

How the heart maintain homeostasis?
via pumping the blood

The cardiovascular system composed from three component:-

1] heart 2] blood 3] blood vessel

1] blood :- component from

① red blood cell ② white blood cell ③ platelet ④ plasma

↳ transfer O_2 , ↳ immune system ↳ clotting ↳ protein,

clearance the cell from CO_2 (40-45)% ↓ (1%) nutrient, hormone

2] blood vessel :- branching of blood vessel

artery, arterial, capillary (arterial, venous), venous, vein

characteristics of the blood vessel?

1] diameter (near the heart → diameter large)

(far the heart → diameter small)

2] three layer of the blood vessel

1] tunica intima :- component from endothelial cell, the function:-

① the main function smooth blood flow ② maintain on the vascular tone (contraction, relaxation) ⇒ stimulation on the produce vasoconstrictor, vasodilator ③ maintain on the balance between coagulation and anticoagulation and maintain the balance between molecules that stimulate the inflammation and molecules that decrease inflammation

What is the mean of the shock?

decreased the blood perfusion (decrease O_2 and nutrient) for certain organ or system of the body (acute circulatory disease). because of the heart failure & all the body will collapse.

Some organs tolerate decrease nutrient and oxygen more than other organ. (specific time for all organ)

the ischemia lead to shock because the shock has stages. (it does not lead to directly death).

in the compensated shock the body tries to restore an unbalanced state to balanced.

2% from hospitalized patients due to shock.

the shock occur 10% in children and (30-40%) in adults.

Shock :- systemic reduction in tissues perfusion (decrease in O_2 and nutrient) \Rightarrow when decreased the oxygen the cell will depend on anaerobic respiration \Rightarrow produce lactic acid \Rightarrow increase acidosis \Rightarrow decreased the pH (depend on glucose).

vital organ (brain, heart, kidney, liver, lung, GI). are affected by ischemia in different ways. (ability tolerate).

Tissue ischemic sensitivity (completely lack of oxygen) :-

- heart, lung, brain \Rightarrow 4-6 min (all organ will stop working)
 - GI tract, liver, kidney \Rightarrow 45-60 min
 - muscle, skin \Rightarrow 2-3 hours
- } \rightarrow store material

what is needed to maintain perfusion

[1] pump (heart) \Rightarrow because of perfusion fail \rightarrow heart failure

[2] pipes (blood vessel) \Rightarrow because of perfusion fail \rightarrow injury \rightarrow pipe failure

these types for shock called warm shock or flushing shock.

blood pressure = Cardiac output \times systemic vascular resistance

stroke volume \wedge heart rate \Rightarrow decreased the cardiac output \Rightarrow increased to stroke volume and heart rate to increased (CO).

\hookrightarrow when increased vascular resistance \Rightarrow increase cardiac output \Rightarrow increase venous returns \Rightarrow increased preload and after load \Rightarrow

All the blood come out by vasodilation centrally and vasoconstriction peripherally.

the relationship :- [1] centrally \Rightarrow direct between the blood pressure and cardiac output because of the systemic vascular resistance is almost non-existent (figure 4.11)

[2] peripherally \Rightarrow reversible between the blood pressure and cardiac output because of the systemic vascular resistance exists. (figure 4.12)

Hallmark symptoms for shock are :-

[1] decreased blood pressure (hypotension) [2] increased heart rate.

by three stages \hookrightarrow second hallmark \hookrightarrow first hallmark

the stages of shock (progressive process) :-

[1] compensated shock :- CO and SVR (peripheral vasoconstriction and central vasodilation) work to keep BP within normal.

On exam :- Tachycardia (increase HR), decreased pulses, cool extremities in cold shock, Flushing and bounding pulses in warm shock, Oliguria (decrease produce urine), labs may show mild lactic acid, tachypnoea (increased respiratory rate), decreased skin perfusion altered mental status \Rightarrow \hookrightarrow \hookrightarrow \hookrightarrow

- 5] pale, cool skin (cardiogenic, hypovolaemic shock).
- 6] flushed skin (Anaphylactic, septic, Neurogenic shock).
- 7] Nausea (القيء), vomiting (القيء), thirst (العطش)
- 8] decreased body temperature (feels cold).
- 9] weakness. *عجز*

Role of anti-diuretic hormone in dehydration? (دور الهرمون المضاد لإدرار الماء في الجفاف)

dehydration (decreased in water) \Rightarrow increase osmolarity \Rightarrow osmoreceptor in hypothalamus detect to increase the osmolarity \Rightarrow release ADH in blood stream \Rightarrow increased reabsorption for water \Rightarrow decreased urine output.

2] progressive shock: compensation mechanism begin to fail.

presentation: hypotension (decreased blood pressure), increase in heart rate, rapid and thready pulse ((النبض) سريع ورفيع), agitation (التهيج), restlessness (القلق), confusion (الارتباك).

doesn't has sympathetic nervous system \Rightarrow cardiac effects are (decreased oxygen, decreased coronary blood flow, Myocardial (myocyte) ischemia, decreased ventricular filling, decreased force of contraction).

\Rightarrow peripheral effects are (peripheral pooling of blood (تجمع الدم في الأوعية), plasma leakage into interstitial space (تسرب), cold, grey and waxy skin, Restlessness, confusion, slow speech (more than compensated), Tachycardia (more than compensated), decreased \uparrow bp) \Rightarrow respiratory

effects are (continue to decrease oxygen \Rightarrow anaerobic respiration (to continue ATP production) \Rightarrow increase lactic acid \Rightarrow increase acidosis \Rightarrow decrease pH and the chemoreceptor detect decrease pH level

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activation for two type from receptors, baroreceptors (detect BP) chemoreceptors (detect to O_2 and CO_2 level) \Rightarrow transmission for Action potential via sympathetic nerve \Rightarrow cardiac and respiratory center (medulla oblongata) \Rightarrow cardiac effect (Increased force of contraction, Increased heart rate (tachycardia), Increased CO), and peripheral effects are (vasoconstriction, increased peripheral resistance \Rightarrow increased systemic circulation blood and decreased in periphery blood), shunting of blood to main organ) \Rightarrow respiratory effects (activation baroreceptor \Rightarrow increased respiratory rate) \Rightarrow renal effects (decreased renal blood flow \Rightarrow activation for renin angiotensin aldosterone system \Rightarrow increased vasoconstriction \Rightarrow increased reabsorption for water and Na^+) \Rightarrow hypothalamus effects (decreased blood flow to hypothalamus \Rightarrow activation for posterior pituitary gland to release anti-diuretic hormone \Rightarrow reabsorption for Na^+ and water \Rightarrow increased vasoconstriction) \Rightarrow hormonal effects (secrete ~~glucagon~~ glucagon (break to glucose), secrete adrenocorticotrophic hormone (secrete cortisol work to increase glucose and blood pressure).] \Rightarrow depend on anaerobic respiration.

Presentation for compensated shock ?

- 1] increased respiratory rate, restlessness (قلق), anxiety (قلق) \Rightarrow earliest sign of shock.
- 2] Tachycardia.
- 3] Falling blood pressure \Rightarrow late sign of shock.
- 4] possible delay in capillary refill. \Rightarrow تأخر إعادة التزويد

2] **Cardiogenic shock** :- pump failure in the heart muscle, the causes for this type :-

Myocardial infarction, congestive heart failure (CHF), obstruction and arrhythmias, coronary heart disease.

The mechanism at the same for hypovolaemic and cardiogenic shock and called cold shock (pale, cold skin)

3] **Distributive shock (vasodilation)** :- causes vasodilation in peripheral opposite two types above, and it is of three types :-

1] **Neurogenic shock** :- loss of tone of blood vessel, the causes for this type are :- nerve damage (spinal cord damage) \Rightarrow causes failure to transmit action potential in the affected area, hypoglycaemia \Rightarrow glucose deficiency is a common causes for neurogenic shock, pain, drug, anaesthesia. \Rightarrow vasodilator as response.

2] **Anaphylactic shock** :- (حساسية) the causes for this type are :- allergic hypersensitivity reaction (food, insect bites (الحشرات), drug, blood ~~transfusion~~ transfusion) \Rightarrow release histamine (inflammatory mediator) \Rightarrow vasodilation \Rightarrow increased capillary permeability \Rightarrow decreased or reduces venous return and blood pressure.

3] **Septic shock** :- systemic infection because of bacterial toxin, the causes for this type are :- wound infection, invasive procedure, respiratory infection, urinary tract infection (UTI), weakness in immune system (cancer patient). pyrexia (increased the temperature), marked generalised vasodilation, micro-clotting (blood clotting in microvessel).

Immunocompromised patient (أشخاص ضعفاء مناعياً) at risk.

- ⇒ stimulate the respiratory center to increase ventilation (تأثير)
- ⇒ allow excess ~~acid~~ acid to be blown off (تأثير) in the form CO_2 .

on exam :- As above (in compensated shock), hypotension, altered mental status, labs may show increased lactic acidosis.

↳ called hypotensive shock because of decreased blood pressure.

③ irreversible shock :- irreversible in one or more organ damage, cardiac arrest (توقف القلب), death occur.

presentation :-

- ① completely loss of peripheral vascular resistance.
- ② confusion, slurred speech (تأثير في الكلام), unconscious.
- ③ irregular heart rate and breathing rate (decrease or increase).
- ④ falling blood pressure (diastolic is zero).
- ⑤ cold, clammy cyanotic skin (بارد، رطب، مزرق).
- ⑥ severely decreased body temperature (انخفاض شديد).
- ⑦ dilated, sluggish in pupils. (توسع واستجابة بطيئة للضوء)

Irreversible shock lead to :-

- ① renal failure
- ② Hepatic failure
- ③ multiple organ system failure
- ④ adult respiratory distress syndrome (decrease surfactant)
- ⑤ death

Note :- when entering progressive shock all type of shock become cold shock.

[3] Fluid (blood) \Rightarrow because of perfusion fail \Rightarrow loss blood volume (decreased in blood volume).

Lead to ~~shock~~ ischemia then shock.

Classification of shock : (type)

III Hypovolaemic :- low volume, the causes for this type are :- dehydration, haemorrhage (bleeding), burns, vomiting, diuresis, sweating and diarrhoea \Rightarrow some causes are related to bleeding and some are not.

the mechanism by which the body returns from a state imbalance to a state of balance in this type of shock ?

activation for sympathetic nervous system \Rightarrow centrally vasodilation and peripherally vasoconstriction \Rightarrow activation for the renal angiotensin aldosterone system \Rightarrow increase angiotensin 2 (angiotensin 1 convert to angiotensin 2 by angiotensin converted enzyme) \Rightarrow increase the secretion of vasoconstriction and decrease the vasodilator and increase reabsorption for Na^+ and water by proximal convoluted tubule \Rightarrow aldosterone increase reabsorption for water and Na^+ in ~~proximal~~ distal convoluted tubules (these things started to increase blood volume)

also affect on hypothalamus \Rightarrow affect on posterior pituitary gland to secrete antidiuretic hormone (ADH) \Rightarrow increase reabsorption for water and Na^+ in collecting duct \Rightarrow increase blood volume increase the secretion of epinephrene and Norepinephrene, decrease ~~secretion of~~ atrial natriuretic peptide (ANP) (the function of this hormone increase excretion for water and Na^+) in right atrium \Rightarrow deactivation in heart.