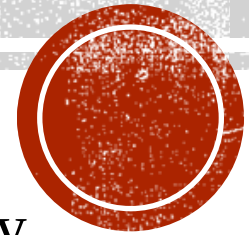


DISORDERS OF RESPIRATORY SYSTEM



By

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Normal respiratory pattern is called **eupnea**.

Respiratory pattern is altered by many ways. Altered patterns of respiration are:

1. **Tachypnea:** Increase in the rate of respiration
2. **Bradypnea:** Decrease in the rate of respiration
3. **Polypnea:** Rapid, shallow breathing resembling panting in dogs. In this type of breathing, only the rate of respiration increases but the force does not increase significantly.
4. **Apnea:** Temporary arrest of breathing
5. **Hyperpnea:** Increase in pulmonary ventilation due to increase in rate or force of respiration. Increase in rate and force of respiration occurs after exercise. It also occurs in abnormal conditions like fever or other disorders.
6. **Hyperventilation:** Abnormal increase in rate and force of respiration, which often leads to dizziness and sometimes chest pain
7. **Hypoventilation:** Decrease in rate and force of respiration
8. **Dyspnea:** Difficulty in breathing
9. **Periodic breathing:** Abnormal respiratory rhythm.



1. HYPOXIA

Hypoxia is defined as reduced availability of oxygen to the tissues. The term anoxia refers to absence of oxygen. In olden days, the term anoxia was in use. Since there is no possibility for total absence of oxygen in living conditions, use of this term is abandoned.

CLASSIFICATION AND CAUSES OF HYPOXIA

Four important factors which leads to hypoxia are:

1. Oxygen tension in arterial blood
2. Oxygen carrying capacity of blood
3. Velocity of blood flow
4. Utilization of oxygen by the cells.

On the basis of above factors, hypoxia is classified into four types:

1. Hypoxic hypoxia
2. Anemic hypoxia
3. Stagnant hypoxia
4. Histotoxic hypoxia.



A. Hypoxic Hypoxia :- Hypoxic hypoxia means decreased oxygen content in blood. It is also called arterial hypoxia. *Causes for hypoxic hypoxia*

Characteristic features of hypoxic hypoxia : Hypoxic hypoxia is characterized by reduced oxygen tension in arterial blood. All other features remain normal.

Hypoxic hypoxia is caused by four factors.

i. Low oxygen tension in inspired (atmospheric) air, which does not provide enough oxygen tension in inspired air is reduced in the following conditions:

- a. High altitude
- b. While breathing air in closed space
- c. While breathing gas mixture containing low partial pressure of oxygen (PO_2).

ii. Respiratory disorders associated with decreased pulmonary ventilation, which does not allow intake of enough oxygen

- a. Obstruction of respiratory passage as in asthma
- b. Nervous and mechanical hindrance to respiratory movements as in poliomyelitis
- c. Depression of respiratory center as in brain tumor
- d. Pneumothorax.

In these conditions, even though enough oxygen is available in the atmosphere, it cannot reach the lungs.



iii. Respiratory disorders associated with inadequate oxygenation in lungs, which does not allow diffusion of enough oxygen. Inadequate oxygenation of blood in lungs occurs in the following conditions:

- a. Impaired alveolar diffusion as in emphysema
- b. Presence of non-functioning alveoli as in fibrosis
- c. Filling of alveoli with fluid as in pulmonary edema, pneumonia, pulmonary haemorrhage
- d. Collapse of lungs as in bronchiolar obstruction
- e. Lack of surfactant
- f. Abnormal pleural cavity such as pneumothorax, hydrothorax, pneumothorax and pyothorax
- g. Increased venous admixture as in the case of bronchiectasis.

In these conditions, in spite of oxygen availability and entrance of oxygen into the alveoli, it cannot diffuse into the blood.

iv. Cardiac disorders, in which enough blood is not pumped to transport oxygen.

In congestive heart failure, oxygen availability and diffusion are normal, but the blood cannot be pumped from heart properly



2. Anemic Hypoxia Anemic hypoxia is the condition characterized by the inability of blood to carry enough amount of oxygen. Oxygen availability is normal. But the blood is not able to take up sufficient amount of oxygen due to anaemic condition.

Characteristic features of anaemic hypoxia Anemic hypoxia are characterized by decreased oxygen carrying capacity of blood. All other features remain normal.

Causes for anaemic hypoxia

Any condition that causes anaemia can cause anaemic hypoxia. It is caused by the following conditions:

1. **Decreased number of RBCs** : RBC decreases in conditions like bone marrow diseases, haemorrhage, etc.
2. **Decreased haemoglobin content in the blood** : Conditions which decrease the RBC count or change the structure, shape and size of RBC (microcytes, macrocytes, spherocytes, sickle cells, poikilocytes, etc.) can decrease the haemoglobin content in blood.
3. **Formation of altered haemoglobin**: Poisoning with chlorates, nitrates, ferricyanides, etc. causes oxidation of iron into ferric form and the haemoglobin is known as **methaemoglobin**. Methaemoglobin cannot combine with oxygen. Thus, the quantity of haemoglobin available for oxygen transport is decreased.
4. **Combination of haemoglobin with gases other than oxygen and carbon dioxide**: When haemoglobin combines with carbon monoxide, hydrogen sulphide or nitrous oxide, it loses the capacity to transport oxygen.



3. Stagnant Hypoxia

Stagnant hypoxia is the hypoxia caused by decreased velocity of blood flow. It is otherwise called hypokinetic hypoxia.

Characteristic features of stagnant hypoxia Stagnant hypoxia are characterized by decreased velocity of blood flow. All other features remain normal.

Causes for stagnant hypoxia : Stagnant hypoxia occurs mainly due to reduction in velocity of blood flow. Velocity of blood flow decreases in the following conditions:

- i. Congestive cardiac failure
- ii. Haemorrhage
- iii. Surgical shock
- iv. Vasospasm
- v. Thrombosis
- vi. Embolism.



4. Histotoxic Hypoxia

Histotoxic hypoxia is the type of hypoxia produced by the inability of tissues to utilize oxygen.

Characteristic features of histotoxic hypoxia Histotoxic hypoxia is characterized by inability of tissues to utilize oxygen even if it is delivered. All other features remain normal.

Causes for histotoxic hypoxia

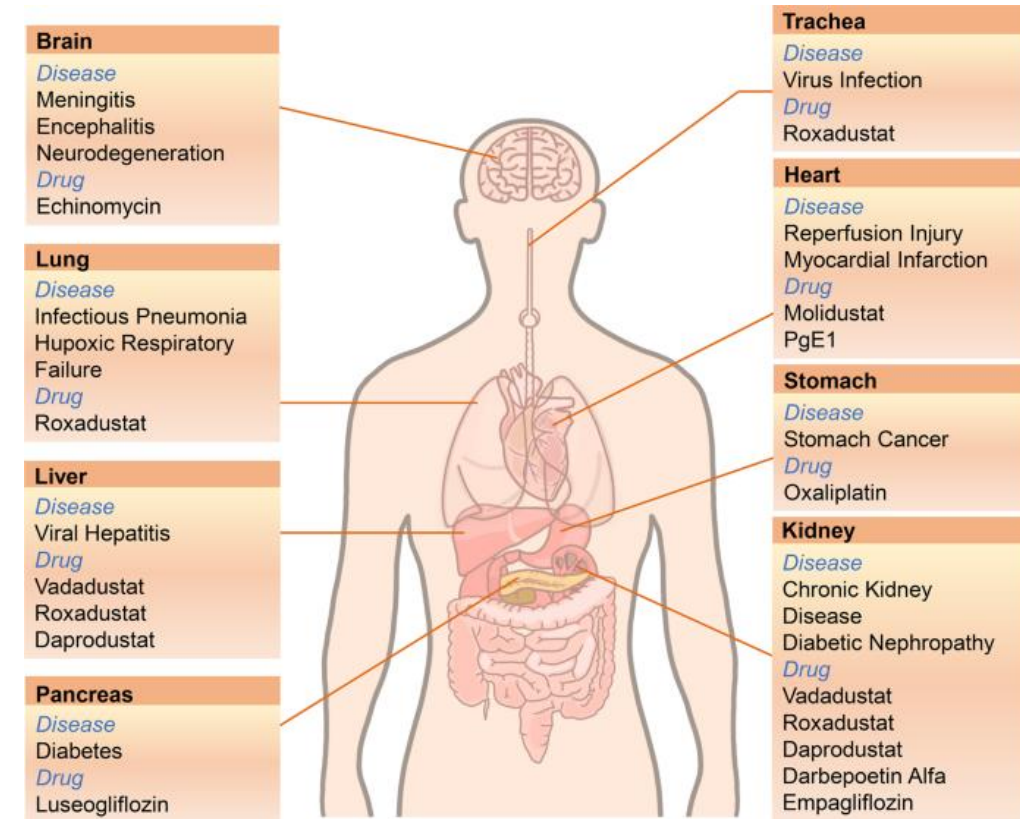
- Histotoxic hypoxia occurs due to cyanide or sulphide poisoning. These poisonous substances destroy the cellular oxidative enzymes and there is a complete paralysis of **cytochrome oxidase system**. So, even if oxygen is supplied, the tissues are not in a position to utilize it.



Effects of Hypoxia

Hypoxia affects various body systems, leading to both immediate and delayed effects.

1. Immediately, it triggers
 - a. erythropoietin secretion to increase RBC production,
 - b. enhances heart rate and respiration initially, but later causes a decline in both.
 - c. The central nervous system experiences symptoms resembling alcohol intoxication, including irritability, disorientation, and impaired judgment.
 - d. Hypoxia also affects digestion, causing nausea, vomiting, and thirst.
 - e. If severe and untreated, it results in unconsciousness and brain death.
2. Delayed effects, depending on exposure duration, include irritability, fatigue, and symptoms of mountain sickness such as nausea and weakness.



TREATMENT FOR HYPOXIA – OXYGEN THERAPY

Best treatment for hypoxia is oxygen therapy, i.e. treating the affected person with oxygen.

Pure oxygen or oxygen combined with another gas is administered.

Oxygen therapy is carried out by two methods:

1. By placing the patient's head in a 'tent' containing oxygen
2. By allowing the patient to breathe oxygen either from a mask or an intranasal tube.

Depending upon the situation, oxygen therapy can be given either under normal atmospheric pressure or under high pressure (hyperbaric oxygen).



In Normal Atmospheric Pressure

With normal atmospheric pressure, i.e. at one atmosphere (760 mm Hg), administration of pure oxygen is well tolerated by the patient for long hours. However, after 8 hours or more, lung tissues show fluid effusion and edema. Other tissues are not affected very much because of **haemoglobin-oxygen buffer system**.

In High Atmospheric Pressure – Hyperbaric Oxygen

- i. Hyperbaric oxygen is the pure oxygen with high atmospheric pressure of 2 or more than 2 atmospheres. Hyperbaric oxygen therapy with 2 to 3 atmosphere is tolerated by the patient for about 5 hours.
- ii. During this period, the dissolved form of oxygen increases in arterial blood because the oxygen carrying capacity of haemoglobin is limited.
- iii. At this level, tissue oxygen tension also increases to about 200 mm Hg. However, tissues tolerate the high partial pressure of oxygen, without much adverse effects. But oxygen toxicity develops when pure oxygen is administered for long periods.



Efficacy of Oxygen Therapy in Different

Oxygen therapy is the best treatment for hypoxia. But it is not effective equally in all types of hypoxias. Value of oxygen therapy depends upon the type of hypoxia. So, before deciding the oxygen therapy, one should recall the physiological basis of different types of hypoxias.

- In hypoxic hypoxia, the oxygen therapy is 100% useful.
- In anaemic hypoxia, oxygen therapy is moderately effective to about 70%.
- In stagnant hypoxia, the effectiveness of oxygen therapy is less than 50%.
- In histotoxic hypoxia, the oxygen therapy is not useful at all. It is because, even if oxygen is delivered, the cells cannot utilize oxygen



ASPHYXIA

Asphyxia is the condition characterized by combination of **hypoxia** and **hypercapnia**, due to obstruction of air passage.

Causes : - Asphyxia develops in conditions characterized by acute obstruction of air passage such as:

1. Strangulation
2. Hanging
3. Drowning, etc.

EFFECTS OF ASPHYXIA

Effects of asphyxia develop in three stages:

1. Stage of hyperpnea
2. Stage of convulsions
3. Stage of collapse.



1. *Stage of Hyperpnea*

Hyperpnea is the first stage of asphyxia. It extends for about 1 minute. In this stage, breathing becomes deep and rapid. It is due to the powerful stimulation of respiratory centres by excess of carbon dioxide.

Hyperpnea is followed by **dyspnoea** and **cyanosis**. Eyes become more prominent.

2. *Stage of Convulsions*

Stage of convulsions is characterized mainly by convulsions (uncontrolled involuntary muscular contractions). Duration of this stage is less than 1 minute.

Hypercapnia acts on brain and produces the following effects:

- i. Violent expiratory efforts
- ii. Generalized convulsions
- iii. Increase in heart rate
- iv. Increase in arterial blood pressure
- v. Loss of consciousness.



3. Stage of Collapse

Stage of collapse lasts for about 3 minutes. Severe hypoxia produces the following effects during this stage:

- i. Depression of centres in brain and disappearance of convulsions
- ii. Development of respiratory gasping occurs : During respiratory gasping, there is stretching of the body with opening of mouth, as if gasping for breath. Duration between the gasps is gradually increased and finally death occurs.
- iii. Dilatation of pupils
- iv. Decrease in heart rate
- v. Loss of all reflexes.

Altogether, asphyxia extends only for 5 minutes. The person can survive only by timely help such as relieving the respiratory obstruction, good aeration, etc.



Dysbarism/DECOMPRESSION SICKNESS

Decompression sickness is the disorder that occurs when a person returns rapidly to normal surroundings (atmospheric pressure) from the area of high atmospheric pressure like deep sea. It is also known as **dysbarism, compressed air sickness, caisson disease, bends** or **diver's palsy**.

CAUSE

1. High barometric pressure at deep sea leads to compression of gases in the body. Compression reduces the volume of gases.
2. Among the respiratory gases, oxygen is utilized by tissues. Carbon dioxide can be expired out. But, nitrogen, which is present in high concentration, i.e. 80% is an inert gas. So, it is neither utilized nor expired.
3. When nitrogen is compressed by high atmospheric pressure in deep sea, it escapes from blood vessels and enters the organs. As it is fat soluble, it gets dissolved in the fat of the tissues and tissue fluids. It is very common in the brain tissues.
4. As long as the person remains in deep sea, nitrogen remains in solution and does not cause any problem.
5. But, if the person ascends rapidly and returns to atmospheric pressure, decompression sickness occurs.
6. Due to sudden return to atmospheric pressure, the nitrogen is decompressed and escapes from the tissues at a faster rate. Being a gas, it forms **bubbles** while escaping rapidly.
7. The bubbles travel through blood vessels and ducts. In many places, the bubbles obstruct the blood flow and produce air **embolism**, leading to decompression sickness.



SYMPTOMS

Symptoms of decompression sickness are mainly due to the escape of nitrogen from tissues in the form of bubbles.

- i. Severe pain in tissues, particularly the joints, produced by nitrogen bubbles in the myelin sheath sensory nerve fibres
- ii. Sensation of numbness, tingling or pricking (paraesthesia) and itching
- iii. Temporary paralysis due to nitrogen bubbles in the myelin sheath of motor nerve fibres
- iv. Muscle cramps associated with severe pain
- v. Occlusion of coronary arteries followed by coronary ischemia, caused by bubbles in the blood6. Occlusion of blood vessels in brain and spinal cord also
- vi. Damage of tissues of brain and spinal cord because of obstruction of blood vessels by the bubbles
- vii. Dizziness, paralysis of muscle, shortness of breath and choking occur
- viii. Finally, fatigue, unconsciousness and death.



RESPIRATORY ACIDOSIS

pH <7.35, CO₂ >45

The lungs cannot get rid of enough CO₂ for some reason...

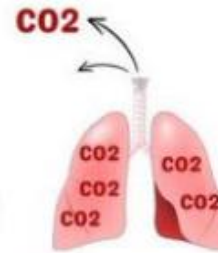
1. **Respiratory center in the brainstem:** Overdose (sedatives → hypovent.), coma
2. **Neuromuscular disorder:** Myasthenia gravis, thoracic injury, obesity
3. **Airway obstruction:** Foreign body
4. **Impaired gas exchange:** COPD, PNA, pulmonary edema, respiratory failure

SYMPTOMS:

Anxiety, shallow resp., confusion, headache, restlessness, blurry vision

TREATMENT:

Bronchodilators, antibiotics, fluids, ventilation



RESPIRATORY ALKALOSIS

pH >7.45, CO₂ <35

The lungs blow off more CO₂ than the body can replace...

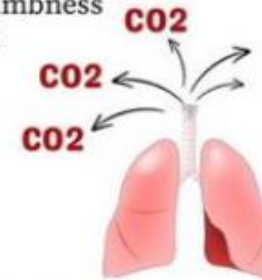
1. **Hypoxia:** Pneumonia, pulmonary embolism, pneumothorax, increased altitude
2. **Other:** Hyperventilation (anxiety), overdose with salicylates

SYMPTOMS:

Dizziness, dry mouth, numbness or tingling in fingers and toes, rapid breathing

TREATMENT:

Reventilate (paper bag), oxygen, antianxiety or sedative medications



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METABOLIC ACIDOSIS

pH <7.35, HCO₃ <22

Buildup of acid in blood by...

1. **Increased production in the blood** (Lactic acidosis, shock, DKA, renal failure, starvation)
2. **Loss of HCO₃:** Severe diarrhea

SYMPTOMS:

Weakness, fatigue, headache, dysrhythmias, Kussmaul respirations, SOB, hyperkalemia

TREATMENT:

Bicarbonate, fluids
DKA: IV Insulin, normal saline, K⁺ & D50

METABOLIC ALKALOSIS

pH >7.45, HCO₃ >26

1. **Loss of H⁺ ions:** Severe vomiting, excess aldosterone, excessive gastric suctioning
2. **Gain of HCO₃ ions:** Loop/thiazide diuretics, hypokalemia, TUMS, TPN food

SYMPTOMS:

Dizziness, decreased respirations, numbness/tingling in toes and fingers, dysrhythmias, hypokalemia

TREATMENT:

Fluid and electrolyte repletion
Decrease nausea/vomiting

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