

Hemoglobin

Interpretive Summary

Description: Hemoglobin is the iron-containing oxygen transport protein inside red blood cells. Under most circumstances, hemoglobin is a measure of red blood cell mass.

Decreased Hemoglobin

Common Causes

- Hemolysis
 - Immune-mediated (IMHA)
 - Infectious: hemotropic mycoplasma, rickettsial diseases, babesiosis, cytauxzoonosis, heartworm
 - Zinc toxicity
- Blood loss
 - Trauma
 - Ruptured neoplasms
 - Parasitism
 - Hemostasis defects
 - Marked thrombocytopenia
- Decreased or ineffective production of red blood cells
 - Anemia of chronic inflammatory disease
 - Decreased erythropoietin (chronic renal disease, hypothyroidism, Addison's disease)
 - Infections (FeLV, FIV, rickettsial)
 - Bone marrow disease/myelophthisis (e.g. lymphoproliferative, myeloproliferative disorders, metastatic neoplasia, myelofibrosis)

Uncommon Causes

- Hemolysis
 - Drugs: methimazole, phenobarbital, sulfas
 - Mechanical fragmentation (e.g. heartworm disease, hemangiosarcoma, DIC)
 - Neoplasia
 - Toxins, envenomations
 - Pyruvate kinase deficiency, phosphofructokinase deficiency
 - Hypophosphatemia
 - Idiopathic
- Blood loss
 - Gastrointestinal ulcers
- Decreased or ineffective production of red blood cells
 - Drugs (chemotherapeutics, radiation, estrogen)
 - Iron or copper deficiency
 - Cobalamin (vitamin B12) or folate deficiency
 - Immune-mediated destruction within the bone marrow
 - Chronic lead poisoning
 - Idiopathic

Related Findings

- Hemolysis
 - Increased reticulocytes
 - Increased leukocytes, +/- decreased platelets
 - Increased serum bilirubin, bilirubinuria, +/- hemoglobinuria
 - Spherocytosis (in dogs), autoagglutination, +/- positive Coombs or saline agglutination test (IMHA)

- Positive serology, PCR, or antigen testing for infectious causes
- Blood parasites visualized on blood smear
- Gastrointestinal metallic foreign body found on abdominal radiographs
- Blood loss
 - Increased reticulocytes
 - Decreased total protein and/or albumin
 - Pleural or peritoneal effusion and/or pulmonary hemorrhage on radiographs or ultrasound
 - Positive fecal ova and parasite screen, positive fecal occult blood
 - +/- Decreased serum iron concentration, normal total iron binding capacity, and decreased serum ferritin (if chronic blood loss)
 - Increased PT and/or PTT, decreased platelets, prolonged buccal mucosal bleeding time, or low von Willebrand factor level
- Decreased or ineffective production of red blood cells
 - Normal to decreased reticulocyte count
 - Increased BUN and creatinine, +/- increased phosphorus, low urine specific gravity (chronic kidney disease)
 - Decreased T4 and free T4, increased TSH (hypothyroidism)
 - Abnormal ACTH stimulation test, decreased sodium, increased potassium, decreased Na/K, and decreased cholesterol and albumin (Addison's disease)
 - Possible decreased white blood cell count and/or platelet count
 - Positive serology or PCR for infectious causes
 - Abnormal findings on bone marrow aspirate cytology or biopsy

Increased Hemoglobin

Common Causes

- Relative increase with normal red blood cell mass
 - Dehydration
 - Splenic contraction
- Secondary physiologic increase in erythropoiesis in response to renal or systemic hypoxemia
 - Chronic lung disease
 - Chronic cardiac disease
- Artifact
 - Marked lipemia

Uncommon Causes

- Relative increase with normal red blood cell mass
 - Internal shifting of fluid
- Secondary physiologic increase in erythropoiesis in response to renal or systemic hypoxemia
 - High altitude
 - Hyperthyroidism
- Secondary increase in erythropoiesis in response to inappropriate erythropoietin secretion
 - Renal: cysts, tumors, hydronephrosis
 - Erythropoietin-secreting tumors (paraneoplastic)
- Primary absolute increase due to red blood cell neoplasia (polycythemia vera)
- Artifact
 - Intravascular hemolysis
 - Hemoglobin derivatives (e.g. Oxyglobin)

Related Findings

- Relative increase with normal red blood cell mass
 - Dehydration
 - Increased total protein and/or albumin
 - Increased sodium and chloride
 - Increased BUN and creatinine, increased urine specific gravity
- Secondary increase in erythropoiesis

- Chronic lung disease
 - Increased reticulocyte count and nucleated red blood cells
 - Decreased PO₂ on arterial blood gas, low SpO₂ on pulse oximeter
 - Pulmonary pathology on thoracic radiographs
 - Chronic cardiac disease
 - Increased Cardiopet® proBNP
 - Cardiomegaly +/- pulmonary edema on thoracic radiographs
 - Abnormalities on echocardiogram with possible right to left shunting
-

Additional Information

Physiology

- Hemoglobin is a large globular protein that is composed of two alpha chains and two beta chains for a total of four iron-containing heme groups bound to four globulin chains.
- Hemoglobin gives blood its characteristic red color and (as oxyhemoglobin) is responsible for oxygen transport by the red blood cells.
- Hemoglobin measurements are the most direct indication of oxygen transport capacity of blood in a patient.
- Neither changes in red blood cell size nor in vitro hemolysis will alter the hemoglobin concentration, although both HCT and PCV may be affected.
- Hemoglobin is not normally found in body fluids other than blood.

Diagnostic Methodology

- Hemoglobin may be measured by either a modified hemoglobin cyanide method (a blood sample is lysed and hemoglobin is released from the red blood cells, the hemoglobin is then treated with a cyanide compound, and concentration then evaluated by spectrophotometry) or directly within the red blood cells.
- Anemia can be a reduction in the numbers (count) of red blood cells (RBC), the concentration of HgB, or the HCT or packed cell volume (PCV). Note that decreases in these parameters may not be uniform, owing to differences in reference intervals or to the presence of abnormal RBCs.
- In general HCT values are approximately three times the value of hemoglobin.

References

- Latimer KS, Mahaffey EA, Prasse KW, eds. *Duncan and Prasse's Veterinary Laboratory Medicine: Clinical Pathology*, 4th ed. Ames, IA: Blackwell; 2003.
- Stockham SL, Scott MA. *Fundamentals of Veterinary Clinical Pathology*, 2nd ed. Ames, IA: Blackwell; 2008.

Last updated 11/1/2013