

Respiratory system

The principal function of the respiratory system:

1. Gas exchange in which oxygen is transferred from the environment to the blood and carbon dioxide is moved in the opposite direction.
2. Role in thermoregulation in most species,
3. acid-base regulation in concert with the kidney,
4. as an endocrine organ (e.g. angiotensin-converting enzyme) these enzymes secreted by lungs which increase blood pressure by vasoconstriction .
5. in the immune response to inhaled immunogens and pathogens. Capillaries in the lungs of the farm animal species and horses also possess intravascular macrophages, which are important as a reticuloendothelial organ in the processing of antigens.

DEFINITIONS

Hypoxia is a broad term meaning diminished availability of oxygen to tissues

Hypoxemia is deficient oxygenation of blood.

Hypercapnia is an abnormally high carbon dioxide tension in blood

Respiratory failure is the inability of an animal to maintain arterial blood oxygenation and carbon dioxide tension within the normal range

Dyspnea labored or difficult breathing in animals at rest or with little exercise.

Polypnea is an excessively high rate of breathing

Tachypnea is an excessively high rate of breathing, with the implication that the breathing is shallow

Hyperpnea is an increased minute ventilation. (is the volume of gas inhaled (inhaled minute volume) or exhaled (exhaled minute volume) from a person's lungs per minute.

Hypoxia :

Failure of the tissues to receive an adequate supply of oxygen

Types of hypoxia:

1.Hypoxic (or hypoxemic) hypoxia :

hypoxia occurs when there is inadequate oxygenation of blood (hypoxemia) and is usually associated with disease of the respiratory tract or other causes of hypoventilation. Situations in which there is inadequate oxygenation of blood in the lungs include hypoventilation, Airway obstruction, diffusion impairment, low inspired oxygen tension.

2.Anemic hypoxia :

It occurs when there is a deficiency of hemoglobin per unit volume of blood (anemia).

3.Circulatory hypoxia

Circulatory hypoxia occurs as a result of inadequate delivery of oxygen to tissue because of inadequate perfusion of tissues by blood. The blood is usually adequately oxygenated but blood flow rate to tissues is not, and therefore the rate at which it delivers oxygen to tissue is less than the amount of oxygen required to support the metabolic function of that tissue.

4.Histotoxic hypoxia

Histotoxic anoxia occurs when oxygen delivery to tissue is adequate because both oxygen content of arterial blood and blood flow are appropriate, but the tissue is unable to utilize oxygen. Cyanide poisoning is the only common cause of this form of hypoxia.

Consequences of hypoxia :

Consequences of inadequate delivery of oxygen include changes in almost all body systems as follows:

1.Central nervous system: hypoxia is evident as mild changes in mentation, such as depression, progressing through decreased alertness to coma and death.

2. **Cardiac changes** include a reduction in the force and efficiency of contraction due to impaired myocardial contractility, and an increased susceptibility to arrhythmia.

3. **Renal function** is reduced during hypoxia, with the renal medulla being most sensitive to decreases in oxygen delivery.

4. **Signs of gastrointestinal dysfunction** during hypoxia include ileus, abdominal pain and abdominal distension due to accumulation of gas and liquid in the gastrointestinal tract.

5. **Liver dysfunction** can be evident as decreases in blood glucose concentration and increases in serum activity of liver-derived enzymes (alkaline phosphatase, gamma-glutamyl transpeptidase, sorbitol (inositol) dehydrogenase) and metabolites (bile acids, bilirubin).

Carbon Dioxide Retention (Hypercapnia)

Respiratory insufficiency results in decreased elimination of carbon dioxide and its accumulation in blood and tissues. Animals breathing room air that are hypercapnic are always hypoxemic. Acute hypercapnia causes a respiratory acidosis that reduces both blood and cerebrospinal fluid pH.

The **clinical signs** of acute hypercapnia are initial anxiety followed by central nervous system depression and eventual coma and death. These clinical abnormalities are attributable to declines in the pH of cerebrospinal fluid (CSF), a consequence of the ease with which carbon dioxide crosses the blood-brain barrier.

Respiratory Failure

Respiratory movements are involuntary and are stimulated and modified by the respiratory centers in the medulla.

Respiratory failure is the terminal stage of respiratory insufficiency in which the activity of the respiratory centers diminishes to the point where movements of respiratory muscles cease. Respiratory failure can be **paralytic**, **dyspneic** or **asphyxial**, or **tachypneic**, depending on the primary disease.

The respiratory failure that occurs in animals with pneumonia, pulmonary edema and upper respiratory tract obstruction is caused by combinations of hypoventilation, ventilation/perfusion mismatch and diffusion impairment, which leads to hypercapnia and hypoxemia.

Paralysis of respiratory muscles occurs in disease such as botulism, tetanus, strychnine poisoning, white muscle disease, severe hypocalcemia and tick paralysis.

The signs of paralytic respiratory failure are

1. a gradual or abrupt cessation of respiratory movements without preceding signs of increased respiratory effort or dyspnea.
2. The animal is often unconscious, or unable to move, during the later stages of the disease.

Treatment:

1. Administration of respiratory stimulants is seldom effective as sole therapy.
2. Administering antimicrobials to an animal with pneumonia
3. Administering furosemide to an animal with pulmonary edema,
4. in addition to supportive care including, potentially, nasal or pharyngeal insufflation with oxygen, or mechanical ventilation.

Principal manifestations of respiratory insufficiency

Respiratory disease is evident as one or more of a variety of signs detectable on clinical examination. The signs vary with the etiology of the disease and its anatomic location. Diseases that impair ventilation or gas exchange have hypoxemia and hypercapnia as prominent life threatening abnormalities. Infectious and inflammatory diseases can cause prominent clinical abnormalities as a result of a systemic inflammatory response and toxemia. The toxemia may be so severe (e.g. in calf diphtheria, aspiration pneumonia and equine pleuritis) as to cause death even though oxygen and carbon dioxide exchange are not greatly impaired.

The common signs of respiratory disease are:

- o Abnormalities in the rate, depth, or ease of breathing
- o Lethargy or exercise intolerance
- o Abnormal posture
- o Abnormal lung sounds
- o Abnormal respiratory noises
- o Coughing
- o Cyanosis
- o Nasal discharge
- o Epistaxis and hemoptysis.

Respiratory tract disease

Respiratory tract diseases interfere with normal gas transfer. Characteristics of respiratory disease that lead to dyspnea or lack of exercise tolerance include:

- o **Flooding of alveoli with inflammatory cells** and/or protein rich fluid - pneumonia and pulmonary edema
- o **Atelectasis** (collapsed alveoli and small airways) - pleural effusion, hemothorax, hydrothorax, pneumothorax, chylothorax, pyothorax, prolonged recumbency of large animals and diaphragmatic hernia
- o **Airway obstruction** - nasal obstruction, pharyngeal/ laryngeal obstruction, tracheal, bronchial obstruction, bronchoconstriction and bronchiolar obstruction.

Interference the diseases of the other systems with respiratory system diseases:

1. Cardiovascular disease

This causes inadequate perfusion of tissues including the lungs. There is reduced oxygen delivery to tissues, even in the presence of normal arterial oxygenation.

2. Diseases of the blood

These cause inadequate delivery of oxygen to tissues because of anemia or presence of hemoglobin that is unable to carry oxygen (methemoglobinemia (e.g. in nitrite poisoning) ; carboxyhemoglobinemia).

3. Nervous system diseases

Diseases of the nervous system affect respiratory function by one of several mechanisms:

- a. **Paralysis of respiratory muscles** occurs in tick paralysis or botulism. Tetanic spasm of respiratory muscles, such as in tetanus or strychnine toxicosis, also impairs or prevents alveolar ventilation. Both flaccid and tetanic paralysis cause hypercapnia and hypoxemia and, in extreme situations, death by suffocation
- b. **Paralysis of the respiratory center**, as in poisoning by nicotine sulfate, or overall central nervous system depression, causes hypoventilation because of impaired ventilatory drive

4. Musculoskeletal diseases

o **Muscle diseases.** Diseases of the respiratory muscles can impair ventilation. These include **white muscle disease** in lambs, calves, and foals, and some congenital diseases (such as glycogen branching enzyme deficiency in foals)

• **Fatigue.** Animals with primary severe respiratory disease can develop fatigue of the respiratory muscles (intercostal, diaphragm, accessory muscles of respiration), which can further impair ventilation

• **Trauma.** Fractured ribs can impair ventilation both because of the pain of breathing and because of mechanical disruption to respiration.

5. Miscellaneous cases:

Respiratory diseases can occur in a number of systemic states in which there is no lesion of the respiratory tract or nervous system. These include:

- **Pain** - such as in horses with colic

- **Hyperthermia** - as can occur with intense or strenuous exercise

- **Acidosis** - as a metabolic disturbance associated with any of a number of diseases but notably gastrointestinal disease that causes excessive loss of cationic electrolytes in feces.

.Environmental causes

- Low inspired oxygen tension, such as in animals at high altitude

- Exposure to toxic gases.

- **poisons:**

Organophosphates and Poisonous plants.

Abnormal breath sounds

Abnormal breath sounds include crackles and wheezes. **Crackles** are discontinuous sounds and **wheezes** are continuous sounds.

Crackles may thus be caused by the presence of exudate and secretions in the airways, and edematous bronchial mucosa. Crackling lung sounds are also audible in cattle with interstitial pulmonary emphysema.

Wheezes are continuous whistling, squeaking sounds caused by vibrations of airways or air passing through a narrowed airway.

Pleuritic friction sounds are a combination of continuous and discontinuous sounds produced by the rubbing together of inflamed parietal and visceral pleura.

Absence of lung sounds The common causes of the 'silent lung' include pleural effusion, space-occupying masses of the thorax, large pulmonary abscess, complete destruction of a lobe of lung including the terminal airways, such as can occur with bronchial lumen occlusion by a foreign body or tumor, and diaphragmatic hernia.

Respiratory Noises

Sneezing is a sudden, involuntary, noisy expiration through the nasal cavities caused reflex by irritation of the nasal mucosae. Sneezing occurs in rhinitis and obstruction of the nasal cavities, and digital manipulation and examination of the nasal mucosae.

Snorting is a forceful expiration of air through the nostrils as in a sneeze, but a snort is a voluntary act used by horses and cattle as a device to intimidate potential predators.

Stridor is an inspiratory stenotic sound originating from a reduction in the caliber of the larynx, as occurs in laryngeal edema and abscess.

Wheezing is a high-pitched sound made by air flowing through a narrow lumen, such as a stenotic or inflamed nasal cavity.

Roaring may occur during exercise and is caused by air passing through a larynx with a reduced lumen, e.g. laryngeal hemiplegia in horses.

Expiratory grunting is a clearly audible grunting noise synchronous with expiration. It is most common in cattle with diffuse pulmonary disease. A painful grunt may occur in painful diseases of the thorax such as fibrinous pleuritis and is unassociated with inspiration or expiration.