



Cardiovascular Block

Physiology Team 430

## 14th Lecture

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# Circulatory shock

**This lecture is Done By :**

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## ❖ Circulatory shock:

Inadequate tissue perfusion with relatively or absolutely inadequate cardiac output

## ❖ Symptoms and signs:

increased heart rate	cold and moist skin	low blood pressure
weakness	thirsty	pallor
cyanosis	Oliguria	increased respiratory rate and thready pulse

## ❖ Stages of shock :

### ➤ Stage 1: Compensated Non-progressive Shock

Marked by:

A. decreased BP leading to increased sympathetic responses:

1-skin vasoconstriction

2-vasoconstriction to the kidneys → ↓urine output and ↑renin secretion → ↑Angiotensin II vasoconstrictor and ↑Aldosterone → ↑Na reabsorption and H<sub>2</sub>O retention)

3-Release of epinephrine and nor-epinephrine

4-Increase heart rate and force of contraction

B-Hypoxia

### ➤ Stage 2: Decompensated Progressive Shock

20- 30% of blood volume is lost and the CVS deteriorates:

1- Decrease of BP below 60 mmHg. Leads to myocardial ischemia, and a decrease in C.O. → More ↓ in BP

2- Intravascular clotting happens when: ↓ in blood volume → ↓ in blood velocity → ↑ Viscosity → Platelets aggregate → Clot formation → Obstruction

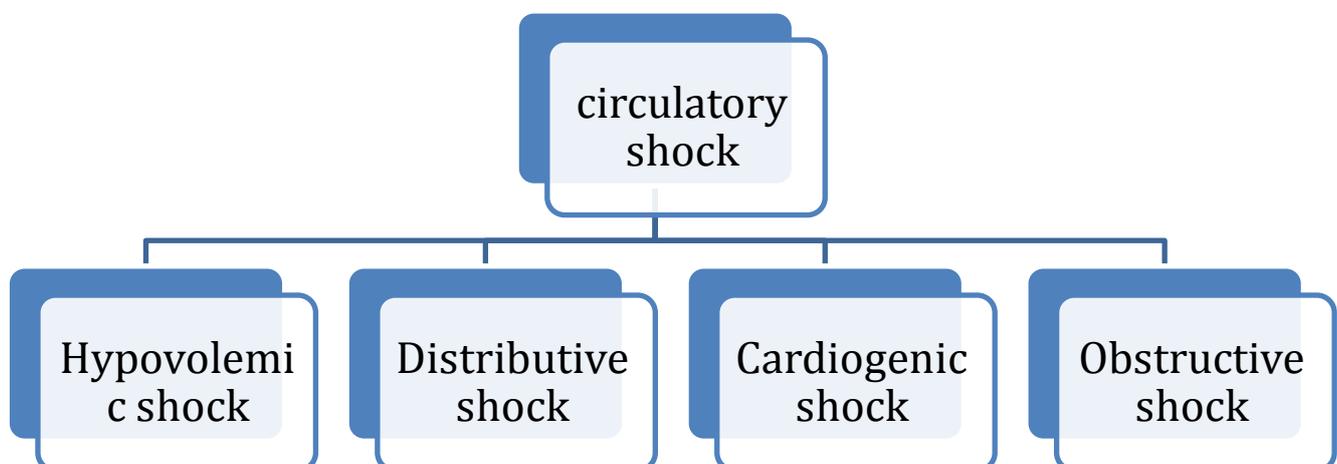
3- Cellular destruction caused by lysosomal rupture and ↓ activity of mitochondria, active transport and general metabolism

4- Build up of lactic acid → Acidosis

### ➤ Stage 3: Irreversible Shock:

The deterioration continues until the heart can no longer pump the blood and death occurs

### ❖ Types of circulatory shock:



## 1- Hypovolemic shock :

### Caused by:

A-Loss of blood volume due to:

→ hemorrhage : **Hemorrhagic shock is the most common cause of hypovolemic shock** .(It decreases the filling pressure of the circulation → ↓Venous return → ↓ C.O. → Shock)

→trauma

→surgery

B-Fluid loss due to:

→severe vomiting

→diarrhea

C-Plasma loss due to:

→burns

### **The loss of effective blood volume leads to:**

- 1- Anxiety, restlessness, altered mental state due to decreased cerebral perfusion and hypoxia
- 2- Hypotension due to decrease in blood volume
- 3- A rapid, weak, thready pulse due to decreased blood flow combined with tachycardia
- 4- Cool, clammy skin due to vasoconstriction
- 5- Rapid and shallow respiration due to sympathetic
- 6- Hypothermia due to decreased perfusion and evaporation of sweat
- 7- Thirst and dry mouth, due to fluid depletion
- 8- Fatigue due to inadequate oxygenation
- 9- Cold and mottled skin, especially extremities, due to insufficient perfusion of the skin
- 10- Distracted look in the eyes or staring into space, often with pupils dilated

### Pathophysiology of hypovolemic shock :

- 1-hypoventilation
- 2-rapid thread pulse
- 3-cold and pale skin
- 4-intense thirst
- 5-rapid respiration
- 6-restlessness

### **2-Distributive shock:**

Marked Vasodilation is caused by these three features :

- A)anaphylaxis → **Due to antigen-antibody reaction, e.g drug -induced reaction**
- B)sepsis
- C)neurogenic → **vasovagal, acute venous dilation**

**Distributive shock is also called:**

- 1- vasogenic shock**
- 2- low resistance shock**

### **3-Cardiogenic shock :**

Caused by inadequate cardiac output which is caused by heart diseases like:

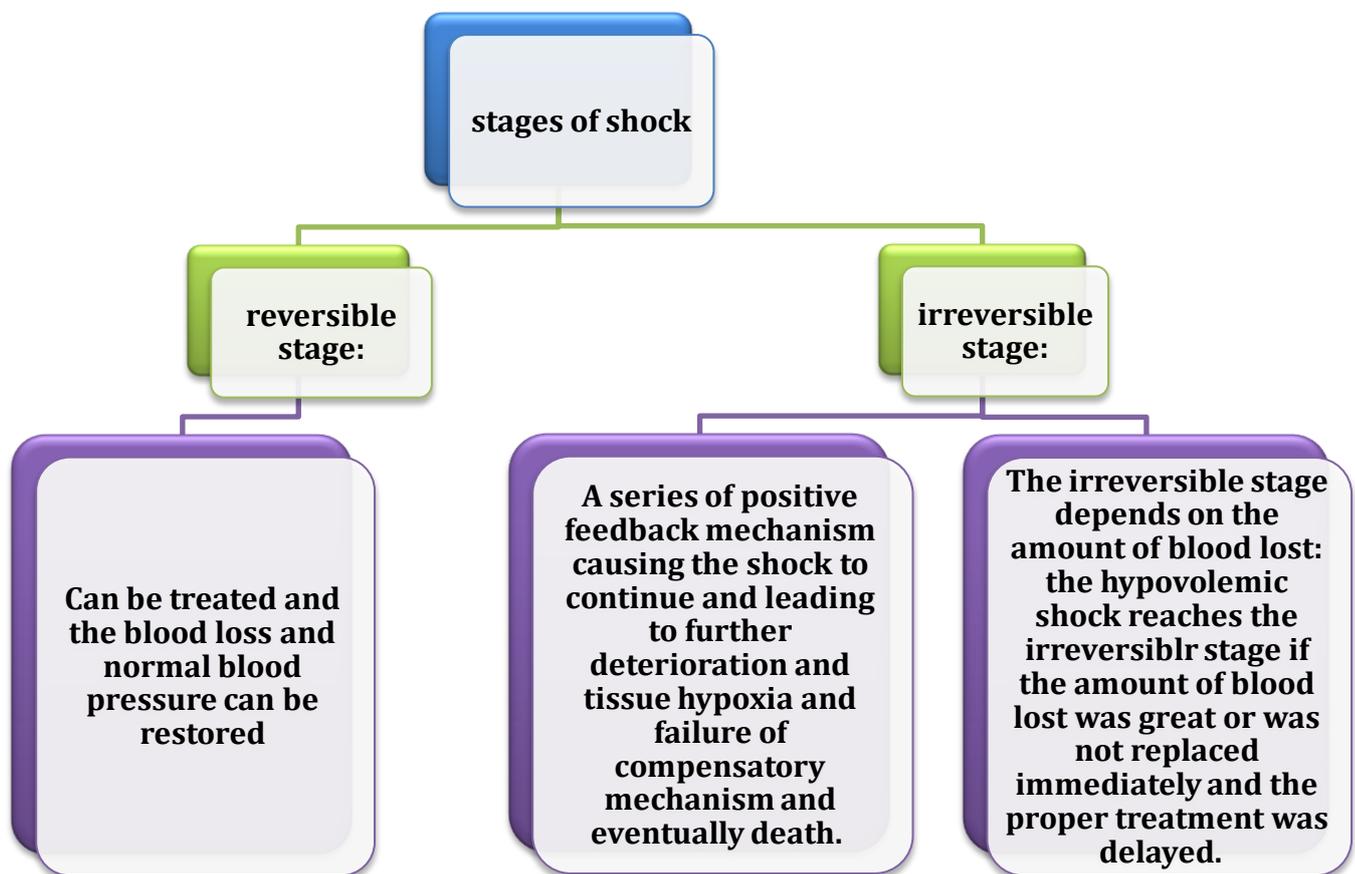
- myocardial infarction.
- congestive heart failure.
- arrythmia.

## **4-Obstructive shock:**

Caused by obstruction of the flow of the blood due to:

- tension pneumothorax .
- pulmonary embolism.

### ❖ Stages of shock :



## ❖ Stages of shock in response to hemorrhage

### A. Reversible stage :

Characterized by compensatory reactions:

1- Rapid compensatory reactions: They are immediate reactions and are activated within seconds or minutes. They include:

➤ **Vasoconstriction** :

Produced by :

1. Baroreceptor reflex in response to drop in ABP.
2. Chemoreceptor reflex.
3. Vasopressin-vasoconstrictor mechanism.
4. Noreadrenaline-adrenaline vasoconstrictor.

Vasoconstriction causes the TRP to increase and hence the ABP.

Vasoconstriction is marked in:

- 1- cold pale skin
- 2- decreased GFR and urine volume
- 3- viscera

The heart or the brain are spared

➤ **Tachycardia** :

Produced by :

- 1-Baroreceptor reflex
- 2-Chemoreceptor reflex
- 3-Increased sympathetic activity

➤ **Venoconstriction :**

Produced by : Sympathetic activity

This reaction is important to :

- 1-maintain the filling pressure of the heart
- 2-Shift blood from reservoirs into the circulation

➤ **Tachypnea ( an increase in respiratory rate ) :**

Produced by :

- 1-activation of chemoreceptor reflex
- 2-activation of sympathetic over activity

This reaction is important to:

- 1-Increase O<sub>2</sub> delivery
- 2-Increase thoracic pump activity

➤ **Restlessness :**

This reaction increases skeletal muscle activity

➤ **Increased secretion of vasoconstrictor factors/hormones**

- Catecholamines by adrenal medulla
- Vasopressin by posterior pituitary: it causes vasoconstriction and restores fluid volume by reducing urine output
- Renin-angiotensin-aldosterone. (preserve salt and water). -

## 2-Responses Activated within hours:

### A. Increased movement of interstitial fluid into capillaries

Called : capillary-fluid shift

Takes about 4 hours

### B. Increased secretion of glucocorticoids by adrenal cortex this reaction helps maintaining blood sugar

### C. Increased 2,3 DPG concentration in RBCs.

This reaction is important to help HB deliver more O<sub>2</sub> to the tissues

shift O<sub>2</sub> dissociation  
curve to the right

This stage is important for:

- Restoration of circulatory plasma volume. Takes 12-72 hrs after moderate hemorrhage
- Restoration of plasma proteins: occur in 2 stages:

a-Rapid entry of preformed albumin from extracellular stores

b-Hepatic synthesis of proteins over 3-4 days

- Restoration of RBCs by:

1- increasing RBCs count in response to erythropoietin within 10 days

2- restoration of red cell mass within 4-8 weeks

## B. Irreversible stage :

This stage include various types of +ve feedback mechanisms lead to drop in CO:

1-Cardiac depression

The drop in APB leads to drop in coronary flow and hence a drop in CO

2-Vasomotor failure

Results from depression of vasomotor center which leads to depression of the heart and causes the CO to drop

3-Release of toxins by ischemic tissues

e.g: histamine, tissue enzymes,

4-Endotoxins

Released from bodies of gram

When blood flow to intestine decreases it will cause an increased formation & absorption of toxins

5-Generalized cellular deterioration:

A. affects mitochondrial activity and causes decreased ATP

B. affects cellular metabolism especially glucose

C. rupture of many lysosomes

D. Drop in active transport of  $\text{Na}^+$  and  $\text{K}^+$  across the cell and causes Na accumulation inside the cell

## ❖ Other types of shock :

### ➤ Neurogenic shock

Due to failure of the nervous system to control diameter of blood vessel and causes increased vascular capacity.

Causes pooling of blood and there is no actual blood loss.

Causes of neurogenic shock:

- 1-Deep general anesthesia depresses the vasomotor center
- 2-Spinal anesthesia blocks the sympathetic nervous system
- 3-Brain damage can be a cause of vasomotor paralysis

Signs of shock may not be present in this type

### ➤ Anaphylactic shock :

An allergic condition in which the cardiac output and arterial BP decrease drastically.

Caused by histamine release by basophils and mast cells which leads to:

- 1-Venous dilation → ↓Venous return
- 2-Dilation of the arterioles → ↓ arterial BP
- 3-Increased capillary permeability → rapid loss of fluid and protein into the interstitial spaces → ↓Venous return

➤ **Septic shock :**

Due to bacterial infection widely disseminated to many areas of the body

Causes:

1-peritonitis

2-Generalized body infection spreading from skin

3-Generalized gangrenous infection resulting from gas gangrene bacilli

4-Infection spreading into the blood from the kidney or urinary tract

**Good Luck 😊**