Physiology Team 434

Shock

Color index

- Important
- Further Explanation

Only in Boys' Slides

Only in Girls' Slides

Explained in **Guyton Chapter 24**

Physiology Team 434
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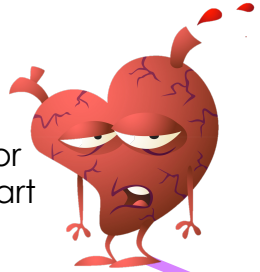
Shock

Inadequate tissue perfusion with: relatively or absolutely inadequate cardiac output.

What do we mean by relatively ?
We mean that the metabolic requirements of the tissues are higher than the cardiac output, so it needs more blood than the cardiac output.

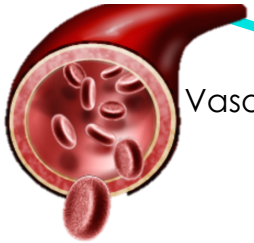
https://youtu.be/9a7N9AU1GiQ

Types of Shock

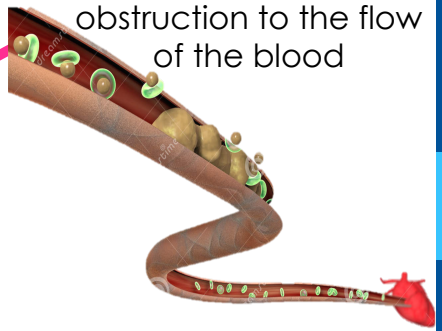


Diseased or insulted heart

Loss of blood, plasma or fluid



Vasodilation



obstruction to the flow of the blood

Hypovolemic shock

Cardiogenic shock

Distributive shock

Obstructive shock

Hypovolemic shock

Loss of blood, plasma or fluid.

Loss of volume

Due to:

- ✓ Hemorrhage.
- ✓ Trauma
- ✓ Surgery

OR

Plasma loss

As in burns

OR

Fluid loss

Due to:

- ✓ Severe Vomiting
- ✓ Diarrhea

✧ Pathophysiology of Hypovolemic Shock

According to the cause, hypovolemic shock is subdivided into;

Hemorrhagic, Traumatic, Surgical, Burn shock.

Rapid respiration

Restlessness

Due to sympathetic overactivity > ↑Muscle pump

Intense thirst

Rapid thready(weak) pulse

Hypotension

Cold ,pale skin

Types of Shock

Cardiogenic shock

- ✧ Results from inadequate output caused by a diseased or insulted heart, such as:
  - ✓ **Myocardial infarction**
  - ✓ **Congestive heart failure**
  - ✓ **Arrhythmias**

Distributive shock

- ✧ Also called vasogenic, low resistance shock
- ✧ The blood is accumulated in a place other than the place its normally present in, so its supposed to be in the circulation but it went to the periphery.
- ✧ There is marked <u>vasodilation</u> caused by:
  - ✓ **Anaphylaxis:** (due to antigen-antibody reaction, e.g drug–induced..)
  - ✓ **Sepsis**
  - ✓ **Neurogenic:** Vasovagal*, acute venous dilation,…

*: Is a malaise mediated by the vagus nerve. When it leads to syncope or "fainting".

Obstructive shock

- ✧ Due to obstruction to the flow of the blood:
  - ✓ **Tension pneumothorax** is the progressive build-up of air within the pleural space.
  - ✓ **Pulmonary embolism** blockage in one of the pulmonary arteries in lungs, caused by a traveled blood clots.

https://youtu.be/rOADTgtWuD4

Treatment of Shock

Most important is the treatment of the cause of the shock

Classification	Treatment
Hypovolaemic 	Rapid infusion of volume-expanding fluids : whole blood, plasma, plasma substitutes, isotonic electrolyte solutions
Cardiogenic 	As for hypovolaemic shock (but smaller volumes and not rapid) + administration of cardiac drugs that enhance contractility.
Distributive 	As for hypovolaemic shock o Antibiotic for septic shock o Epinephrine & anti-histaminergic drugs for anaphylatic shock o Sympathomimetic drug for neurogenic shock
Obstructive 	Removal of obstruction. e.g., pericardiocentesis in cardiac tamponade and oxygen. anti-coagulation and oxygen in pulmonary embolism.

Stages Of Shock

✧ Reversible stage

In which **compensatory reactions & appropriate treatment help** restoration of blood pressure & blood loss.

✧ Irreversible Stage

In which a series of **positive feed back mechanisms*** **take place** leading to further deterioration & tissue hypoxia.
This depends on amount of blood lost.
When blood loss is excess and not immediately replaced and proper treatment is delayed ➔ this stage is reached and the patient may die.
There is also **failure of compensatory**

- **Reversible**
  - Rapid compensatory reaction within seconds-minutes
  - Responses Activated within hours
  - Responses activated from hours-days
- **Irreversible**
  - Positive feed back mechanisms

* : حاجة تؤدي إلى الاسوء

Reversible Stage

Seconds to Minutes	Within Hours	Hours to Days
✧ **Release of vasoconstrictor factors/hormones:** o **Catecholamines** by adrenal medulla. o **Vasopressin** (ADH[1]) by posterior pituitary, causes: ✓ Vasoconstriction. ✓ Restores fluid volume by reducing urine output. o **Renin-angiotensin-aldosterone.** ✓ Preserve salt and water	✧ **Increased movement of interstitial fluid into capillaries** (Capillary fluid shift) Fluid from ECF will move to the vessels	✧ **Restoration of plasma proteins**, occurs in 2 stages: ✓ **Rapid entry of preformed albumin** from extracellular stores. ✓ **Hepatic synthesis** of proteins over 3-4 days.
✧ **Tachycardia** produced by: o **Baroreceptor** reflex. o **Chemoreceptor** reflex. o Increased **sympathetic** activity.	✧ **Increased secretion of glucocorticoids** by adrenal cortex ✓ Help to maintain blood sugar	✧ **Restoration of RBCs** ✓ **Increase RBCs count in response to erythropoietin** within 10 days. ✓ **Restoration of red cell mas** within 4-8 weeks.

1: AntiDiuretic Hormone

Reversible Stage cont.

Seconds to Minutes

✧ **VENOconstriction,** caused by:
- Sympathetic activity

✧ Importance:
✓ Maintain filling pressure of the heart.
✓ Shift blood from reservoirs (veins) into the circulation.

✧ **Tachypnea,** caused by:
- Activation of chemoreceptor reflex.
- Sympathetic overactivity.

✧ Importance:
✓ ↑O2 delivery
✓ ↑Thoracic pump > ↑VR

✧ **Vasoconstriction**, produced by:
- Baroreceptor reflexes.
- Chemoreceptor reflex.
- Vasopressin-vasoconstrictor mechanism.
- Noreadrenaline-adrenaline vasoconstrictor mechanism (due to activation of adrenal medulla)

Within Hours

✧ **Increased 2,3 DPG concentration in RBCs**

✧ Importance:
✓ Help HB deliver more O2 to the tissues.
(shift O2 dissociation curve to the right)

Hours to Days

✧ **Restoration of circulatory plasma volume.**
Takes 12-72 hrs. after moderate hemorrhage.

Vasoconstriction is marked in:

✧ **Skin:** cold and pale.
✧ **Kidneys:** drop in GFR and urine volume.
✧ **Viscera**

✧ **Heart and brain are spared in all this.**

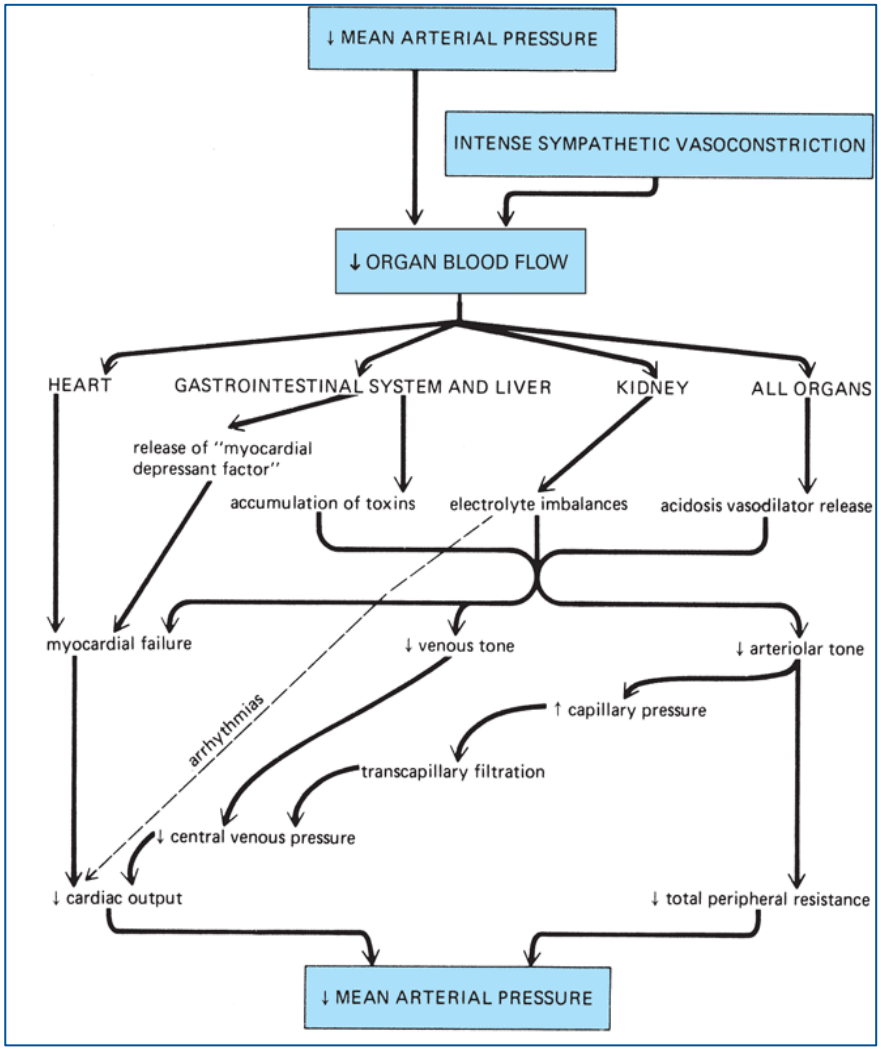
Irreversible Stage

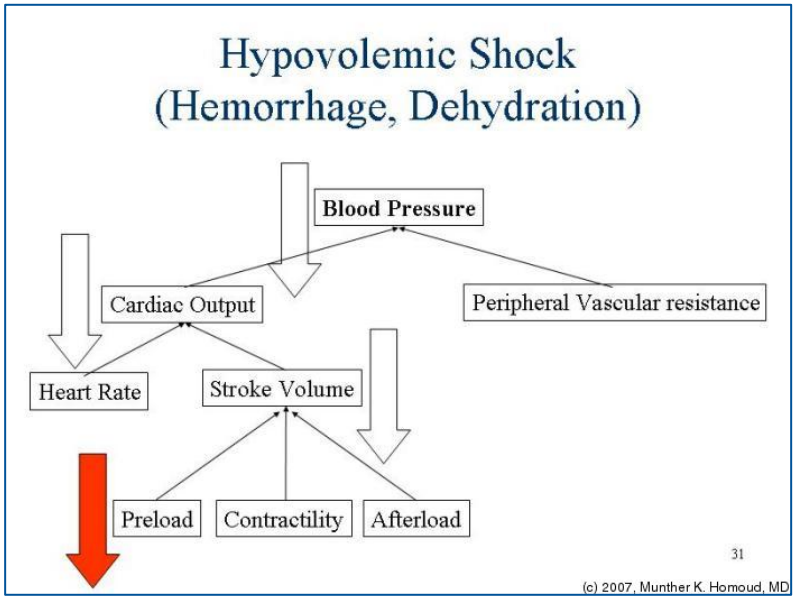
Positive Feedback Mechanisms

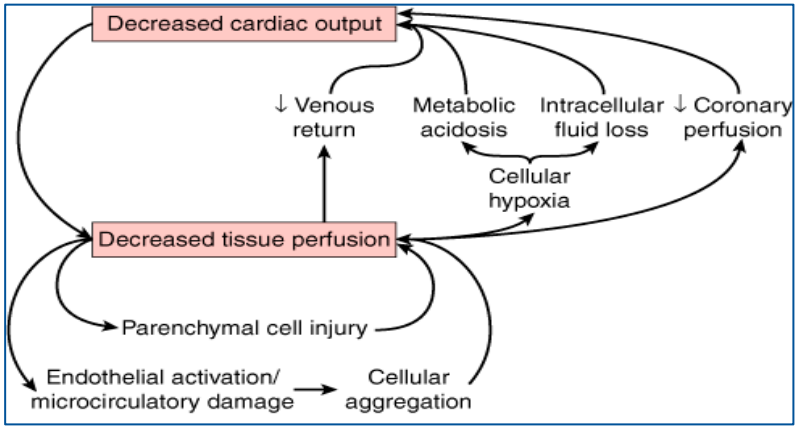
All lead to drop in CO

Cardiac Depression	Vasomotor Failure	Endotoxin	Toxins By Ischemic Tissues	Cellular Deterioration
The drop in ABP ↓ **Drop in coronary flow** ↓ **(-) heart** ↓ **CO drops**	**Vasomotor center depression** ↓ **Heart depression** ↓ **CO drops**	**Released from gram +ve bacteria** (When blood flow to intestine decreases) ↓ **Absorption of toxins** ↓ **Cardiac Depression** ↓ **CO drops**	E.g. histamine, tissue enzymes, **Potassium**, ... ↓ hyperkalemia ↓ Cardiac arrhythmia ↓ Cardiac depression ↓ CO drops	✧ (-) of mitochondrial activity inside the cells lead to **decrease in ATP**. ✧ (-) of cellular metabolism, especially **glucose**. ✧ Drop in active transport of Na+ and K+ across the cell , **Na+ accumulate inside the cell**. ✧ **Rupture of many lysosomes**.

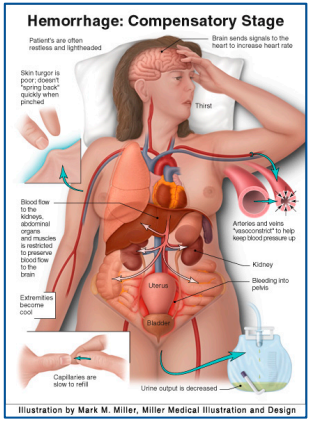
(-) = Decrease in function or dead.

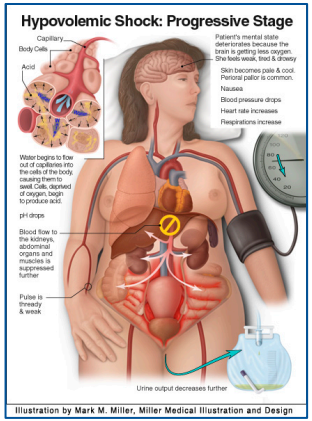

↓ MEAN ARTERIAL PRESSURE
INTENSE SYMPATHETIC VASOCONSTRICTION
↓ ORGAN BLOOD FLOW
HEART
GASTROINTESTINAL SYSTEM AND LIVER
KIDNEY
ALL ORGANS
release of "myocardial depressant factor"
accumulation of toxins
electrolyte imbalances
acidosis vasodilator release
myocardial failure
↓ venous tone
↓ arteriolar tone
↑ capillary pressure
arrhythmias
transcapillary filtration
↓ central venous pressure
↓ cardiac output
↓ total peripheral resistance
↓ MEAN ARTERIAL PRESSURE

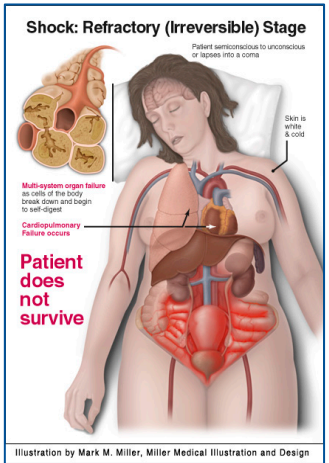

Hypovolemic Shock
(Hemorrhage, Dehydration)
Blood Pressure
Cardiac Output
Peripheral Vascular resistance
Heart Rate
Stroke Volume
Preload
Contractility
Afterload
31
(c) 2007, Munther K. Homoud, MD

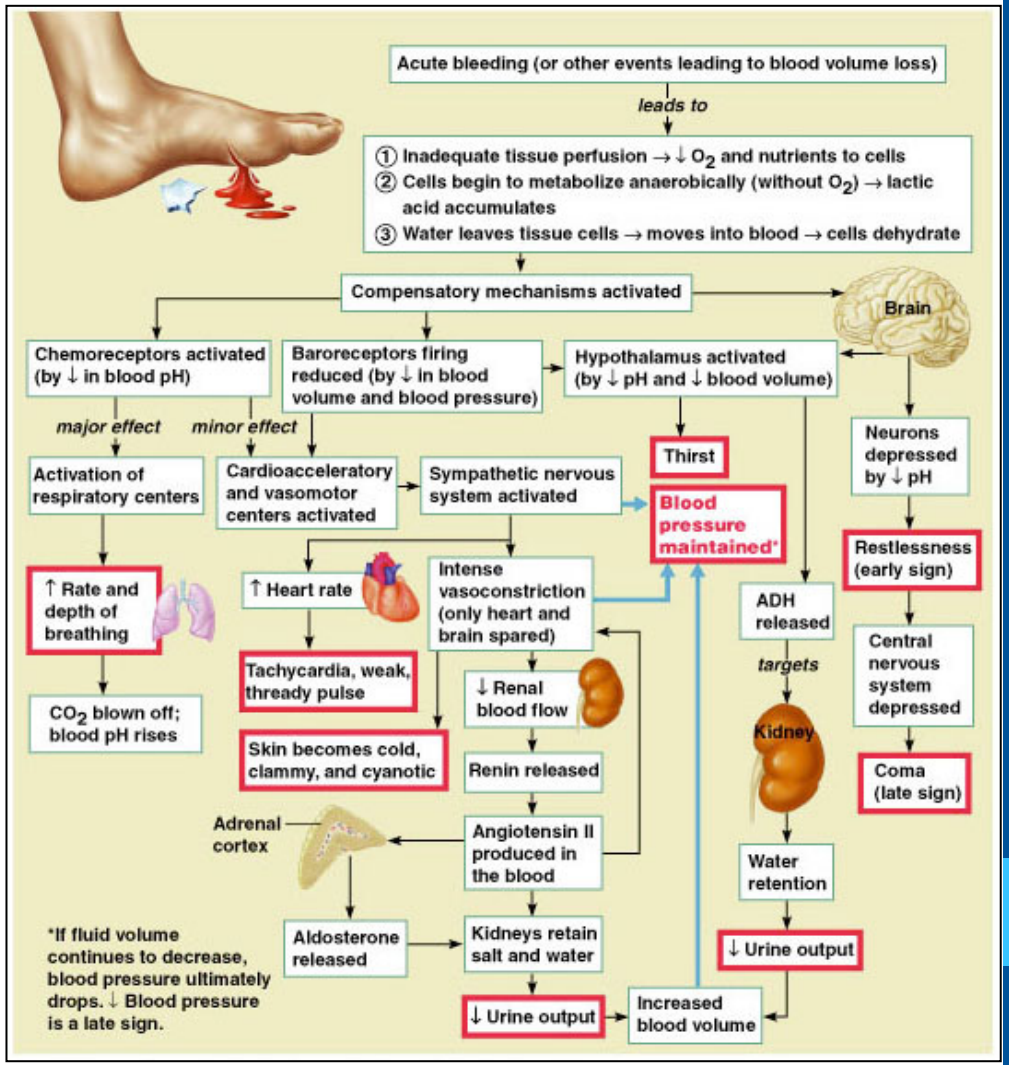

Decreased cardiac output
↓ Venous return
Metabolic acidosis
Intracellular fluid loss
↓ Coronary perfusion
Cellular hypoxia
Decreased tissue perfusion
Parenchymal cell injury
Endothelial activation/ microcirculatory damage
Cellular aggregation

Summaries


Hemorrhage: Compensatory Stage
Patient's are often restless and lightheaded
Brain sends signals to the heart to increase heart rate
Skin turgor is poor; doesn't "spring back" quickly when pinched
Thirst
Blood flow to the kidneys, abdominal organs and muscles is restricted to preserve blood flow to the brain
Arteries and veins "vasoconstrict" to help keep blood pressure up
Kidney
Uterus
Bleeding into pelvis
Extremities become cool
Bladder
Capillaries are slow to refill
Urine output is decreased
Illustration by Mark M. Miller, Miller Medical Illustration and Design


Hypovolemic Shock: Progressive Stage
Capillary
Body Cells
Acid
Patient's mental state deteriorates because the brain is getting less oxygen. She feels weak, tired & drowsy
Skin becomes pale & cool. Perioral pallor is common.
Nausea
Blood pressure drops
Heart rate increases
Respirations increase
Water begins to flow out of capillaries into the cells of the body, causing them to swell. Cells, deprived of oxygen, begin to produce acid.
pH drops
Blood flow to the kidneys, abdominal organs and muscles is suppressed further
Pulse is thready & weak
Urine output decreases further
Illustration by Mark M. Miller, Miller Medical Illustration and Design


Shock: Refractory (Irreversible) Stage
Patient semiconscious to unconscious or lapses into a coma
Skin is white & cold
Multi-system organ failure as cells of the body break down and begin to self-digest
Cardiopulmonary Failure occurs
Patient does not survive
Illustration by Mark M. Miller, Miller Medical Illustration and Design


Acute bleeding (or other events leading to blood volume loss)
leads to
① Inadequate tissue perfusion → ↓ O_2 and nutrients to cells
② Cells begin to metabolize anaerobically (without O_2) → lactic acid accumulates
③ Water leaves tissue cells → moves into blood → cells dehydrate
Compensatory mechanisms activated
Brain
Chemoreceptors activated (by ↓ in blood pH)
Baroreceptors firing reduced (by ↓ in blood volume and blood pressure)
Hypothalamus activated (by ↓ pH and ↓ blood volume)
major effect
minor effect
Activation of respiratory centers
Cardioacceleratory and vasomotor centers activated
Sympathetic nervous system activated
Thirst
Neurons depressed by ↓ pH
Blood pressure maintained*
Restlessness (early sign)
↑ Rate and depth of breathing
↑ Heart rate
Intense vasoconstriction (only heart and brain spared)
ADH released
Central nervous system depressed
CO_2 blown off; blood pH rises
Tachycardia, weak, thready pulse
↓ Renal blood flow
targets
Kidney
Skin becomes cold, clammy, and cyanotic
Renin released
Coma (late sign)
Adrenal cortex
Angiotensin II produced in the blood
Water retention
*If fluid volume continues to decrease, blood pressure ultimately drops. ↓ Blood pressure is a late sign.
Aldosterone released
Kidneys retain salt and water
↓ Urine output
↓ Urine output
Increased blood volume

Summaries

MCQs

1-In almost all patients who have severe burns, so much plasma lost, the resulting condition is:
A. Neurogenic shock
B. Hypovolemic shock
C. Septic shock
D. Histamine shock

2- Positive feed back mechanisms is a marked sign of:
A. Reversible shock stage
B. Irreversible shock stage

3- Increase in glucocorticoids secretions help in:
A.O2 transport
B. Maintain iron in blood
C. Maintain sugar in blood

1.B
2.B
3.C

Done by:

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BEST OF LUCK