Anemia constitutes one of the most common hematologic disorders in cats, particularly because of the relatively high prevalence of retroviral infections and hemoparasites, and because cat’s hemoglobin is extremely susceptible to oxidative injury.

DEFINITIONS

Reticulocytes

Reticulocytes are immature red blood cells (RBCs) that preserve ribosomes and other organelles. They are visualized with vital stains such as new methylene blue (NMB). On Wright’s- or Giemsa-stained blood smears, they appear as larger RBCs with a bluish tinge (i.e., polychromatophilic RBCs).

The cat produces two types of reticulocytes, which are classified as either aggregate or punctate on the basis of their morphologic appearance. Aggregate forms become punctate reticulocytes after approximately a 10 to 12 hour maturation time; punctate reticulocytes circulate for approximately 10 days. Therefore, aggregate forms indicate active bone marrow regeneration, whereas the punctate forms represent cumulative regeneration. Most laboratories report only the aggregate forms in their reticulocyte counts.

Regenerative Anemias

Regenerative anemias are characterized by the presence of polychromasia and reticulocytosis; nucleated RBCs may also be present in the blood smear. Anemias in this class are associated with either peripheral loss (i.e., bleeding) or destruction (i.e., hemolysis) of RBCs; hence they are always due to extra-medullary causes.
Nonregenerative Anemias
Nonregenerative anemias are characterized by lack of bone marrow regeneration. They are usually normocytic and normochromic and can be due to primary bone marrow or extramarrow disorders.

HISTORY
Exposure to drugs has been associated with the development of anemia in cats; implicated drugs include acetaminophen, benzocaine, methylene blue, griseofulvin, acepromazine, chloramphenicol, sulfathrimethoprim, propylthiouracil, and methimazole.a Certain toxins, such as onions and other oxidants, can also result in Heinz body hemolysis. Additional factors of importance are history of blood loss, presence of parasites (e.g., fleas in kittens), feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV) infections, and other chronic inflammatory disorders.

PHYSICAL EXAMINATION
The following physical examination findings in cats with anemia may offer important etiopathogenic clues:

• Fever
• Lymphadenopathy
• Hepatomegaly
• Splenomegaly
• Petechiae
• Ecchymoses
• Diarrhea
• Melena
• Bleeding
• Fleas (important in kittens)

Fever and hepatosplenomegaly in an anemic cat are suggestive of either hemobartonellosis or leukemia, whereas generalized lymphadenopathy and hepatosplenomegaly are common in cats with lymphoma or leukemia. The presence of fleas or hookworms in a kitten with anemia suggests chronic blood loss (i.e., iron deficiency).

INTERPRETATION OF THE COMPLETE BLOOD COUNT
After establishing that the cat is anemic (i.e., packed cell volume [PCV] <27%), the first step is to determine whether the anemia is regenerative or nonregenerative. The anemia is regenerative if the reticulocyte percentage is over 2.5% to 3%; however, reticulocyte counts should be interpreted in light of the patient's PCV (i.e., to achieve regeneration, the reticulocyte count or percentage should be higher in a cat with a lower PCV).

The second step is to determine the serum or plasma protein concentration, which is helpful in differentiating blood loss anemia from hemolysis (i.e., low in blood loss, normal in hemolysis).

Evaluation of RBC indices also provides a clue as to the pathogenesis of the anemia:

• Mean corpuscular volume (MCV)—Microcytic cells are characteristic of iron deficiency anemia (mainly in kittens with flea infestation or in weanlings). Normocytic cells are characteristic of anemia of chronic disease, hypoproliferative anemias, and anemia of renal disease, whereas macrocytic anemias include all regenerative anemias (reticulocytes have higher MCV and lower hemoglobin content than mature RBCs, therefore regenerative anemias are usually macrocytic and hypochromic) and FeLV/FIV-associated RBC aplasia/hypoplasia.

• Mean corpuscular hemoglobin concentration (MCHC)—Hypochromic RBCs are rare in cats, except in cases of regeneration (see above). Normochromic cells usually occur in cats with normocytic anemias (see above). The presence of hyperchromic cells indicates technical interference with hemoglobin refractometric readings (e.g., in hemoglobinemia from hemolysis or when inclusion bodies that increase refractivity are present [e.g., Heinz bodies]).

After interpreting the indices, a blood smear should be evaluated for involvement of other cell lines (e.g., other cytopenias, presence of immature cells), as well as for RBC morphologic abnormalities. Abnormalities in RBC shape include spherocytes, which are difficult or impossible to identify in cats due to the lack of central pallor in normal RBCs in this species, and schistocytes (fragments) common in disseminated intravascular coagulation (DIC). RBC inclusions such as Howell-Jolly bodies (residual DNA and RNA common in hyposplenism and regenerative anemias), Heinz bodies (which are easier to visualize in NMB-stained smears, represent oxidative injury to hemoglobin, and are common in normal cats because the nonsinusoid spleen in this species does not “pluck” them from the RBCs), and hemoparasites are common in cats.

The boxes on p. 9 summarize the main features
of regenerative and nonregenerative anemias in cats.

**DIAGNOSIS**

The boxes on this page provide some information on the diagnostic approach to cats with anemia. In general, since regenerative anemias are always the result of RBC loss or destruction (i.e., hemorrhage or hemolysis), extramedullary causes of disease should be ruled out first. In cats with regenerative anemia and low serum protein concentration, blood loss should be strongly suspected and an effort should be made to identify the source. If the protein concentration is normal to high, the most likely diagnosis is hemolytic anemia (see box on regenerative anemias, above). When evaluating cats with suspected hemolytic anemia, a careful examination of the blood smear is mandatory, as *Hemobartonella felis* or Heinz bodies may be readily identified (the latter are easier to visualize on NMB-stained smears). A direct Coombs’ test to detect RBC-bound immunoglobulins should always be submitted for cats with suspected immune-mediated hemolysis. Certain hematologic findings may be suggestive of a specific disease process (e.g., thrombocytopenia and lymphocytosis in cats with hemobartonellosis or “doxycycline-responsive hemolytic anemia”).
When the anemia is nonregenerative and extramedullary causes such as acute bleeding, renal disease, chronic disorders, and iron deficiency have been ruled out, a bone marrow aspirate usually confirms a diagnosis of primary bone marrow disease. Bone marrow disorders that typically lead to anemia (and other cytopenias) include hypoplasia, myelophthisis, and myelodysplasia. The presence of neoplastic cells in the blood smear is highly suggestive of a diagnosis of leukemia.

**TREATMENT** (see box at right)

The treatment of cats with acute blood loss anemia is relatively simple because it is aimed at halting the bleeding and providing blood volume expansion through the administration of blood, crystalloids, or colloid solutions. A unit of fresh, compatible feline blood usually suffices in most cases of acute bleeding. If blood is not available, crystalloid or colloid solutions are also effective.

The primary cause of hemolysis should be treated; however, if an etiologic agent cannot be identified (i.e., RBC parasite, drug), I usually institute doxycycline (2.5 to 5 mg/kg PO sid) and prednisone (4 to 8 mg/kg PO sid) therapy. The same doses of doxycycline are used for cats with confirmed hemobartonellosis, and similar doses of prednisone, with or without chlorambucil (20 mg/m² PO every 2 weeks), are used for cats with Coombs’-test positive immune hemolytic anemia.

Intravenous phosphate supplementation should be used in cats with diabetes mellitus that develop hypophosphatemic intravascular hemolysis in association with insulin therapy (this usually occurs when the serum phosphate concentration is <1.5 mg/dl). Potassium phosphate (0.01 to 0.02 mmol/kg/hr for 6 hours) is added to the intravenous fluid solution; serum phosphate concentrations should be reevaluated after a 6 to 12 hour trial of this phosphate supplement.

In cats with nonregenerative anemias due to peracute blood loss, the treatment outlined above is indicated. In cats with anemia of chronic disease, eliminating the primary cause resolves the anemia; moreover, because the anemia is so mild, cats are rarely symptomatic. Chronic blood loss leading to iron-deficiency anemia should be treated by eliminating its cause (e.g., fleas, source of bleeding); supplementation with iron is not necessary if the cat is on a high-quality cat food diet. Cats with chronic renal dis-

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**PRINCIPLES OF TREATMENT IN CATS WITH ANEMIA**

**Regenerative Anemias**
**Blood Loss Anemia**
- Arrest the bleeding
- Replacement therapy
  - Crystalloids
  - Colloids
  - Compatible whole blood (50 to 60 ml/cat)

**Hemolytic Anemia**
- Hemobartonellosis: Administer doxycycline (2.5–5 mg/kg PO sid–bid)
- Immune-mediated: Administer prednisone (4–8 mg/lb PO sid) and/or chlorambucil (20 mg/m² PO every 2 weeks)
- Drug-related: Remove offending agent
- Hypophosphatemia: Administer potassium phosphate (0.01–0.02 mmol/kg/hr for 6 hours)

**Nonregenerative Anemias**
**Hypoproliferative Anemias**
- Myelophthisis: Treat primary disorder with chemotherapy
- RBC aplasia/hypoplasia
  - No effective treatment
- Replacement therapy if indicated
- Anabolic steroids may be beneficial
  - Administer nandrolone decanoate (1–4 mg/kg SQ or IM once every 1–3 weeks)
  - If cat is FeLV- and FIV-negative, immunosuppressive doses of corticosteroids are indicated
- Myelodysplasia: Administer anabolic steroids as above OR cytosine arabinoside (5–10 mg/m² SQ bid)

**Anemia of Renal Disease**
- Treat primary disorder
- Administer anabolic steroids as above
- Administer erythropoietin (100–150 IU/kg SQ 2 or 3 times per week)

**Iron-Deficiency Anemia**
- Remove inciting cause
- Iron supplementation?

**Acute Blood Loss**
- Treat as blood loss anemia

**Anemia of Chronic Disease**
- Remove inciting cause
- Administer anabolic steroids as above

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Leukeran®—Glaxo Wellcome, Research Triangle Park, NC.
Deca-Durabolin®—Organon, West Orange, NJ.
Cytosar-U®—Upjohn, Kalamazoo, MI.
Epogen®—Amgen, Thousand Oaks, CA.
ease benefit from human recombinant erythropoietin® at a dosage of 100 to 150 IU/kg SQ two to three times a week; the treatment interval should be lengthened once the PCV reaches approximately 25% to avoid inducing iatrogenic polycythemia. Approximately one-third of cats receiving human recombinant erythropoietin develop antibodies against this protein. The treatment of cats with myelophthisis (outlined in the box on p. 10) in general is quite unrewarding.

Epogen®—Amgen, Thousand Oaks, CA.

**RECOMMENDED READINGS**


