"He who studies medicine without books sails an uncharted sea, but he who studies medicine without patients does not go to sea at all"
William Osler

Medicine

430

Shock

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O Definition of Shock:

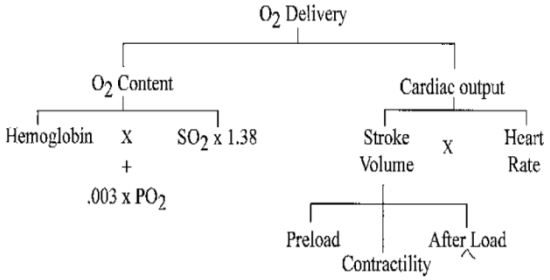
Reduction of effective tissue perfusion (blood supply), leading to cellular and circulatory dysfunction. Shock is a medical emergency if unrecognized or inadequately treated will result in high mortality.

Hypotension becomes critical only when inadequate blood flow disturbs organ function, because the metabolic needs of cells are not being met, this is referred as shock. There is a reduction in circulating blood volume, blood pressure and cardiac output.

The Aim of perfusion is to achieve adequate Cellular Oxygenation, and this requires:

1) Red Cell Oxygenation, that involves:
   - Oxygen delivery to alveoli, which needs:
     - Adequate FiO_2.
     - Patent Airways.
     - Adequate Ventilation.

FiO_2 (Fraction of inspired oxygen) is an assumed percentage of oxygen concentration participating in gas exchange in the alveoli.



   - Oxygen exchange with the blood, which needs:
     - Adequate oxygen diffusion into blood.
     - Adequate RBC mass/Hgb levels.
     - Adequate RBC capacity to bind O_2 ,

Depends on: pH and Temperature

2) Red Cell Delivery To Tissues:
   - Adequate perfusion
     - Blood volume
     - Cardiac output
       - Heart rate
       - Stroke volume

(Increasing either heart rate or stroke volume increases cardiac output)

     - Conductance :
       - Arterial resistance
       - Venous capacitance

To maintain adequate perfusion, blood volume should be sufficient, cardiac muscles must work properly, and blood vessels should be normal. Failure of one or more of these factors causes Shock.

   - Adequate RBC mass
   - Adequate Hgb levels
   - Adequate RBC capacity to unbind O_2, depending on:
     pH & Temperature.

O Consequences of Shock. (Hypoperfusion)

Inadequate perfusion causes:

- Inadequate cellular oxygenation (Hypoxia)
- Shift from aerobic to anaerobic metabolism, which eventually lead to:

1) accumulation of Lactic Acid → metabolic Acidosis → cell death.
2) Inadequate energy production → metabolic failure → cell death.

• Cellular death leads to tissue and organ death

Some cells can produce energy without oxygen (anaerobic metabolism) for a short time, although it is inefficient. Other organs (e.g. brain) are made up of cells that can only make the energy necessary for survival in the presence of a continual supply of oxygen (aerobic metabolism). Tissues differ in their ability to withstand anoxia (lack of oxygen). The brain and the heart are the most sensitive. Initially a lack of oxygen affects organ function but with time irreversible damage is done (within minutes in the case of the brain) and revival is impossible.

• **Glycolysis** is an inefficient source of energy production, 2 ATPs for every glucose, it produces pyruvic acid.
(Can occur without oxygen = Anaerobic Metabolism)

• **Oxidative phosphorylation:** Each pyruvic acid is converted into 34 ATP (plus 2 ATPs from Glycolysis) , net result is 36 ATPs
(can't occur without oxygen = Aerobic Metabolism)

• Effects of Shock on some organs:
  • Lung → Hypoxemia.
• Liver → ↑ liver enzymes.
  • Peripheral Circulation → Hypotension.
• Heart → depression of myocardial contractility.
  • Brain → decreased mental status.

Shock Syndromes and their Causes.

Hypovolemic Shock (reduced blood volums)	**Cardiogenic Shock** (blood pump problem)	**Obstructive Shock** (obstruction to blood flow around the circulation)	**Distributive Shock** blood is not reaching the tissues due to vascular problem
• Blood loss: - traumatic. e.g. sever hemorrhage. - non traumatic. e.g. Vaginal, GI, GU bleeding. • Fluid Loss: e.g. dehydration, Burns (serum loss) Sweating Diarrhea, Vomiting (water and electrolytes loss) Diuresis (increased excretion of urine) • Third space losses: - Pancreatitis - Peritonitis - Bowel obstruction	• Myopathic: - MI - CHF - Cardiomyopathy • Arrhythmic -Tachycardia -Bradycardia • Mechanical -Valvular Failure e.g. HOCM. (Hypertrophic Obstructive Cardiomyopathy)	•Impaired diastolic filling: -Cardiac tamponade, in which fluid in the pericardium prevents inflow of blood into the heart (venous return) -Constrictive pericarditis , in which the pericardium shrinks and hardens -Tension pneumothorax through increased intrathoracic pressure, bloodflow to the heart is prevented (venous return). • Increased ventricular afterload: -Pulmonary embolism	1-Septic Shock cause: severe infection. 2-Anaphylactic Shock. Severe allergic shock may be triggered by substances like: penicillin. Histamine is released, • Blood vessels -Dilate (resistance loss) -Leak (volume loss) • Extravascular smooth muscle spasm -Laryngospasm -Bronchospasm 3-Neurogenic shock. Due to excessive parasympathetic activity or decreased sympathetic activity that reduce heart rate, and in turn, the cardiac output. 4- Endocrinologic shock. Adrenal insufficiency.

O How to diagnose Shock?

- Signs & Symptoms
  - Restlessness, anxiety, and combativeness = **earliest signs of shock**
  - Brain: decreased mental status (unconsciousness)
  - Kidney: Oliguria.
  - Peripheral Circulation: Hypotension, cold clammy skin, rapid thread pulse. (Thread pulse: A small fine pulse that feels like a small cord or thread under the finger)
  - Lung: Hypoxemia.
  - Liver: increased liver enzymes.
  - ↓ Urine output
  - Skin temperature cold clammy
  - BP (narrow pulse pressure, Postural l↓ BP)
  - Skin color: peripheral cyanosis
  - Compensatory responses such as tachycardia and pallor.

Markers of Hypoperfusion:

- An increase in Serum Lactate (Due to anaerobic metabolism)
- Perfusion related academia
- Hypotension (Late sign)

O Management of Shock

Hypovolemic Shock	Cardiogenic Shock
Goal: Restore circulating volume, tissue perfusion & correct cause. - ABC, Airways, Breathing, Circulation. - Initially, control external bleeding. - Rapid re expansion of circulating - intravascular blood volume. - Elevate lower extremities. - Avoid Trendelenburg (Trendelenburg position, the body is laid flat on the back (supine position) with the feet higher than the head by 15-30 degrees) - Two large bore IV lines/central line (isotonic saline). - Fluids / Blood & Products/vasopressors - Target arterial BP - SBP ≥ 90 mmHg - MAP ≥65 mmHg (mean arterial BP) - Bladder catheter - Arterial Cannulation	**History:** Chest pain, Palpitations, SOB, RHD,IHD. **Physical exam:** Signs of ventricular failure Heart : Murmurs,S3,S4 **Management:** - supine, or head and shoulders slightly elevated - **DO NOT** elevate lower extremities. - Treat rate, then rhythm, then BP. - Correct bradycardia or tachycardia. - Correct irregular rhythms - Treat BP o Increase cardiac contractility (Inotropes) o Dobutamine, Dopamine Irregular rhythms § o BP 90 mmhg (increase LV filling -> adequate perfusion) o keep open line, micro-drip set o correct hypoglycemia -> insulin o treat the underlying cause if possible o Respiratory support (endotracheal intubation) -> correct hypoxemia + acidosis. (Information from 429 Medicine Team)

Obstructive Shock	Distributive Shock
Treat the underlying cause • Tension Pneumothorax • Pericardial Tamponade • anticoagulation - Isotonic fluids - Control airway: intubation.	**Septic Shock Management:** -ABC . - Assist ventilation: oropharyngeal airway, endotracheal tube, tracheostomy + augment oxygenation. - Monitor/restore Tissue perfusion: expand circulatory volume, support cvs function - IV Fluids, Vasopressors Identification & Eradication of septic foci: empirical antibiotic therapy (IV) - Specific Therapies e.g. : Protein kinase c, antithrombin, il-1 antagonists, antigoagulants, anti-infammatory, etc. **Anaphylactic Shock management:** -Suppress inflammatory response •Antihistamines • Corticosteroids -Oppose histamine response • Epinephrine (bronchospasm & vasodilation) - Replace intravascular fluid Isotonic fluid titrated to BP ~ 90 mm. **Neurogenic Shock management:** - Patient supine; lower extremities elevated. -Infuse isotonic crystalloid. -Maintain body temperature.

• Consequence of Volume Lose

* 15 % (750 ml) → compensatory mechanism maintains cardiac output.
* 15 – 30 % (750 – 1500 ml) →decreased BP & urine output
* 30 – 40 % (1500 – 2000 ml) →impaired compensation & profound shock along with sever acidosis.
* 40 – 50 % → refractory stage

• Tissue ischemic sensitivity:

- Heart, brain, lung: 4 to 6 minutes
- GI tract, liver, kidney: 45 to 60 minutes
- Muscle, skin: 2 to 3 hours

-Resuscitate Critical Tissues First!

-Best indicator of resuscitation effectiveness is the **Level of Consciousness**

Avoid vasopressors until hypovolemia ruled out, or corrected

Vasopressors :

o dopamine

o vasopressin

o dobutamine → adequate ventricular performance

o norepinephrine → increase arterial pressure

Squeezing a partially empty tank can cause ischemia, necrosis of kidney and bowel.

The Trendelenburg Position

Above: a Groden autopsy photo. tilted to match the photo below. Notice that the large wound is in a similar relation to the ear as the wound In the McClelland drawing.

Above: the McClelland drawing, depicting the wound as recalled by the Parkland witnesses.

Above: an online depiction of the Trendelenburg Position

Above: an online depiction of the Trendelenburg position. Would a doctor standing at the head of a patient in such a position be able to look down into the wound depicted in the McClelland drawing? Or would he be more likely to confuse the large wound in the autopsy photo at top left with a wound on the back of the head?