Jul 12th, 1:35 PM - 1:55 PM

Anemia in Camelids

Jane Woodrow
jwoodrow@utk.edu

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I. Definition of anemia
- Decrease in red cell mass measured by reduction in RBC numbers, PCV and hemoglobin levels
- Decreases the oxygen carrying capacity

II. Causes
- Blood loss: Bone marrow is normal and will respond with erythropoiesis
  - External: Trauma, artery rupture, GI parasites, GI ulcers, GI neoplasia, renal loss, ectoparasites, coagulopathies
  - Internal: Trauma, artery rupture, coagulopathy
- Hemolysis: Bone marrow is normal and will respond with erythropoiesis
  - Intravascular hemolysis
    - Red blood cells lyse in circulation -> Release hemoglobin into circulation
    - Discolors the plasma -> Hemoglobinemia
    - If at a high level, hemoglobin is filtered through the kidneys -> Hemoglobinuria
    - Usually extravascular hemolysis occurring as well
    - Causes of intravascular hemolysis: Immune mediated, Erythroparasites (Babesia), other organisms (Lepto, Clostridium), Oxidant injury/Heinz Body anemia (copper, red maple leaf), Severe hypophosphatemia, end stage renal or liver failure
  - Extravascular Hemolysis
    - Red Blood cells are phagocytized by macrophage in the liver, spleen, or bone marrow
    - No hemoglobin is released into circulation -> NO hemoglobinemia or -uria
    - This can happen alone or in combination with intravascular hemolysis
    - Causes of Extravascular hemolysis: Autoimmune, Erythroparasites, Other organisms
- Inadequate erythrocyte production
  - Anemia of chronic disease or chronic inflammation
  - Nutritional deficiency (iron, B12, Folic acid)
  - Aplastic anemia, bone marrow failure
  - Inadequate erythropoietin (chronic renal disease)

III. Diagnostics
- Color of whole blood, plasma and urine
- PCV: Normal between 20% and 30%
- RBC count: Count less than 10x10^6 cells/ul as a break point for anemia
- Hemoglobin: Concentration less than 10g/dL as a break point for anemia
- FAMACHA

- Hemogram
    - Mean Corpuscular Volume (MCV)
        - A reflection of mean erythrocyte size
        - *Increased* MCV (macrocytosis) indicates regeneration, larger RBCs
        - *Decreased* MCV (microcytosis), can be result of iron deficiency
        - Not used in camelids because the elliptical shape has an inconsistent effect on automated analysis
    - Mean Corpuscular Hemoglobin (MCH)
        - An estimation of the amount of hemoglobin in the blood per erythrocyte
        - *Increased* MCH may indicate the presence of reticulocytes or hemolysis
        - *Decreased* MCH may be due to iron deficiency
    - Mean Corpuscular Hemoglobin Concentration (MCHC)
        - Measure of the concentration of hemoglobin in a given volume of packed red blood cells
        - *Increased* MCHC may be due to hemolysis (in vitro or in vivo)
        - *Decreased* MCHC may be due to iron deficiency
    - Basophilic stippling
        - Blue granules are residual DNA
        - Can be normal with regeneration
        - If no signs of regeneration, may indicate lead poisoning
    - Heinz Bodies
        - Due to oxidative stress to RBCs causing denaturation of hemoglobin that then precipitates as aggregates
        - Methylene blue staining
        - Think of onions, brassica plants, red maple leaves, copper
- Chemistry: Renal and liver enzymes, Albumin level, Phosphorus
- Iron profile of iron deficiency

Serum Iron	**Decreased**
TIBC	Increased
% Iron Saturation	Decreased
Bone Marrow Iron	Decreased
Bone Marrow Histology	Can appear hypercellular; can be increased numbers of metarubricytes
Ferritin	Decreased

IV. Most common in the hospital

- Parasites
- Poor body condition
- Not necessarily common, but always R/O *Mycoplasma haemolamae* as a confounding factor

V. Clinical Signs
- Variable signs, dependent on etiology
- Primary clinical sign is mucous membrane pallor
- Underweight, recent weight loss
- Dyspnea, depression, +/- icterus, hemoglobinemia/-uria, methemoglobonemia/-uria, fever

VI. Treatment
- Based on the cause
- Blood transfusion can be life saving
    - Blood volume is about 7% of their body weight
    - DO NOT take more than 20% of the blood donor's volume, or about 10-15ml of blood/kg of body weight
    - Transfusion volume (L)= blood volume * $((PCV_{desired}-PCV_{actual})/PCV_{donor})$
    - 2-3mls/kg of whole blood increases PCV by 1%
- Proper deworming
- Proper nutrition, TPN or PPN
- Iron, B12 supplements

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