

# 11 SHOCK AND METABOLIC RESPONSE TO SURGERY

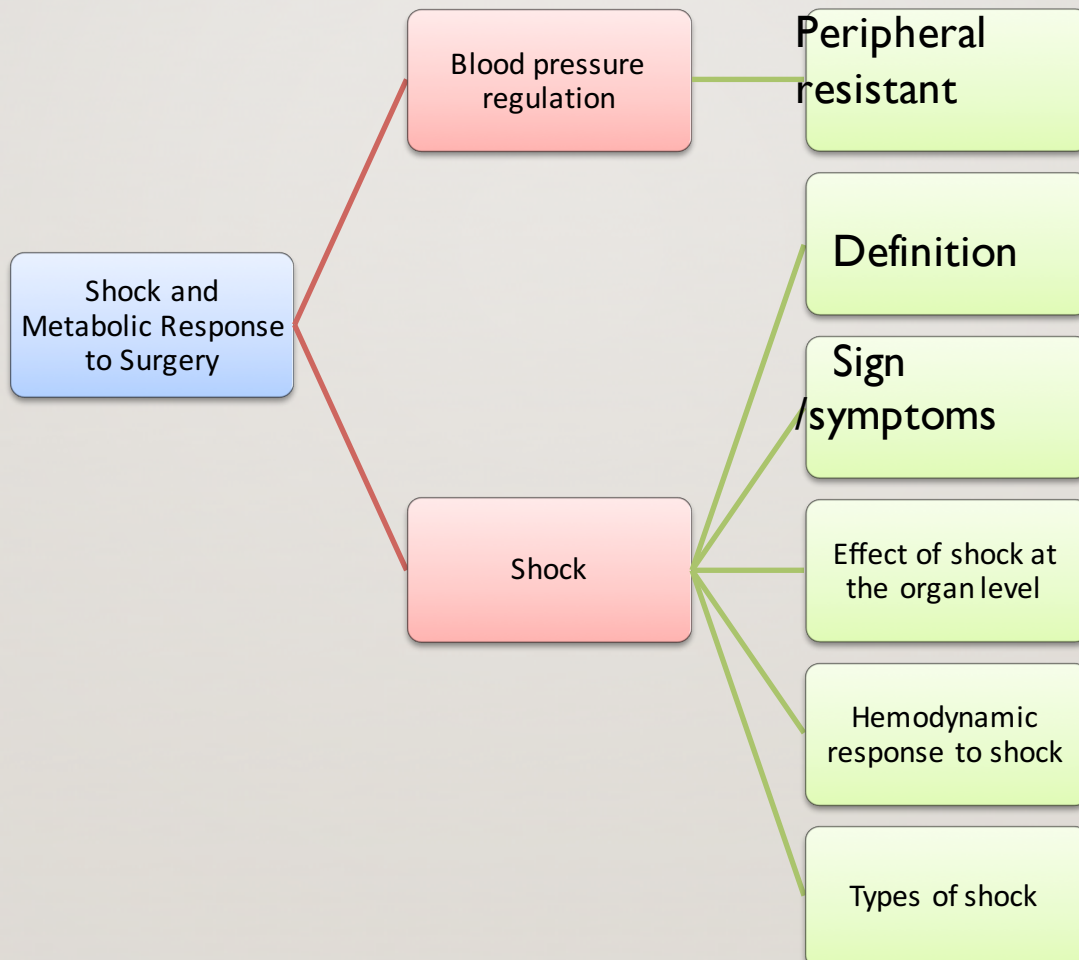
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# OBJECTIVES

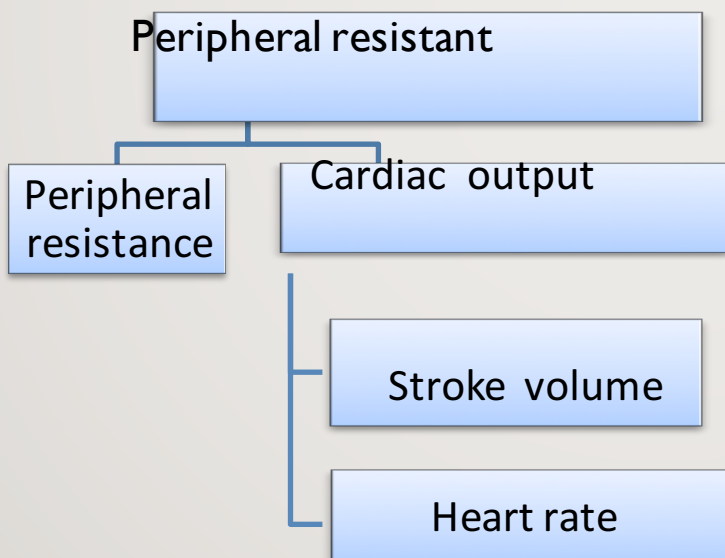
1. To understand physiology of sustaining blood pressure.
2. To learn about the classifications of shock.
3. To understand the consequences of the natural ~~history of shock.~~
4. To be able to diagnose and plan appropriate treatments for different types of shock.



# Blood Pressure Regulation

Changes in many elements regulate blood pressure (BP) and perfusion:

1. Intravascular volume.
2. Heart.
3. Arteriolar bed.
4. Capillary exchange network.
5. Venules.
6. Venous capacitance circuit.
7. Large vessel patency.



~~~~~  
**Peripheral Resistance:**

$$PR = (Pa - Pv) / CO$$

\* *Pa* = pressure in the artery.

\* *Pv* = pressure in the vein.

# Shock

**Shock:**

*It mostly affects veins since veins maintain intravascular volume for longer time.*

**Definition:** It is the state of altered tissue perfusion severe enough to induce derangements in normal cellular metabolic function.

- In short: low perfusion that causes tissue hypoxia.

**Types of shock:** more than one type may be present.

| Type of Shock                                                                                                                                                                          | Clinical Causes                                | Primary mechanism                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>1. Hypovolemic</b>                                                                                                                                                                  | Volume loss                                    | Exogenous blood, plasma, fluid or electrolyte loss                                                         |
| <b>2. Cardiogenic</b>                                                                                                                                                                  | Pump failure                                   | Myocardial infarction, cardiac arrhythmias, heart failure                                                  |
| <b>3. Distributive</b> "shock that will result in vasodilatation > vasodilatation or leak > lead to the movement of the blood outside the vessel > decrease the end diastolic volume." | ↑ venous capacitance or arteriovenous shunting | Septic shock, spinal shock, autonomic blockade, drug overdose<br><b>"Neurogenic, anaphylactic, septic"</b> |
| <b>4. Obstructive</b>                                                                                                                                                                  | Extra-cardiac obstruction of blood flow        | Vena caval obstruction, cardiac tamponade, pulmonary embolism, aortic compression or dissection            |

\* VC = vasoconstriction.

### Signs/symptoms:

Clinical signs and symptoms of shock relate to decreased organ perfusion:

✂ **Mental status changes:** decreased cerebral perfusion, e.g. delirium, syncope.

✂ **Decreased urine output:** decreased renal perfusion.

✂ **Cold clammy extremities:**

Decreased perfusion to the skin due to diverted blood flow.

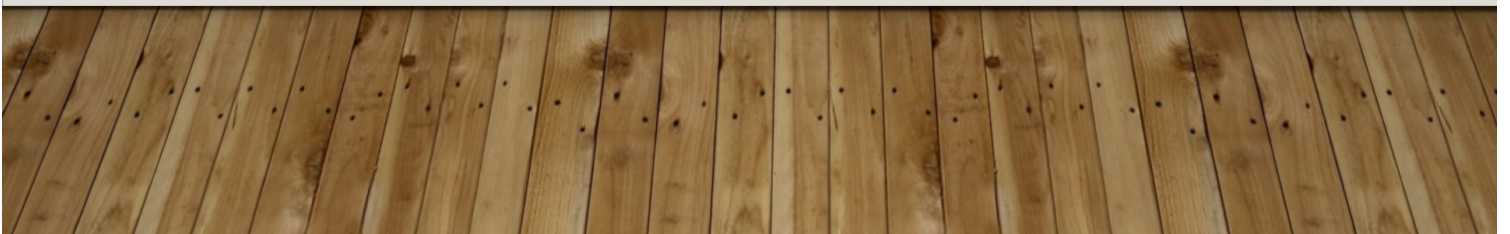
Hemodynamic parameters that may indicate shock:

Heart rate: Initial tachycardia (attempt to increase CO).

Rhythm: Regular and tachycardic.

Blood pressure: Low.

Cardiac output: Usually low.



## Effects of shock at the organ level:

- **Kidney:** Oliguric renal failure (to increase tubular reabsorption & decrease secretion).
- **Lung:** Capillary leak associated with or caused by sepsis and infection.
- **GI tract:** Failure of intestinal barrier (sepsis, bleeding); VC of splanchnic circulation; hypoperfusion.
- **Liver:** Liver failure, which is a rare cause.

## Hemodynamic response to shock:

Mechanisms for restoring cardiovascular homeostasis:

1. **Redistribution of blood flow:** Attempt to preserve perfusion to vital organs.
2. **Augmentation of cardiac output:**
  - Increased heart rate.
  - Increased peripheral resistance.
3. **Restoration of intravascular volume.**

*The organ that will contribute in responding to shock is the kidney, how?*

*The kidneys are part of the solution not the problem when the body responds to shock. It will retain salt that will maintain intravascular volume.*

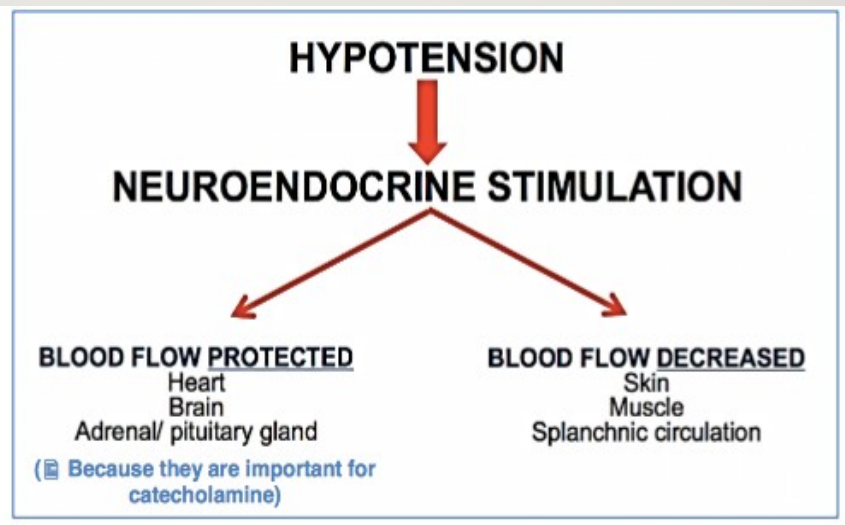
## Redistribution of blood flow:

*Norepinephrine is released from the adrenal gland it acts on alpha receptors which causes vasoconstriction. It's usually given in distributive shock.*

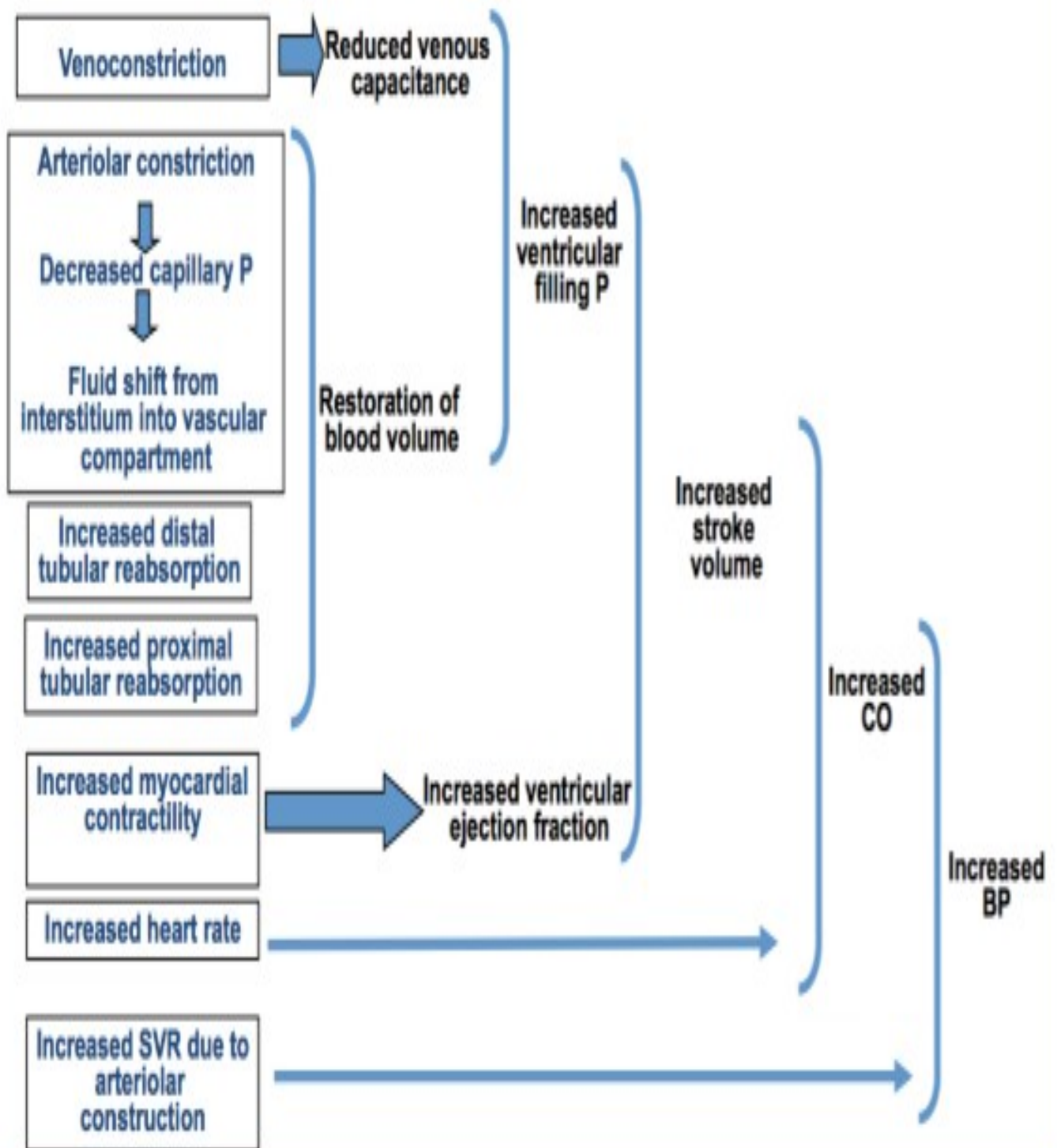
Epinephrine → 50%  $\alpha_1$  and 50%  $\beta_2$

Norepinephrine → 80%  $\alpha_1$  and 20%  $\beta_2$

Thus, NE has a more desirable effect in shocked patients



# HEMODYNAMIC RESPONSE TO SHOCK





## Types of shock:

### 5 Hypovolemic shock:

• **Decrease** in intravascular blood volume → **decrease** in cardiac output and tissue perfusion.

• **Causes:**

a. **Hemorrhage**. e.g. trauma, haematemesis, ruptured aortic aneurysm

b. Vomiting. → **Dehydration**

c. Diarrhea. → **Dehydration**

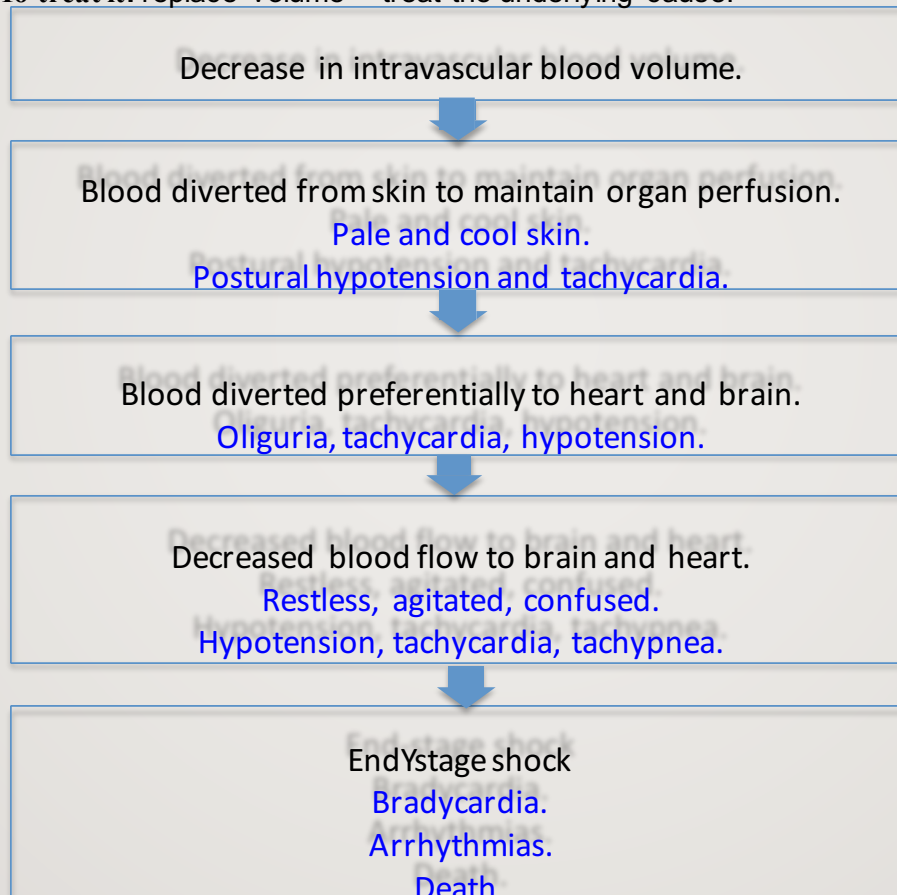
d. Fluid sequestration:

Y Intraluminal – bowel obstruction.

Y Intraperitoneal – pancreatitis.

Y Interstitial – burns.

• **To treat it:** replace volume + treat the underlying cause.



Hypovolaemic shock can be divided into four categories, depending on the amount of blood loss : ( class I, II, III, IV).

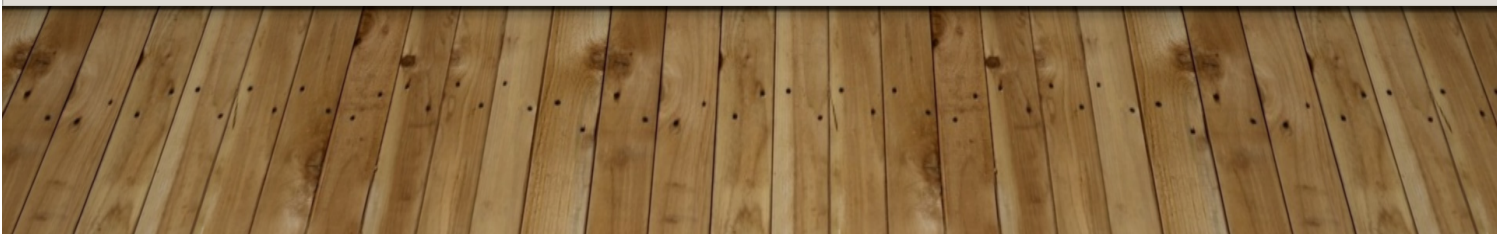
**The symptoms and signs relate to the amount of blood lost:**

I.minimal symptoms

II.Tachycardia  $>100$ , tachypnoea, decreased pulse pressure, pale, sweaty, cold peripheries.

III.Classic symptoms of shock – tachycardia  $>120$ , hypotension, tachypnoea, pallor, cold peripheries, decreased conscious level, oliguria.

IV.Immediate threat to life – tachycardia  $>140$ , hypotension (unobtainable diastolic), pallor, cold peripheries, unconscious ( $>50\%$ ), anuria.



## Types of shock:

### 2U Cardiogenic shock:

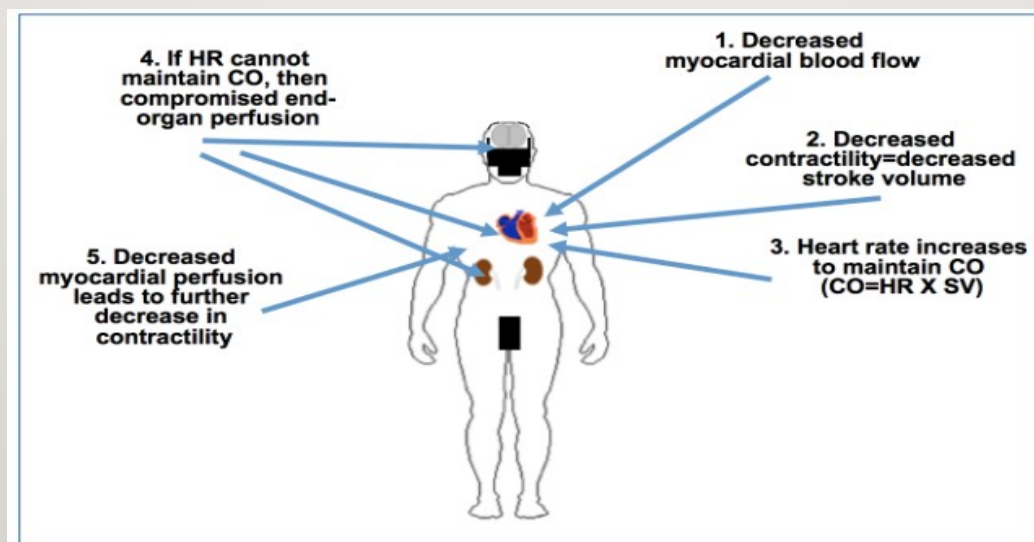
- Caused by the progressive loss of myocardium.
- Usually due to an **acute myocardial infarction**.
- When the total amount of myocardium affected reaches a critical point, myocardial function begins to deteriorate.
- While stroke volume decreases, the heart rate increases in an effort to maintain cardiac output ( $CO = SV \times HR$ ).
- But increased HR is limited and CO falls to levels that are inadequate to support end-organ function.
- Coronary perfusion decreases and this in turn causes progressive myocardial ischemia with progression of myocardial injury.

### Decreased cardiac function:

- Decreased ventricular function:
  - a) Myocardial infarction.
  - b) Pericardial tamponade.
  - c) Tension pneumothorax.
- Ineffective cardiac contraction:
  - a) Primary arrhythmias.

#### *How do you know if it is cardiogenic shock or not?*

1. Shortness of breath (SOB).
2. Raised JVP.
3. Lower limb edema.
4. Basal crepitation.



## Types of shock:

### 2UCardiogenic shock (Cont.):

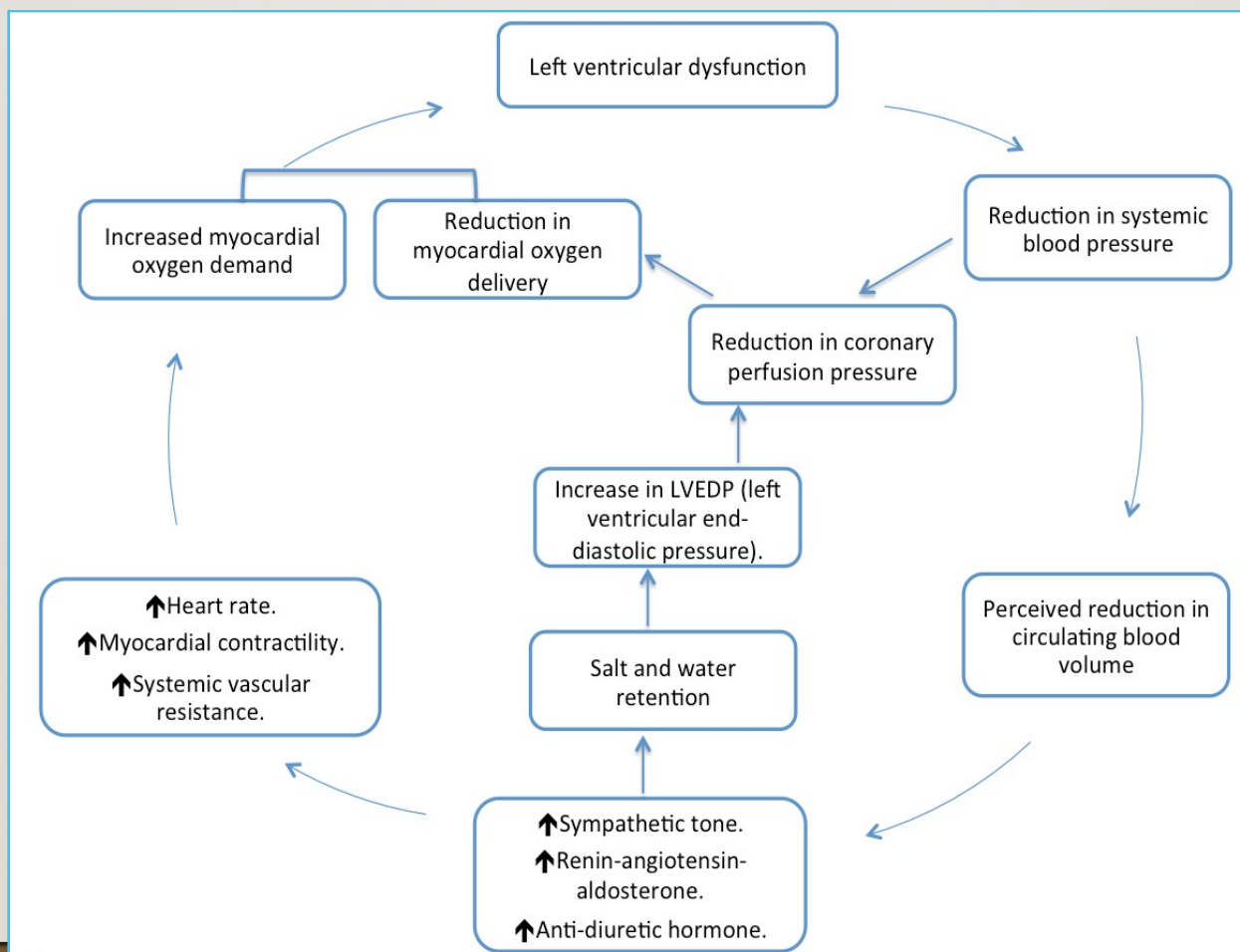
#### Clinical findings:

1. Hypotension.
2. Tachycardia.
3. Tachypnea.
4. Oliguria.

#### • To treat it:

- **Treat the underlying cause.**
- In cardiogenic shock **the volume is not the problem.**
- It's the only shock that you **DON'T give fluid** because the patient might develop **pulmonary edema** (because the ventricle is not functioning, all volume will go to the right ventricle then to lung).
- It is **very important** to differentiate between cardiogenic shock and other types, because cardiogenic shock is the only type in which patient is **!!never!!** given more volume

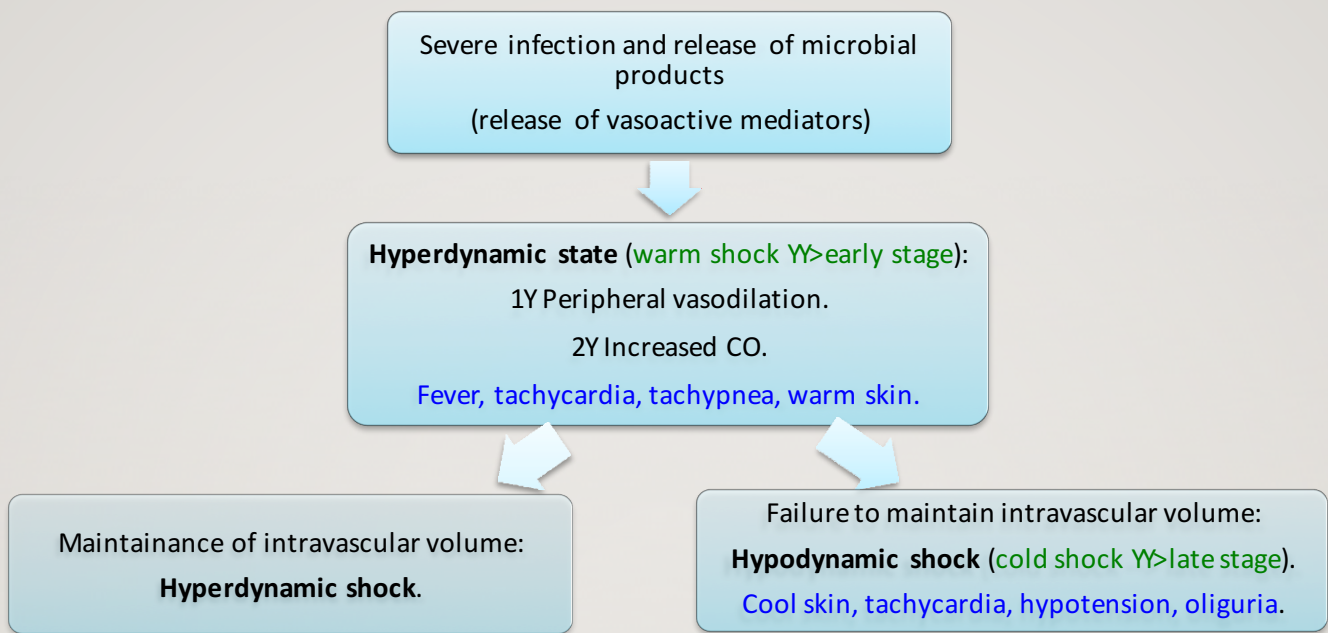
#### Events in cardiogenic shock:



## Types of shock:

### 3U Distributive shock:

#### A. Septic shock:



- To treat it: replace volume + give antibiotics.

In septic shock, initially extremities are warm (warm shock)

#### Notes

U Sepsis usually arises from a localized infection, with GramUve (38%) and increasingly Gram+ve (52%) bacteria being the most frequently identified pathogens.

UCardiac output typically increases to compensate for the peripheral vasodilation.

# Types of shock:

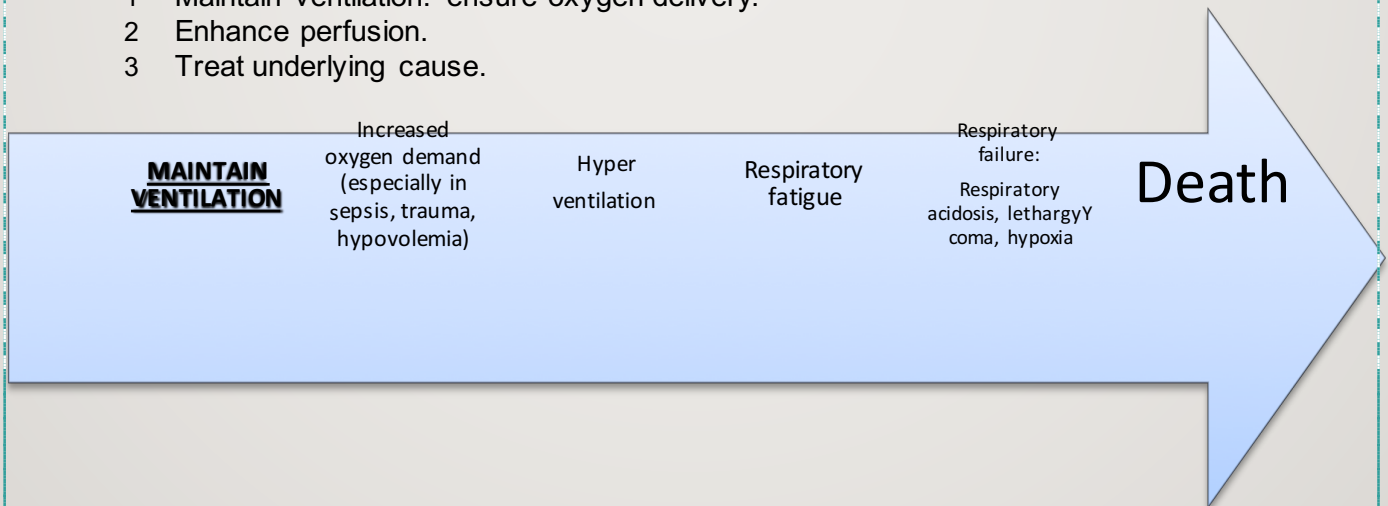
## 3U Distributive shock (Cont.):

### B. Neurogenic shock:

- It is a shock that result from a **high spinal cord injury (e.g. cervical spine traumatic injury)**. The injury is at level T2 or above. **Neurogenic shock is usually due to spinal cord injury above T2, mostly C3**
- This will result in **loss of sympathetic tone (unopposed parasympathetic tone)**.
- Loss of sympathetic tone will result in:
  - 1 Arterial and venous dilatation causing **hypotension**.
  - 2 **Bradycardia** as a result of unopposed vagal tone.
- The typical feature (**unique finding**) is **hypotension** with **bradycardia** (**non-neurogenic patient usually have tachycardia as a result of shock**).
- **Management of neurogenic shock:**
  1. Assessment of airway.
  2. Stabilization of the entire spine.
  3. Volume resuscitation.
  4. Rule out (R/O) other causes of shock.
  5. High dose corticosteroids.
  6. **In the non-trauma setting neurogenic shock is self-limiting.**

### Principles of resuscitation:

- 1 Maintain ventilation: ensure oxygen delivery.
- 2 Enhance perfusion.
- 3 Treat underlying cause.



## Systemic Inflammatory Response Syndrome (SIRS):

**Definition:** The patients demonstrate a similar response as sepsis but **WITHOUT** INFECTIVE AGENTS. It's just an inflammatory process.

**The criteria are 2 or more to call it SIRS.**

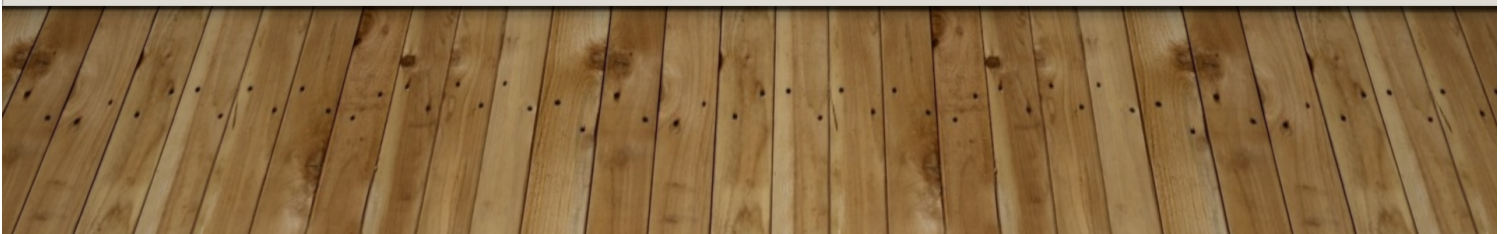
- 1) Temperature:** >38 or < 36 (in sepsis it could be hypothermia OR hyperthermia!).
- 2) Heart rate:** >90
- 3) RR (respiratory rate):** > 20 **or** a pCO<sub>2</sub> < 34 mmHg (4.3 kpa).
- 4) WBC:** > 12,000 **or** < 4,000 **with** more than 10% bands.

## Adult respiratory distress syndrome (ARDS).

### **What is ARDS?**

*It is a systemic release of inflammatory mediators, causing inflammation, hypoxemia and frequently **multiple organ failure** (the end result of untreated shock).*

*It may accompany many conditions, but most importantly: sepsis, pancreatitis, and severe traumatic injury.*





## SUMMARY

1. Shock is an altered state of tissue perfusion severe enough to induce derangements in normal cellular function.
2. Neuroendocrine, hemodynamic and metabolic changes work together to restore perfusion.
3. Shock has many causes and often may be diagnosed using simple clinical indicators.
4. Generic classification of shock:
  - a. **CIRCULATORY shock:**
    - Y Critical reduction in tissue perfusion results in organ dysfunction and, if untreated, death.
    - Y Usually accompanied by signs and symptoms:
      - Oliguria.
      - Mental status changes.
      - Weak thread pulse.
      - Cool clammy limbs.
  - b. **SEPTIC shock:**
    - Y Hypotension.
    - Y Vasodilation with warm limbs.
5. Treatment of shock is primarily focused on restoring tissue perfusion and oxygen delivery while eliminating the cause.

### Diagnosing shock state based on hemodynamic parameters

| Type               | Central venous pressure | Cardiac output         | Systemic vascular resistance (SVR) |
|--------------------|-------------------------|------------------------|------------------------------------|
| <b>Hypovolemic</b> | Decreased               | Decreased              | Increased                          |
| <b>Cardiogenic</b> | Increased               | Decreased              | Normal or Increased                |
| <b>Septic</b>      | Decreased or Increased  | Increased              | Decreased                          |
| <b>Traumatic</b>   | Decreased               | Decreased or Increased | Decreased or Increased             |
| <b>Neurogenic</b>  | Decreased               | Decreased              | Decreased                          |
| <b>Hypoadrenal</b> | Decreased or Increased  | Decreased or Increased | Decreased or Increased             |

**THANK  
YOU**

