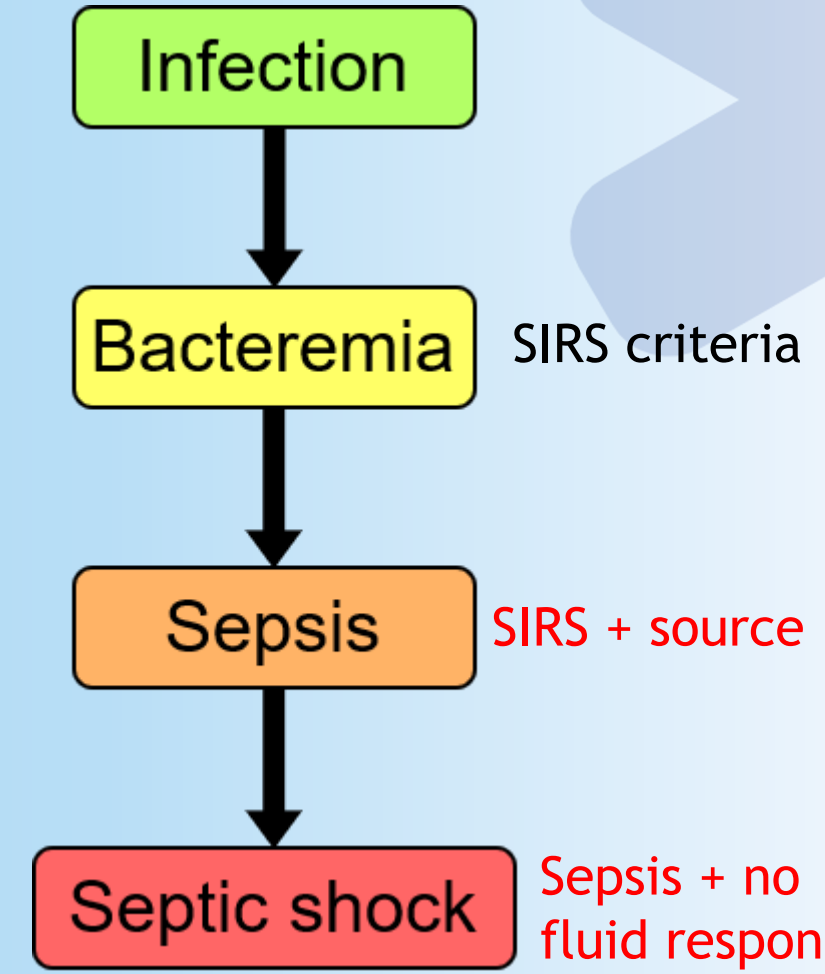
Causes of Distributive Shock

Shock	Etiology	Mechanism of vasodilation
Septic	Severe disseminated infection or disruption of walled-off infection.	Bacterial products and proinflammatory cytokines
Anaphylactic	Severe allergic reaction to food, medication, or insect bites.	Mast cell and basophil release of histamine
Neurogenic	Severe spinal cord injury or traumatic brain injury.	Autonomic disruption of vascular tone

With sepsis, be very sensitive

Septic shock

- Dysregulated host response to infection
- Excess inflammatory mediators disseminate in the bloodstream.
  - TNF-a
  - IL-1
- Preceded by fever, high WBC counts, other signs of infection (SIRS criteria)
- Shock due to hypotension, vessel damage, cell injury.
- qSOFA score uses mental status, systolic BP, and respiratory rate to assess mortality risk of septic shock.



https://onlinemeded.org/spa/in-the-icu/shock-3-septic-shock/video-lesson

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Measured and estimated using a pulmonary artery catheter

Summary - Types of Shock

Primary change
Compensatory response

Shock	Cause	Skin	Preload (PCWP)	Cardiac output	Afterload (SVR)
Hypovolemic	Hemorrhage, dehydration, burns	Cold, clammy	↓↓	↓	↑
Cardiogenic	MI, HF, valve dysfunction, arrhythmia	Cold, clammy	↓ or ↑	↓↓	↑
Obstructive	Tamponade, massive PE, tension pneumothorax	Cold, clammy	↓ or ↑	↓↓	↑
Distributive	Sepsis, anaphylaxis	Warm	↓	↑	↓↓
	CNS injury	Dry	↓	↓	↓↓

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