

General Systemic States

Hypothermia

- Hypothermia is a lower than normal body temperature.

Etiology

1. Excessive loss of heat due to exposure to excessively cold air temperatures.
2. Insufficient heat production due to:
 - a. Insufficient body reserves of energy and insufficient feed intake result.
 - b. Secondary to diseases cause in the ability to shiver and skeletal muscle contraction associated with decreased cardiac output, decreased peripheral perfusion, and shock; e.g., parturient paresis, acute ruminal acidosis, during anesthesia and sedation.
 - o A sudden fall in body temperature in a previously febrile animal, called “premortal fall”, is an unfavorable prognostic sign.
3. Combination of excessive heat loss and insufficient heat production; e.g., insufficient energy intake or starvation of newborn farm animals in a cold environment.

Clinical Findings

- A decrease in body temperature to below 37° C.
- Weakness.
- Decreased activity.
- Cold extremities.
- Varying degrees of shock.
- Bradycardia, weak arterial pulse, and collapse of the major veins are characteristic.
- The mucous membranes of the oral cavity are cool and there is a lack of saliva.
- In hypothermia secondary to other diseases:
 - o Usually not marked.
 - o There are clinical findings related to the underlying illness.
 - o Successful treatment of the primary disease returns the temperature to normal range

Treatment

- Newborn animal of any age with mild hypothermia (37–39° C) are:
 - o Dried off if necessary to reduce heat loss.
 - o Given ewe or cow colostrum by stomach tube “warm colostrum”.
 - o Placed in a sheltered pen with the ewe.
- Newborn animal with severe hypothermia (<37° C) are:
 - o Dried off.
 - o Given an intraperitoneal injection of 20% glucose at a temperature of 39° C.
 - o Placed in warming pens.
 - ♣ When the lamb’s temperature reaches 37° C, it is removed from the warmer and immediately fed ewe or cow colostrum by stomach tube at a rate of 50 mL/kg BW.
- Circulation should be improved by providing fluid therapy as necessary.
- In foals, additional insulation with foal rugs and leg bandages will reduce heat loss from the dry body surface.

Control

- Provide necessary monitoring at the time of parturition in animals being born in cold environments.
 - Recognize and treat animals with diseases leading to hypothermia.
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Hyperthermia

- Hyperthermia is the elevation of core body temperature caused by excessive heat production or absorption, or to deficient heat loss.
- Unless the body temperature reaches a critical point, a short period of hyperthermia is advantageous in an infectious disease because:
 - o Phagocytosis and immune body production are facilitated.
 - o The viability of most invading organisms is impaired.

Etiology

1. Physical reasons:

- a. High environmental temperature.
 - b. Prolonged and severe muscular exertion
 - c. Inadequate ventilation such as on board ship or during road transportation.
2. Neurogenic hyperthermia: damage to hypothalamus, e.g., spontaneous hemorrhage.
 3. Dehydration caused by insufficient tissue fluids to accommodate heat loss by evaporation.
 4. Excessive muscular activity: for example, strychnine poisoning

Clinical Findings

First stage:

- Elevation of body temperature.
- Increase in heart and respiratory rates with weak pulse of large amplitude.
- Sweating and salivation.
- The animal may be restless but soon becomes dull, stumbles while walking, and tends to lie down.
- In the early stages there is increased thirst and the animal seeks cool places, often lying in water or attempting to splash itself.

Second stage:

- The respirations become shallow and irregular, and the pulse becomes very rapid and weak.
- Marked absence of sweating.
- Collapse, convulsions, and terminal coma.
- Death occurs in most species when the core temperature exceeds the normal value by approximately 5 to 7° C (8–10° F).
- Abortion may occur if the period of hyperthermia is prolonged.

Treatment

- Adequate drinking water is essential.
- Shade and air movement is of considerable assistance when multiple

animals are exposed to high air temperature.

- If treatment of individual animals is necessary because of the severity or duration of the hyperthermia, affected animals should be
 - o Immediately placed in the shade.
 - o Hosed on the midline of the back with cold water.
 - o Fans should be immediately placed in front of the animal to promote evaporative cooling.
 - o Cooled water, with and without added electrolytes, should be provided.
- The rectal temperature should be monitored frequently during cooling, and water application should be stopped when the rectal temperature has returned to normal.
- Because affected animals may not be interested in or capable of drinking, the intravenous administration of fluids therapy is indicated in animals that are weak, recumbent, or dehydrated.

Control

- Shade is essential factor in maintaining the comfort of livestock and preventing heat stress.
- Provide cool clean water and plenty of trough space for drinking.
- Intermittent sprinkler systems (wet time of 1–2 min with an adequate dry off time of 20–30 min).
- Continuous application of water increases the local humidity and decreases the effectiveness of evaporative cooling.
- Minimize handling during periods of greatest heat stress.

Fever (pyrexia)

- Fever is an elevation of core body temperature above that normally maintained by an animal and is independent of the effects of ambient conditions on body temperature.
- Fever is a combination of hyperthermia and infection or inflammation that results from an elevated set point for temperature regulation.

Etiology

- Septic Fevers: infection with bacteria, viruses, protozoa, or fungi as:
 - o Localized infection such as abscess, cellulitis, and empyema.
 - o Intermittently systemic, as in bacteremia and endocarditis.
 - o Consistently systemic, as in septicemia.
- Aseptic Fevers
 - o Chemical fevers, caused by injection of foreign protein and intake of dinitrophenols
 - o Surgical fever, caused by breakdown of tissue and blood.
 - o Fever from tissue necrosis, e.g., breakdown of muscle after injection of necrotizing material.
 - o Severe hemolytic crises (hemoglobinemia).
 - o Extensive infarction.
 - o Extensive necrosis in rapidly growing neoplasms such as multicentric lymphosarcoma in cattle.
 - o Immune reactions such as anaphylaxis and angioneurotic edema

Treatment

- Identify and treat the primary disease.
 - o The selection of antimicrobial, the route of administration, and the duration of treatment depend on the cause of the infection, its severity, and the accessibility of the lesion to the drug.
 - o The use of antimicrobial agents to prevent secondary bacterial infections in animals with viral diseases
- In animals with a fever of unknown origin:
 - o Broad-spectrum antimicrobial agents seem rational.
- Antipyretics
 - o If the fever is high enough to cause discomfort or inappetence, or is so high that death from hyperthermia is possible, then nonsteroidal anti-inflammatory drugs (NSAIDs) should be

administered, e.g.: flunixin meglumine, are inhibitors of prostaglandin synthesis

Sepsis

Sepsis is a life-threatening condition caused by the response of the body to an infection, where

normally the body releases chemicals into the bloodstream to fight an infection, accompanied with the

presence of systemic inflammatory response syndrome (SIRS), and characterized by presence of at least

two of the following abnormalities is:

- Hyperthermia or hypothermia.
- Tachycardia.
- Tachypnea or hyperventilation.
- Leukopenia, leukocytosis, or >10% band neutrophils.
- Severe sepsis is sepsis accompanied by organ dysfunction.
- Septic shock is a severe sepsis with hypotension (arterial blood pressure <65 mm Hg).
- Septicemia is the acute invasion of the systemic circulation by pathogenic bacteria accompanied by septic shock with possible bacterial localization in various body systems or organs.
 - o It is a common cause of morbidity and mortality in newborn farm animals that have not received a sufficient quantity of colostrum in the first 24 hours after birth.
- Bacteremia is the acute invasion of the systemic circulation by pathogenic bacteria without sepsis or septic shock. Bacteria are present in the bloodstream for only transitory periods and do not produce clinical signs.
- Viremia is the invasion of the systemic circulation by pathogenic viruses with localization in various body tissues and in which the lesions produced are characteristic of the specific virus.
- Many infections associated with rickettsias, protozoa, and fungi are also spread hematogenously

throughout the body but usually do not initiate a systemic inflammatory response syndrome.

Etiology

- Neonatal septicemias are caused most commonly by gram-negative bacteria, e.g., *E. coli*.
- In adult animals: *Histophilus somni*, *Pasteurella* spp., *Mannheimia haemolytica*, and some viruses.
- Secondary Septicemias:
 - o Subacute radiation injury causes septicemia resulting from loss of leukocyte production because of injury to bone marrow.
 - o Congenital defect in the immune system or when immunosuppression occurs as a result of corticosteroid therapy or toxin such as bracken.

Clinical Findings

- Fever.
- Cardiovascular dysfunction.
- Shock.
- Submucosal and subepidermal hemorrhages that are usually petechial and occasionally ecchymotic.
- Tachycardia, tachypnea, and shock-induced organ dysfunction with cardiovascular hypotension, myocardial asthenia, and respiratory distress may occur in severe cases.
- Specific signs may occur as the result of localization of the infection in different organs.

Treatment and Control

- Identify and treat the primary disease.
- Broad-spectrum antimicrobial agents and general supportive measures.
- Intensive care of the newborn with septicemia is important.
- Strict hygienic precautions to avoid spread of infection are also necessary.

Toxemia and Endotoxemia

- Toxemia is a clinical systemic state caused by widespread activation of host defense mechanisms to the presence of toxins produced by bacteria or injury to tissue cells.
 - o Toxemia does not include the diseases caused by toxic substances produced by plants or insects or ingested organic or inorganic poisons.
 - o Endotoxemia is the most common form of toxemia in large animals caused by the presence of lipopolysaccharide, the cell-wall components of gram-negative bacteria, in the blood.

Etiology

- Antigenic Toxins:
 - o Produced by bacteria and to a lesser extent by helminths.
 - o Stimulate the development of antibodies.
 - o Antigenic toxins are divided into exotoxins and endotoxins.
 - ♣ Enterotoxins are exotoxins that exert their effect principally on the mucosa of the intestine.
- Metabolic Toxins:
 - o Accumulate as a result of incomplete elimination of toxic materials normally produced by body metabolism.

Clinical Finding

- Acute toxemia:
 - o Depression, anorexia, and muscular weakness.
 - o Heart rate is increased.
 - o Fever (in early stages).
- Endotoxemia:
 - o Depression.
 - o Hyperthermia followed by hypothermia.
 - o Tachycardia followed by decreased cardiac output.
 - o Decreased systemic blood pressure.
 - o Cool skin and extremities.
 - o Diarrhea.
 - o Congested mucosae with an increased capillary refill time.
 - o Muscular weakness, leading to recumbency.

Treatment

- The principles of treatment of endotoxemia or septic shock include:
 - (1) removal of the foci of infection.
 - (2) administration of antimicrobial agents with a gram-negative spectrum.
 - (3) aggressive fluid and electrolyte therapy
 - (4) NSAIDs or glucocorticoids for the inhibition of products of the cyclooxygenase pathway.
- Glucose should always be included in the infusion fluids because hypoglycemia, increased glucose utilization, and inappetence are usually present in endotoxemic animals.
- The rationale for the use of glucocorticoids includes the following:
 - o Organelle and cell-membrane stabilization.
 - o Improved cellular metabolism and gluconeogenesis.
 - o Improved microcirculation.
 - o Decreased production of endogenous toxins such as myocardial depressant factor.
 - o Decreased leukocyte activation and degranulation.
 - o Minimal reticuloendothelial depression and histologic organ damage.

Shock

- Shock is a reduction of cardiac output (circulating blood volume) below a critical point because of inadequate venous return to the heart (vascular failure).
 - o Cardiogenic shock caused by acute or chronic heart failure.

Etiology

- There are four main ways that vascular failure occurs:
 1. Hypovolemic shock: caused by loss of blood, plasma, or free water.
 - o e.g., Fluid loss and dehydration, such as in neonatal calf diarrhea.
 2. Hemorrhagic shock: caused by the rapid loss of blood.
 - o e.g., Acute hemorrhage with loss of 35% or more of total blood volume.
 3. Maldistributive shock: caused by
 - o increased capillary permeability.
 - o pooling of blood in capacitance vessels (such as the veins in the splanchnic circulation).
 - o pooling of plasma in a large third space such as the thoracic or abdominal cavities.

- o e.g., Endotoxemia in neonatal septicemia, salmonellosis, coliform mastitis in lactating dairy cattle, toxic metritis in cattle.
- 4. Obstructive shock: caused by a mechanical obstruction, such as pericardial tamponade or pulmonary artery thrombosis. Obstructive shock is extremely rare in large animals

Clinical Findings

- o Depression, weakness, and listlessness.
- o Fall in temperature to below normal (the skin is cold).
- o The mucosae are pale gray to white and dry.
- o The capillary refill time is extended beyond 3 to 4 seconds.
- o Increase in heart rate to 120 to 140 beats/min, with abnormalities of the pulse (small and weak).
- o Cardiac arrhythmias.
- o Venous blood pressure is greatly reduced in hypovolemic and hemorrhagic shock.
- o Anorexia is usual but thirst may be evident and there is anuria or oliguria.

Treatment

- Identification of the cause
 - o There is greater success in the treatment and management of hypovolemic and hemorrhagic shock.
 - o Effective treatment and management of maldistributive shock is less successful unless the sepsis can be controlled and the source of the endotoxemia eliminated.
- Fluid therapy
 - o The rapid administration of intravenous fluids is the most important therapy:

o Isotonic Crystalloid Solutions

♣ Most commonly used treatments for hypovolemic and maldistributive shock in large animals, such as lactated Ringer's solution, are preferable to 0.9% NaCl solutions.

♣ Glucose solutions are not indicated in the treatment of shock (because glucose provides free water without giving a hyposmolar solution).

♣ Isotonic crystalloid solutions expand the interstitial fluid volume and promote urine flow.

♣ The disadvantages of the use of isotonic crystalloid solutions are the large volume required for treatment.

o Colloids

♣ Colloid solutions (plasma, dextran, gelatin polymers, and hydroxyethyl starches) induce a more sustained increase in plasma volume than crystalloid solutions and smaller volumes are required for therapy.

♣ Colloid solutions are expensive and are rarely used in cattle and occasionally used in horses, with the exception of blood transfusion.

• Ancillary Treatment

o Corticosteroids

♣ There is considerable controversy over the use of corticosteroids in shock.

♣ Corticosteroids are frequently used in the treatment of shock in animals.

o Cyclooxygenase Inhibitors, such as:

♣ IV flunixin meglumine (0.25 mg/kg BW).

♣ IM ketoprofen (0.5–2.2 mg/kg BW).

o Antibiotic Therapy

♣ A broadspectrum bactericidal antibiotic, or a combination of antibiotics to achieve a broad.

♣ spectrum, should be used.

Pain

- Pain is an aversive sensory and emotional experience representing awareness by the animal of damage or threat to the integrity of its tissues.
- Pain is basically a protective mechanism to ensure that the animal moves away from noxious (damaging) influences and providing immobility of the affected part.
- A major difficulty with pain in animals is the difficulty of pain measurement.
 - o In animals, pain is assessed by three methods:
 - (1) observation of behavior.
 - (2) measurement of physiologic parameters, including heart rate, blood pressure, sweating and polypnea, that indicate sympathetic activation.
 - (3) measurement of the plasma concentration of factors that indicate sympathetic activation, such as plasma cortisol, epinephrine, norepinephrine, and nonesterified fatty acid concentrations.
 - The detrimental effects of pain include the following:
 - o Suffering and stress resulting in delayed healing.
 - o Increased catabolism and decreased feed intake
 - o Prolonged recovery and longer recumbency.
 - o Ineffective respiratory ventilation, and development of respiratory acidosis and acidemia.
 - o The potential of acute pain to lead to chronic pain.

Etiology

- In animals, there are three types of pain:
 1. Cutaneous (or superficial) pain:
 - o caused by agents or processes that damage the skin, such as burning, freezing, cutting, and crushing, laminitis, infected surgical wounds, foot rot, or crushing by trauma.

2. Visceral pain:

o Examples of visceral pain include the following:

- ♣ Inflammation, such as in peritonitis, nephritis, and enteritis.
- ♣ Distension of viscera, including the stomach, intestines, ureters, and bladder.
- ♣ Swelling of organs as in hepatomegaly and splenomegaly.
- ♣ Stretching of the mesentery and mediastinum.

3. Musculoskeletal (or somatic) pain:

o can be caused by lacerations and hematomas of muscle, myositis, space-occupying lesions of muscle, osteomyelitis, fractures, and arthritis.

Clinical Findings

• Physiologic Responses

- o Tachycardia
- o Polypnea
- o Pupillary dilatation
- o Hyperthermia
- o Sweating

Note: the severity of the pain determines the degree of response.

• Behavioral Responses

- o Abnormal posture and gait when the pain is musculoskeletal, such as lameness, a shuffling gait, and rapid shifting of weight from one leg to another.
- o Unrelated activities such as rolling, pawing, crouching, or grinding of teeth when the pain is visceral.
- o Rolling, falling, and lunging upward and backward (often falling against walls).

Elicitation of Pain by the Veterinarian

- Pressure by palpation, including firm ballottement, depress the back in a horse or arch the back upward from below in a cow.
- Pressure by compression, as with hoof testers for detecting the presence of pain in the hoof.

- Movement by having the animal walk actively or by passively flexing or extending limbs or neck.
- Stimulation of pain related to coughing by eliciting the cough reflex

Treatment

- Treatment of the causative lesion is a major priority.
- The treated lesion may remain painful for varying lengths of time.
- Analgesic Agents:
 - o Local anesthetic agents such as lidocaine (lignocaine), mepivacaine, and bupivacaine.
 - o NSAIDs such as flunixin meglumine, ketoprofen, carprofen, and meloxicam
 - o α 2-Agonists such as xylazine and detomidine.
 - o Opioids such as morphine, fentanyl.
- Supportive Therapy
 - o Application of moist heat to a local lesion
 - o Providing adequate bedding is important for an animal that is recumbent for long periods.
 - o Distracting a horse with colic by walking.
- The provision of adequate amounts and quality of feed and water is essential, especially if the animal is immobilized and because appetite is often poor.

Stress

- Stress is a systemic state that develops when the animal's mechanisms concerned with adapting its body to the environment are extended beyond their normal capacities.
 - o Stress is any stimulus, internal or external, chemical or physical or emotional, that excites neurons of the hypothalamus to release corticotrophin releasing hormone at rates greater than would occur at that time of the day in the absence of the stimulus.
 - o Stressors can be environmental factors that stimulate homeostatic, physiologic, and behavioral responses in excess of normal.

- o The importance of stress is that it may:
 - ♣ Lead to the development of psychosomatic disease.
 - ♣ Increase susceptibility to infection.
 - ♣ Represent an unacceptable level of consideration for the welfare of animals.
 - ♣ Reduce the efficiency of production.

Causes of stress

- Any environmental influences that elicit physiologic responses, including:
 - o Road transportation for prolonged periods.
 - o Climate, especially temperature, either as excessive heat or cold.
 - o Excessive physical effort, as in endurance rides for horses.
 - o Pain, especially analgesia-masked pain in severe colic in horses.
 - o Housing, such as:
 - ♣ Crowding.
 - ♣ Presence or absence of bedding.
 - o Nutritional deficiencies.
 - o Herding and flocking instincts.

Management of Stress

- Livestock industry must develop systems of handling and housing that will minimize stressors.
- Monitor the well-being of animals and determine whether or not they are under stress.
- Give due care to the appropriate selection.
- Use anesthetics and analgesics when pain is being inflicted, such as in dehorning and castration.
- Improve the conditions under which animals are transported, including stocking density, ventilation, temperature and humidity, noise, vibration, prolonged deprivation of feed and water.