

Hypoxia and cyanosis

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Objectives

- **By the end of this lecture you should be able to:**
- Define **hypoxia** and list its various physiological and pathological causes.
- Outlines the treatment of hypoxia.
- Define hypercapnea and list its causes and manifestations.
- Define **hypo and hyper-ventilation** in terms of arterial PCO₂ and PO₂.
- Define **cyanosis** and its clinical presentation

TABLE 5.5 Causes of Hypoxemia

Cause	Pa _{o₂}	A - a Gradient	Supplemental O ₂ Helpful?
High altitude (↓ PB; ↓ P _I O ₂)	Decreased	Normal	Yes
Hypoventilation (↓ P _A O ₂)	Decreased	Normal	Yes
Diffusion defect (e.g., fibrosis)	Decreased	Increased	Yes
Ṡ/Ḡ defect	Decreased	Increased	Yes
Right-to-left shunt	Decreased	Increased	Limited

TABLE 5.6 Causes of Hypoxia

Cause	Mechanism	Pa _{o₂}
↓ Cardiac output Hypoxemia	↓ Blood flow ↓ Pa _{o₂} ↓ O ₂ saturation of hemoglobin ↓ O ₂ content of blood	— ↓
Anemia	↓ Hemoglobin concentration ↓ O ₂ content of blood	—
Carbon monoxide poisoning	↓ O ₂ content of blood Left shift of O ₂ -hemoglobin curve	—
Cyanide poisoning	↓ O ₂ utilization by tissues	—

Hypoxia

Is defined as deficiency of oxygen in the tissue cells.

It can be classified into the following groups:-

- **Hypoxic or arterial hypoxia**
- **Anemic hypoxia**
- **Stagnant hypoxia**
- **Histiotoxic hypoxia**

I-Hypoxic or arterial hypoxia

Reduced arterial PO₂ it can be due to

- Alveolar hypoventilation
- Diffusion abnormalities
- Right to left shunt
- Ventilation-perfusion imbalance (including increased physiological dead space and physiological shunt).

II-Anemic hypoxia

- It is caused by reduction in the oxygen carrying capacity of the blood, due to decreased amount of Hb or abnormal type of Hb which is unable to carry oxygen.
- The PO₂ and % Hb-O₂ is normal.

Causes:

1- Anemia

2-Abnormal Hb e.g met hemoglobin, carboxyhemoglobin.

III-Stagnant hypoxia:

- **Caused by reduced blood flow through the tissues,** so more and more oxygen is extracted from the blood, and due to slow circulation less oxygen is carried by the blood at the lung , leading to hypoxia.
- **Causes:**
- 1-General slowing of the circulation, as in heart failure and shock
- 2-Local slowing e.g vasoconstriction, cold, arterial wall spasm.

IV- Histiotoxic hypoxia

- This is inability of the tissues to use oxygen due to inhibition of the oxidative enzyme activity
- e.g cyanide poisoning causing blockade of the cytochrome oxidase activity

Effects of hypoxia

- According to the degree of hypoxia it could lead to impairment of judgment, inability to perform complex calculations, headache, nausea, irritability, dyspnea, increased heart rate, reduction in muscle working capacity, even coma and death may result.

Treatment of hypoxia

- Is by giving oxygen therapy in a tent or high oxygen tension mask.
- This is useful in hypoxic hypoxia, but of less value in other types of hypoxia .
- Histiotoxic hypoxia will not benefit from O₂ therapy.



Hypercapnea

Excess of CO₂ in body fluids, it usually occurs with hypoxia, PCO₂ increases above 52 mmHg, it decreases the PH.

In hypoxia caused by hypoventilation, CO₂ transfer between the alveoli and the atmosphere is affected as much as is O₂ transfer. Hypercapnia then occurs along with the hypoxia.

In circulatory deficiency, diminished flow of blood decreases CO₂ removal from the tissues, resulting in tissue hypercapnia in addition to tissue hypoxia. However, the transport capacity of the blood for CO₂ is more than three times that for O₂, and thus the resulting tissue hypercapnia is much less than the tissue hypoxia.

Features of hypercapnea

- Air hunger Dyspnea (A PCO₂ between 60-70 mmHg)
- Peripheral vasodilatation
- Sweating
- Warm extremities and bounding pulse
- Muscle twitching
- Headache, drowsiness and semicomatose (PCO₂ rises to 80 to 100 mm Hg)
- Papilloedema (swelling of optic disc).
- Anesthesia and death can result when the PCO₂ rises to 120 to 150 mm Hg.
- At these higher levels of PCO₂, the excess CO₂ now begins to depress respiration rather than stimulate it, thus causing a vicious circle:
 - (1) more CO₂,
 - (2) further decrease in respiration,
 - (3) then more CO₂, and so forth—culminating rapidly in a respiratory death.

Cyanosis



Cyanosis

- Blue discoloration of the skin and mucus membrane due to more than 5 g/dl of reduced (deoxygenated) hemoglobin in the arterial blood.
- A person with anemia almost never develop cyanosis due to low amount of Hb for 5 grams to be deoxygenated /100ml blood.