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Anaemia in Domestic Animals

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Abstract:

Anaemia is one of the most common haematological disorders affecting domestic animals characterised by a reduction in the number of red blood cells or haemoglobin concentration in blood. It could be caused by blood loss, over-destruction of erythrocytes, nutritional deficiencies, infections, parasitic infestations, toxicities or bone marrow disorders. Anaemia has a detrimental effect on health, productivity, growth, reproduction and working efficiency of livestock and companion animals. There are different classifications of anaemia like classification based on morphology, etiology and bone marrow response. Clinical signs are frequently seen as pale mucous membranes, weakness, reduced stamina, rapid breathing and loss of appetite. Proper diagnosis includes history taking, physical examination, haematological evaluation and laboratory investigations. Early diagnosis and treatment like nutritional supplementation, parasite control, blood transfusion and control of underlying diseases are important for successful recovery. Balanced nutrition, regular deworming, vaccination, hygienic management and routine veterinary check-ups are preventive measures and play a vital role in reducing the incidence of anaemia in domestic animals.

Introduction:

Anaemia is a condition in which the body has a reduced number of circulating erythrocytes or decrease in haemoglobin concentration. It may also be defined as decrease in number of the RBCs in an animal for that particular species, breed, age and geographic location. It may either be due to decreased production of erythrocytes or haemoglobin or increased destruction of red blood cells (RBCs). Anaemia is suggested clinically by pale or white mucous membranes, exercise intolerance, tachycardia, weakness, tachypnoea, possible systolic murmurs and collapse. Clinical manifestations of anaemia are seen as per the severity, the duration (short or long-term), and the underlying reason of the illness [1].

Classification of Anaemias:

Different authors have classified anaemia differently.

Morphological classification of anemia	Classification of anemia based on etiology	Classification of anemia according to a bone marrow response
<ul style="list-style-type: none"> •Macrocytic normochromic anemia •Macrocytic hypochromic anemia •Normocytic normochromic anemia •Normocytic hypochromic anemia •Microcytic normochromic anemia •Microcytic hypochromic anemia II). 	<ul style="list-style-type: none"> •Blood loss anemia- Extravascular (hemorrhagic) and Intravascular (hemolytic) •Dys-haemopoietic anemia (Nutritional deficiency anemias) •Hereditary anemia: Generically determined defects in erythropoiesis 	<ul style="list-style-type: none"> i.Regenerative ii.Non-regenerative

I) Morphological Classification of Anaemia:**1. Macrocytic and normochromic anaemia:**

It denotes the presence of immature RBCs in the circulation (macrocyte). The size of erythrocyte is bigger than normal (macrocyte) with usual color.

Causes: Results from deficiency of Vit. B12, Erythrocyte Maturation Factor (EMF), Cobalt, folic acids and niacin.

2. Macrocytic and Hypochromic anaemia:

In these erythrocytes are bigger in size with low haemoglobin concentration. It is seen in the regenerative phases after haemorrhages due to- Trauma, Surgical bleeding, Parasites, Epistaxis.

3. Normocytic Normochromic anaemia:

It results from depression of erythropoiesis and are therefore often referred to as aplastic anaemias or hypoplastic anaemia due to neoplastic diseases, radiation & certain toxicities produce. The size of the RBC is normal and haemoglobin concentration is also normal.

4. Normocytic and hypochromic anaemia:

In this type of anaemia, there is reduced concentration of the haemoglobin due to dietary deficiency of iron, copper, nicotinic acid, riboflavin, ascorbic acid, thyroxin, pyridoxine.

5. Microcytic and normochromic anaemia:

In this type the RBCs are smaller than the normal size with normal staining properties due to chronic interstitial nephritis, worm infection, chemical poisoning, chronic infection e.g., Brucellosis, Tuberculosis, Ionizing radiations.

6. Microcytic and hypochromic anaemia:

In this anaemia, RBC is smaller in size than normal and also having low concentration of

haemoglobin. These are classical iron deficiency anaemias or “Tired blood” due to dietary deficiency of iron, manganese, copper, cobalt, riboflavin, pyridoxine, ascorbic acid, nicotinic acid and thyroxin.

II. Classification of Anaemia Based on Etiology:

1. Blood Loss Anaemia:

A. Extravascular (Haemorrhagic) Anaemia:

Normally, there is a balance between blood production and blood loss. But, in this condition blood loss is greater than production. Haemorrhagic anaemia results from severe haemorrhages. In this condition there is extravascular destruction of erythrocytes.

Types: The various types of haemorrhagic anaemias are:

- i) Acute Haemorrhagic Anaemia:** Etiology: Severe injury, sweet clover poisoning, ingestion of mouldy hay or silage, dicoumarol (inhibits the conversion of thrombin into prothrombin and inhibits the clotting mechanism), warfarin poisoning, Braken fern poisoning (there is acute thrombocytopenia due to thiamine deficiency which causes haemorrhages)
- ii) Chronic Haemorrhagic Anaemia:** Etiology: Blood sucking worms: In Cattle and sheep: Hemonchus, Fasciola, Bunostomum. In Horses: strongyles, In Dog: Ancylostomas, Ectoparasites: ticks, lice and flies, Protozoa: coccidiosis in dog, Hemorrhagic diseases: chronic bovine hematuria, Gastrointestinal ulcers and vascular tumors
- iii) Purpura And Hemorrhagic Diseases:** Accumulation of blood under the skin due to spontaneous rupture of capillaries causes purpura. Haemorrhages result even due to mild damage to capillary endothelium.

Other Coagulating Defects:

- i) Hemophilia:** It is a condition in which coagulation of blood does not occur after injury and it ends in fatally. It is inherited defect.
- ii) In liver diseases,** fibrinogen, factor V, prothrombin, factor VII & factor IX are not synthesized, which are required for coagulation of blood. Bile is required for the absorption of the vitamin k, so in hepatitis the deficiency of vitamin k occurs.
- iii) In Poisoning** by di-coumarin, it depresses the activity of vitamin k and so lowers the creation of the prothrombin, factor VII, factor IX and factor X.
- iv) In anaphylactic shock** in dogs, large amount of heparin is liberated resulted in bleeding. Some snake venom possesses the coagulants so bites of such snakes may result in fatal bleeding.

B. Intravascular (Haemolytic) Anaemia:

In this condition intravascular destruction of erythrocyte occurs. Anaemia is normochromic and macrocytic becoming hypochromic and microcytic as the iron stores are used up. In this condition

haemoglobin is broken up into heme and globin. The iron of the heme is stored by the RE cells for the future use. The pigment part is excreted as chole-bilirubin and urobilinogen. The protein moiety is broken down into amino acids in liver which are again used for the synthesis of the hemoglobin again.

i) Infectious Diseases: Inflammatory diseases are reported to be a common cause of anaemia.

- **Protozoal infections:** e.g., babesiosis, theileriosis, Nagana (a disease of cattle, antelope, and other livestock in southern Africa), trypanosomiasis, anaplasmosis and eperythrozoonosis.
- **Bacterial infections:** e.g., leptospirosis, Bacillary hemoglobinuria, staphylococci and streptococci, *Clostridium hemolyticum*, Ehrlichiosis (*Haemobartonella canis*)
- **Viral Infection:** Feline leukemia virus (FeLV), Equine Infections Anaemia, and Feline immunodeficiency virus (FIV), Chicken infectious anaemia.

ii) Immunological Causes :

Autoimmune Hemolytic Anaemia: An auto-antibody is produced that attacks the patient's red blood cells. Jaundice of the newborn: The maternal IgG passes through the placental barrier and binds to the fetal red blood cells. Abnormal auto-antibodies in malignant tumors, collagen diseases cause autoimmune hemolytic anaemia- spontaneous agglutination of erythrocytes. Immune-mediated conditions are the most frequent causes of hemolytic anaemia in dogs (IMHA). Red blood cells are destroyed when the body no longer recognises them as its own and produces antibodies against circulating red blood cells in incompatible blood transfusion.

iii) Other Causes:

- **Hypersensitivity of certain drugs:** sulphanimide, quinine. paraamino-salicylic acid & certain anti-pyretic drugs may cause hemolytic anaemia in cattle.
- **Phenothiazine** (in horses).
- **Water intoxication:** Excessive drinking of the cold water when the calves (rarely in older cattle).
- **Immune mediated Hemolytic Anaemia:** The most prevalent cause of hemolytic anaemia in dogs is immuno-mediated hemolytic anaemia, which may occur either spontaneously or due to neoplasms, infections, drugs, or vaccines [2].

2. Dyshemopoitic Anaemia (defect in the formation of erythrocytes):

These are nutritional anaemias. Examples of this type may be anaemia due to decreased production of erythrocytes, or haemoglobin. This problem may be occurred in formation of stroma protein or haemoglobin. The chemicals required for the synthesis of haemoglobin are porphyrins. A failure in production of haemoglobin leads to accumulation of large amounts of porphyrins and causes porphyrinuria and porphyria. Animals with the disease may be subject to photodynamic photosensitisation.

A. Dietic Deficiency of Extrinsic Factors:

i) **Cobalt Deficiency and Vitamin B₁₂:** In ruminants, vitamin B₁₂ is synthesised by the ruminal microflora with the aid of cobalt. So, cobalt deficiency causes reduced production of vitamin B₁₂, which is essential for the synthesis of RNA and DNA. So vitamin B₁₂ deficiency causes arrest of maturation of prorubricytes and metamyelocytes. So that DNA synthesis is depressed, nuclear maturation is delayed, but haemoglobin synthesis is not.

ii) **Folate Deficiency:** folic acid is also necessary for the maturation of prorubricytes and metamyelocytes. So, deficiency also leads to delayed maturation of the erythroblasts and it leads to the macrocytic anaemia.

B. Deficiency of Intrinsic Factor:

The gastric mucosa contains certain enzymes which helps in the absorption of vitamin B₁₂. But, in gastric diseases the enzyme synthesis is impaired ultimately leading to the less absorption of vitamin B₁₂ and in turns it leads to anaemia.

C. Failure to store the erythrocyte maturation factor (Vit.B₁₂):

The vitamin B₁₂ is also known as Erythrocyte Maturation Factor (EMF) and is stored in the liver. In hepatic diseases the storage of vitamin B₁₂ does not occur and leads to the anaemia.

D. Failure to use the EMF:

The failure of mobilization the EMF from liver and failure to utilization of EMF also give rise to the macrocytic anaemia.

E. Hypopituitarism:

The hypopituitarism leads to defective metabolism of the carbohydrate, so there is less production of the energy, so lack of energy reduces the rate of erythropoiesis which in turn leads to anaemia.

F. Diminished Haemoglobin Formation:

The blood picture may be normocytic hypochromic or microcytic hypochromic, depending upon stage of anaemia.

G. Deficiency of Iron:

Heme synthesis requires iron. Pig milk is deficient of the iron so piglets suffer from anaemia. The ingestion of phytic acid and phosphorous with iron, from insoluble complexes of iron which are excreted through the faeces and leads to iron deficiency and further which leads to the anaemia.

H. Deficiency of Copper:

Copper is an important catalyst in the use of iron in the formation of haemoglobin. The iron deficiency causes the microcytic anaemia.

I. Deficiency of Pyridoxine:

Pyridoxine is required to utilise iron in the synthesis of heme.

J. Deficiency of Ascorbic Acid:

Vitamin C is essential for the reduction of Fe⁺⁺⁺ (ferric ion) to Fe⁺⁺ (ferrous ion) state that is easily absorbed. Ascorbic acid is also needed for the synthesis of folic acid.

K. Deficiency of Nicotinic Acid:

Nicotinic acid is concerned in synthesis of pyridine nucleotide which takes part in cell respiration. So, nicotinic acid deficiency inhibits the respiration of immature red cells, this is seen in dogs and pigs.

L. Deficiency of Riboflavin:

Riboflavin is concerned with the breakdown and preparation of the amino acids in the globin molecule, so deficiency leads to the impaired haemoglobin.

M. Deficiency of Thyroxin:

The thyroxin is required for the metabolism of fats and carbohydrates. Impaired thyroxin production results in the decreased metabolism of the CHO and fat, so leads to decrease production of the energy, so decrease in synthesis of haemoglobin rate. In this normocytic or macrocytic anaemia is seen [3].

3. Hereditary anaemia:

It is a genetic blood disorder where RBCs are destroyed faster than they are produced. Caused by inherited defects (membranopathies, enzymopathies, or hemoglobinopathies), this leads to fatigue, jaundice, and pale skin. Common types include Hereditary Spherocytosis and Sickle Cell Disease.

III) Classification of Anaemia by Bone Marrow Response:

- **Role of Erythropoietin:** Erythropoietin stimulates the differentiation of the bone marrow stem cells to rubriblast. It governs the rate of hemoglobin synthesis.
- **Synthesis and regulation:** Its secretion is controlled by oxygen content of renal arterial blood. Hypoxia is stimulus for erythropoietin secretion. This is reason for the polycythemia found in high altitude disease.

1. Regenerative Anaemia:

It can be caused by hemorrhage or hemolysis (the rupture or destruction of blood cells). Bone marrow responding and there is presence of good number of reticulocytes in circulation. Findings that denote regeneration are polychromasia, reticulocytosis and hypercellular bone marrow.

2. Non-Regenerative Anaemia:

Bone marrow do not respond to anaemic state and reticulocytes are absent in circulation. Bone marrow examination is indicated; it may reveal the pathophysiologic mechanism. Polychromasia and reticulocytosis are absent.

- A. Toxic Inhibition of BM:** The blood picture in this type of the anaemia is microcytic normochromic. The marrow is normal and active but incapable to use the hematinic so regenerative form does not occur.

Causes: Chemical poisons: e.g., Nitrogen mustard (cytotoxic), folic acid metabolites, streptomycin, sulphonamides, chloromycetin, bismuth, gold, arsenic, benzyl, hair dyes, insecticides.

B. Aplastic Anaemia: It is due to incomplete or faulty development of an organ or part. This occurs due to aplasia of bone marrow, where there is utter inactivity. The anaemia seen is normochromic and normocytic.

C. Myelophthistic Anaemia: Myelo-phthisic anaemia is a normocytic, normochromic anaemia which occurs when normal marrow space is infiltrated and replaced by nonhematopoietic or abnormal cells due to specific toxins, granulomatous disorders, tumours, primary myelofibrosis, and lipid storage diseases.

Diagnosis of Anaemia:

As with any disease, the diagnosis rests on information gained from historical, physical and laboratory findings.

- **History:** The following may be significant- Exposure to toxic chemicals, Drug administration, Recent transfusions or colostral ingestion, Family or herd occurrence, Age at onset.
- **Physical Findings:** Clinical signs suggesting the presence of anaemia and these includes; Pale mucus membrane, loss of stamina, Weakness, exercise intolerance, Tachycardia and polypnea particularly after exercise, Heart murmur caused by reduced viscosity and increased turbulence of the blood, Hypersensitivity to cold, Shock if one third of blood is lost in a short period of time, haemoglobinuria, Icterus, haemorrhage or fever, depending on the pathophysiologic mechanism involved. Signs are less marked if onset is slow and animal can adapt to the reduced erythrocyte mass.
- **Laboratory Findings:** The easiest and most accurate way of determining anaemia is the PCV. Its results should be examined with the data of the hydration status and any modification by splenic contraction. Hb concentration and RBC count may be used. Other laboratory procedure includes: Erythrocyte indices which are helpful in classification of anaemia. Peripheral blood examination of RBC morphology- for morphological classification of anaemia.
- **Reticulocyte counts:** For regenerative & non-regenerative anaemias. Assessment of IMHA- three criteria-i) presence of in-saline agglutination or ii) significant positive titre by Coombs test and iii) The presence of significant Spherocytosis.
- **Peripheral blood smear examination:** for parasitic anaemia (parasites occur within or on the cell surface- hemoprotozoal diseases). *Hemobartonella felis*, *Anaplasma marginale*, *Babesia canis*, *B. equi*, *B. caballi* and *Eperythrozoon suis* are most commonly encountered). Serum biochemical assessment: General health parameters, STP, LFT, KFT, icterus index.
- **Serum micromineral assessment:** Iron, copper, cobalt, zinc, Folic acid and VitB₁₂ estimation. For

parasitic anaemias (due to helminthic and other parasites)- you will have to collect and process the faecal samples collected from suspected cases.

- **Microbiological assessment:** for bacterial and viral diseases (for haemolytic and haemorrhagic anaemia) associated with anaemia
- **Bone Marrow Examination:** For both regenerative & non-regenerative types and for detection of other bone marrow abnormalities, bone marrow assessment is indicated when peripheral blood irregularities are detected. The most common signs are unexplained thrombocytopenia, poorly regenerative anaemia, persistent neutrophilia. Sites of Bone marrow biopsy: Proximal femur, ilium, proximal humerus, proximal rib and sternum [4].

Prevention of Anaemia in Domestic Animals:

1. **Parasite Control:** Use monthly, year-round preventatives for fleas, ticks, and worms. Heavy flea infestations can cause fatal, acute anaemia in small pets, while ticks carry diseases that destroy red blood cells
2. **Regular Veterinary Wellness Check-ups:** Annual or biannual blood screenings are crucial to catch developing anaemia before symptoms appear.
3. **Balanced Nutrition:** Ensure pets consume high-quality, balanced diets to prevent nutritional deficiencies like iron deficiency.
4. **Toxin and Hazard Prevention:** Keep household chemicals, rat poison, and certain medications secured. Ingestion of substances like onions, garlic, or zinc can cause hemolytic anaemia.
5. **Vaccination & Screening:** Prevent infectious diseases like Lyme disease or Babesia through vaccination and, when necessary, routine screening, as these can cause immune-mediated destruction of red blood cells.
6. **Specific Considerations:**
 - **Preventing Acute Blood Loss:** Protect pets from traumatic injuries (e.g., car accidents) which can lead to severe blood loss and anaemia.
 - **For High-Risk Breeds:** Some breeds such as Labrador Retrievers, Miniature Schnauzers, American Cocker Spaniels and Shih Tzus, are more prone to anaemia and should have more frequent veterinary check-ups.
 - **Nutritional Supplements:** In consultation with a veterinarian, pets with deficiencies may require iron or vitamin supplementation, particularly if chronic blood loss from parasites has occurred.
 - **Home Safety:** Secure household garbage to prevent pets from eating inappropriate items, such as certain human foods, that could lead to toxicity and subsequent anaemia.

Treatment for Anaemia in Domestic Animals:

- **Blood Transfusion:** Essential for severe or life-threatening anaemia to stabilize the patient, particularly in cases of severe blood loss, immune-mediated haemolytic anaemia (IMHA), or parasite infection (e.g., Babesia).
- **Treating Underlying Causes:**
 - Parasites: Deworming or flea/tick control
 - Immune-Mediated Anaemia: Immunosuppressive drugs.
 - Infections: Antibiotics such as doxycycline.
 - Kidney Disease: Recombinant human erythropoietin (EPO) injections to stimulate red blood cell production, along with iron supplementation.
 - Iron Deficiency: Iron supplementation (oral or parenteral) for iron deficiency.
 - Poisoning: Vitamin (K1) for rodenticide toxicity.
 - Supportive Care: Nutritional support, including feeding a high-quality, balanced diet to provide essential nutrients for blood cell production.
 - Monitoring: Frequent veterinary checks, including blood tests like Packed Cell Volume (PCV) or Haematocrit (HCT), are necessary to monitor response to therapy.

Conclusion:

Anaemia is a major health problem in domestic animals and may result in reduced productivity, poor growth, weakness and even death if untreated. The condition is caused by a variety of reasons, including nutritional deficiencies, parasitic infestations, infectious diseases, haemorrhage, toxicities and hereditary disorders. The type and cause of anaemia can be only determined by clinical examination and laboratory investigations and a correct diagnosis is necessary. With appropriate treatment and correction of the underlying cause, the health and survival of the affected animals can be greatly improved. The incidence of anaemia can be very effectively reduced by implementing preventive measures like balanced feeding, deworming on regular basis, vaccination, proper hygiene and routine use of veterinary services. Hence, there is a need for proper awareness and management practices for the health, welfare, and productivity of domestic animals.

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