# Shock

*Sunday 4 Nov 2007 , Dr.Aayed Al-Qahtani*

Hi !! These are some guiding signs :

(!) : Important note .

☒ : The Dr didn't mention this at all but it was found in the slides .

✡ : Is a risk question --> The Dr said that this point was important or asked a question about it .

- Have Q's ? found errors ? send them at : surgeryqueens@gmail.com

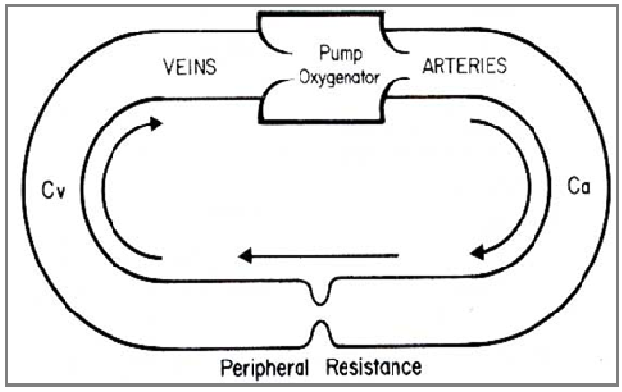
- Have fun studying ,, or .. at least اخلصوا النية لله.

## OBJECTIVES

- To understand Physiology of sustaining blood pressure .
- To learn about the classifications of shock .
- To understand the consequences of the natural history of shock .
- To be able to diagnose and plan appropriate treatments for different types.

## CHANGES IN MANY ELEMENTS REGULATE BP AND PERFUSION :

- Heart
- Arteriolar bed
- Capillary exchange network
- Venules
- Venous capacitance circuit (*imp.)
- Large vessel patency




### Decreased peripheral resistance :

*Decreased arterial blood pressure*
*[Mean Arterial Blood Pressure: (MAP) = CO XPR]*

*-peripheral resistance is found is arteries and asterioles.*
*-decreased peripheral resistance means there is vasodilatation and therefore blood stasis leading to decreased perfusion.*

### Increased peripheral resistance : (there is vasoconstriction)

*Decreased venous return*
*Decreased EDV*
*Decreased SV (stroke volume: volume of blood ejected in each contraction).*
*Decreased CO (CO = HR X SV)*
*Decreased arterial blood pressure (MAP=CO X PR).*

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- *Things that influence stoke volume:*

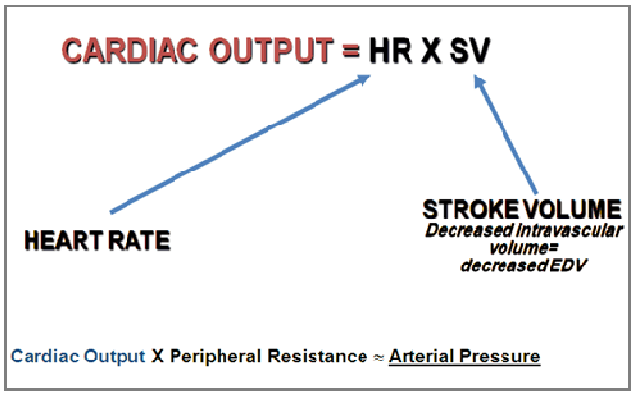
*-vasodilatation: increases venous return leading to increase in stoke volume.*
*-heart failure*
*-bradycardia* } *decrease stroke volume*

(!) Heart Rate X Stroke Volume = Cardiac Output
(!) Cardiac Output X Peripheral Resistance = Arterial Pressure

## (☒) HOW DOES INTRAVASCULAR VOLUME AFFECT BP & PERFUSION?

- **Alters mean blood pressure**
  Decrease in intravascular volume = decreased BP

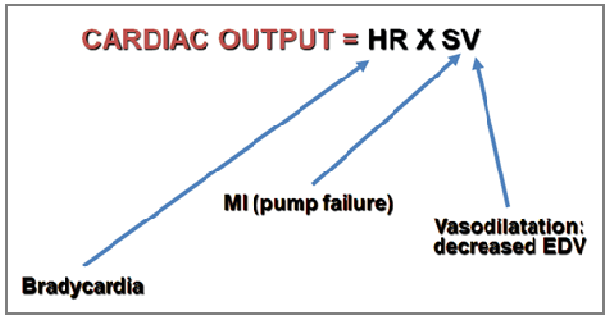
- **Alters venous return to the heart**
  - Decrease in intravascular volume =
  - Decreased venous return =
  - Decreased end diastolic volume
  - CO = HR x SV
  - CO X SV rate ≈ MAP ( mean arterial pressure )
- **How can intravascular volume be lost?**
  - Bleeding
  - Failure to rehydrate
  - Loss of third space fluids (sweating)




## (☒) HOW DOES CARDIAC FUNCTION ALTER BP &PERFUSION?

- **Cardiac output is the result of:**
  - Heart rate
  - Contractility
  - Loading conditions

- **Examples of changes that can alter cardiac output:**
  - Heart rate (bradycardia or tachycardia)
  - Contractility (MI or cardiomyopathy)
  - Load (histamine release: vasodilatation)



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## (☒) HOW DOES THE RESISTANCE CIRCUIT: ARTERIOLAR BED AFFECT BP & PERFUSION?

- Decreases in arteriolar tone produce:
- Hypotension
- Decreased perfusion to vital organs
- Increases in tone will prevent optimal cardiac performance (increased after load = decreased contractility)

## (☒) HOW DOES THE CAPILLARY EXCHANGE NETWORK AFFECT BP & PERFUSION?

- Largest area of the vascular tree
- Site of exchange of nutrients, electrolytes and fluids
- Alterations in microvascular integrity (e.g., capillary leak syndrome) result in loss of intravascular volume
- Blockage of or shunting away from small vessels leads to decreased tissue perfusion

## (!) HOW DOES THE VENOUS CAPACITANCE CIRCUIT AFFECT BP & PERFUSION?

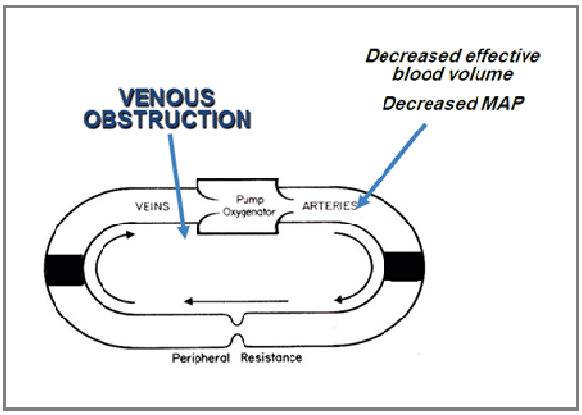
- Venous capacitance is the portion of the circulatory system that contains 80% of the intravascular volume. (The area of veins and venules and initial parts of capillaries that form pooling of blood.)
- Decrease in effective circulating blood volume and MAP caused by:
  - Decreases in venous tone
  - Increases in venous vascular capacitance

## HOW DOES LARGE VESSEL PATENCY AFFECT BP & PERFUSION?

- Obstruction of the systemic or pulmonic circuit will decrease ventricular ejection and systemic perfusion.
- Venous obstruction will decrease venous return.
- Examples of obstructive shock (the heart is ok and the volume is ok but the obstruction is from the outside):
  - **Massive pulmonary embolism**
  - **Venous occlusion**

**(!) Obstruction of vessels not heart.**

- Similar to this is cardiac tamponade.




## Definition of Shock :

State of altered tissue perfusion severe enough to induce derangements in normal cellular metabolic function. (Altered level of tissue perfusion resulting in tissue hepoxia.)

**(!)** *All types of shock eventually result in impaired tissue perfusion & the development of acute circulatory failure or shock syndrome .*

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## TYPES OF SHOCK

| Type Of Shock | Clinical Causes | Primary Mechanism |
|---|---|---|
| Hypovolemic | Volume loss | Exogenous blood, plasma, fluid or electrolyte loss |
| Cardiogenic | Pump failure | Myocardial infarction, cardiac arrhythmias, heart failure |
| Distributive | Increased venous capacitance or arteriovenous shunting * | Anaphylactic shock , septic shock, spinal shock, autonomic blockade, drug overdose |
| Obstructive | Extra-cardiac obstruction of blood flow ( e.g. 1- problem in vessels "pulmonary embolism" 2- cardiac temponade) | Vena caval obstruction, cardiac tamponade, pulmonary embolism, aortic compression or dissection |
| (!) MORE THAN ONE TYPE MAY BE PRESENT | | |

-*Arteriovenous shunting: Is flowing of blood to other abnormal extra sites that have high perfusion (like a tumor) so the blood shunts from the main circulation and causes hypoxia to the normal body tissue.

_ Neurogenic shock is due to damage to sympathetic nerve supply to vessels leading to vasodilatation and shock.
- Commonest cause of nuerogenic shock is spinal cord injury (usually cervical).

◘ The Clinical Signs & Symptoms of Shock Related to Decreased Organ Perfusion :

- **Mental status changes ( decreased cerebral perfusion ) :**
  - ☒ Loss of consciousness , restless , irritable , apprehensive , unresponsive except to painful stimuli only.
- **Decreased urine output :** decreased renal perfusion .
- **Pale:** **Cold clammy extremities :** due to vasoconstriction for redistribution of blood and flowing of blood to more important organs like heart and brain leading to decreased perfusion to unimportant organs (like the skin causing it's coldness).

*Pallor and decreases urine output are the primary changes.

- **EKG changes (usually late):**

1. May indicate myocardial ischemia
2. May be primary event (cardiogenic shock) or due to decreased myocardial perfusion due to shock from other causes.

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## Hemodynamic Parameters That May Indicate Shock :

- **Heart rate :** Initial tachycardia (attempt to increase CO)
- **Rhythm :** Regular and tachycardic .
- **Blood pressure :** Low (Hypotension)
- **Cardiac output :** Usually low
- **Tachypnea , pallor .**

**(!) BP is not an early sign , we first check the tachypnea & tachycardia.**

## Effects of Shock at Organ Level :

- **Kidney :** Oliguric renal failure ( b/c decreased renal perfusion → renin secretion → angiotensin II → vasoconstriction + aldosterone release → sodium & water retention.
- **Liver :** Liver failure
- **GI tract :** Failure of intestinal barrier (sepsis, bleeding)
- **Lung :** Capillary leak associated with or caused by sepsis and infection (ARDS = adult respiratory distress syndrome)

## Hemodynamic Response to Shock :

Mechanisms for restoring cardiovascular homeostasis & blood flow :

- **Redistribution of blood flow :** Attempt to preserve perfusion to vital organs.
- **Augmentation of cardiac output :** Increased heart rate + Increased peripheral resistance.
- **Restoration of intravascular volume:** 1- decrease in urine out put.
  2- fluid will come out from extravascular spaces to intravascular )

## Hemodynamic Response to Shock (redistribution of blood flow ):

Hypotension causes neuroendocrine stimulation :

- **Decreased blood flow from (vasoconstriction by hormonal stimulation):** Skin , Muscle , Splanchnic circulation (GIT).
- **Protected blood flow to (vasodilatation by hormonal stimulation) :** Heart , Brain , Adrenal/pituitary gland.

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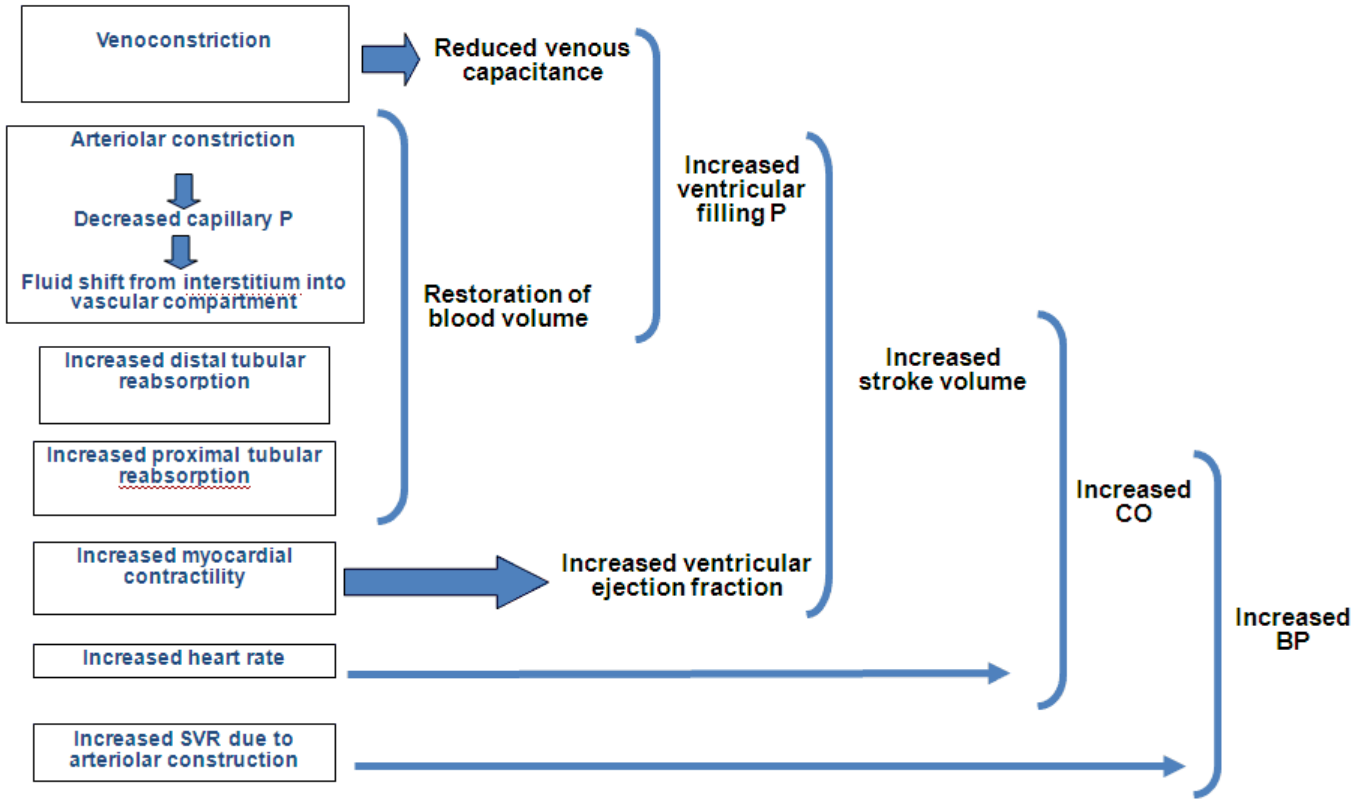
## HEMODYNAMIC RESPONSE TO SHOCK




*very important for you to know the factors on the left .. understand this figure well.*

## Cardiogenic Shock :

Decreased Cardiac Function (due to intrinsic or extrinsic causes) :

- **Decreased ventricular function :**
  - Myocardial infarction
  - Pericardial tamponade
  - Tension pneumothorax
- **Ineffective Cardiac Contraction :**
  - Primary arrhythmias
- **Clinical Findings of Cardiogenic Shock :**
  - Hypotension
  - Tachycardia
  - Tachypnea
  - Oliguria

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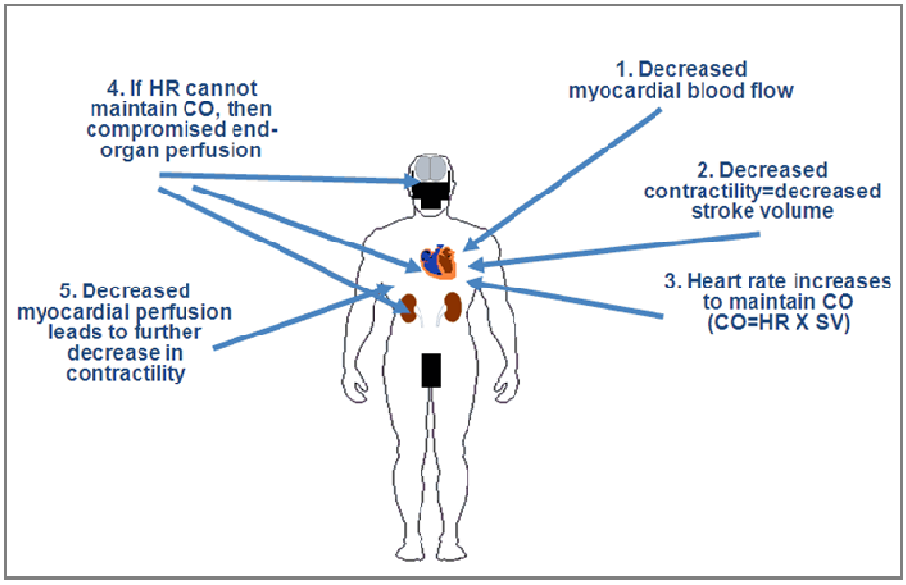
## Mechanism :

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 x 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 (vicious circle).




**Events in Cardiogenic Shock**

## Hypovolemic Shock :

- **Hemorrhage**
- **Diuretics**
- **Vomiting**
- **Diarrhea**
- **Fluid Sequestration :** *( third spacing : fluid leaking in a space outside the circulation, the fluid volume in the body is normal but it is redistributed in the body.)*
  - Intraluminal : bowel obstruction ( fluid volume in the bowel is not absorbed b/c of obstruction )
  - Intraperitoneal : pancreatitis
  - Interstitial : burns

➔ **Decrease in intravascular blood volume ➔ Decrease in cardiac output & tissue perfusion.**

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**-Note: Ascites is not considered one f the third spacing.**

## Mechanism :

When there is decrease in intravascular blood volume → blood is diverted from skin to maintain organ perfusion ( Presented as : pale and cool skin , postural hypotension and tachycardia ) →then , blood is diverted preferentially to heart & brain ( Presented as : Oliguria ,Tachycardia , Hypotension ).

## Septic Shock :

-Severe infection with release of microbial products ( release of vasoactive mediators ) → Hyperdynamic state to pump blood ( peripheral vasodilation , increased CO , fever , tachycardia , tachypnea , warm skin ) →

- **Maintenance of intravascular volume :** hyperdynamic shock
- **Failure to maintain intravascular volume :** hypodynamic shock ( cool skin , tachycardia , hypotension , oliguria )

-There will be vasodilatation → decreased peripheral resistance → increased venous capacitance → increased peripheral volume → decreased venous return → increased heart rate (tachycardia) with decreased stroke volume.

**(!)Remember:** Initially (early phase: first 2-3 hours) there is fever and warm skin and extremities due to vasodilatation and warm blood flow, in a later phase the skin becomes pale and cool due to vasoconstriction and decreased COP where the body fails to maintain the volume.

### DIAGNOSING SHOCK STATE BASED ON HEMODYNAMIC PARAMETERS

| TYPE | Central Venous Pressure | Cardiac Output | SVR |
|---|---|---|---|
| Hypovolemic | Decreased | Decreased | Increased |
| Cardiogenic | Increased | Decreased | Normal or Increased |
| Septic | Decreased or increased | Increased | Decreased |
| Traumatic | Decreased | Decreased or increased | Decreased or increased |
| Neurogenic | Decreased | Decreased | Decreased |
| Hypoadrenal | Decreased or increased | Decreased or increased | Decreased or increased |

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## (!) ✡ Systemic Inflammatory Response Syndrome (SIRS) :

- The patients demonstrate a similar response as sepsis but without infective agents.
- The commonest cause is trauma to an organ where the body starts reacting to that.
- The criteria are : (two or more to call it SIRS)
  - Temperature >38 or < 36
  - Heart rate >90
  - RR > 20 or a pco2 < 34 mmHg (4.3 kpa)
  - WBC > 12,000 or < 4,000 with more than 10% bands

## Neurogenic Shock :

- A type of distributive shock , the most common cause is spinal cord injury .
- It is a shock that result from a high spinal cord injury ( e.g Cervical spine injury)
- This will result in loss of sympathetic tone .
- Loss of sympathetic tone will result in:
  - Arterial and venous dilatation causing hypotension.
  - **(!)** ✡ Bradycardia as a result of unopposed vagal tone (unlike other kinds of shock where there will be initial tachycardia making this bradycardia a very characteristic sign in neurogenic shock.)
- ✡ **The typical feature is hypotension with Bradycardia.**
- Management of neurogenic shock
  - Assessment of airway.
  - Stabilization of the entire spine.
  - **(!)** Volume resuscitation.
    ***ALL types of shock we do volume resuscitation except : Cardiogenic shock ( b/c the volume is normal )**
  - R/O other causes of shock.
  - High dose corticosteroids.

## Principles of Resuscitation :

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

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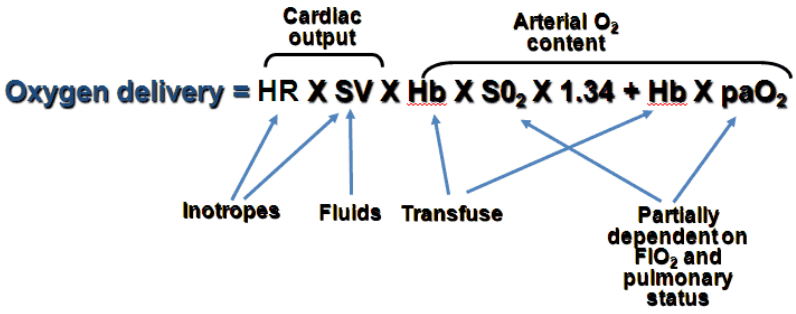
## Treatment of Shock :

ENHANCING PERFUSION/OXYGEN DELIVERY




SUMMARY :

- Shock is an altered state of tissue perfusion severe enough to induce derangements in normal cellular function.
- Neuroendocrine, hemodynamic and metabolic changes work together to restore perfusion.
- Shock has many causes and often may be diagnosed using simple clinical indicators.
- Treatment of shock is primarily focused on restoring tissue perfusion and oxygen delivery while eliminating the cause .

In cardiogenic shock there will be:
1-raised JVP
2-pulmonary edema
3-bilateral cripitations
-so this means we don't give more volume in resuscitating because if we do in that case there will be more lung congestion.

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Wait .. !! there's MORE (some Q's & important notes ) :

★ Hypovolemic shock is a volume problem.

★ Cardiogenic shock is a pump problem .

★ Distributive shock is a vessel problem.

★ Anaphylactic shock , neurogenic shock , septic shock are all classified under distributive shock.

★ Most common cause of cardiogenic shock is anterior left ventricular MI .

★ In distributive shock , pump is fine but volume is not reaching the tissues .

★ Anaphylactic shock : allergic reaction to an antigen.

★ Neurogenic shock is the rarest form of shock .

★ For your knowledge : neurogenic shock is due to impaired descending sympathetic pathways in the spinal cord , this leads to loss of vasomotor tone & innervations to the heart , leading to pooling of the blood in the lower limbs .

★ In septic shock , there are two phases :

1- warm shock ( early phase ) : hyperdynamic response , vasodilation.

2- cold shock ( late phase ) : hypodynamic response , decompensated state , vasoconstriction.

★ The only type that is presented with bradycardia is neurogenic shock .

★ Fluid is the usual initial step in management in all types of shock EXCEPT in cardiogenic shock ( b/c the volume is normal ).

★ Bradycardia is hallmark of neurogenic shock, because loss of sympathetic tone.



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