A Systematic Approach to the Diagnosis and Pathophysiologic Classification of Anemias

by
A. E. Ledet, D.V.M., M.S., Ph.D.*

Anemia is a disorder in which the patient suffers some degree of tissue hypoxia as a consequence of decreased oxygen carrying capacity of blood.[4] It is defined as a decrease to below normal of erythrocyte numbers and/or hemoglobin concentration per unit volume of blood.[1]

The classification of anemia can be on the basis of morphologic or pathophysiologic criteria. Morphologic classification subdivides anemias into macrocytic, normocytic, and microcytic according to cell size and normochromic or hypochromic according to hemoglobin concentration. Pathophysiologic classification subdivides anemias according to decreased red cell production, increased red cell destruction, and blood loss. Each classification scheme has its own advantages and disadvantages, however pathophysiologic classification is best suited for relating anemias to specific disease processes.

Clinical signs of anemia are lethargy, lack of stamina, loss of weight and possibly decreased appetite. The onset of anemia may be rapid or slow. Pallor of mucous membranes, rapid pulse and deep rapid respirations develop with severe anemias. Vomiting, fever and icterus may occur in an acute hemolytic crisis. Splenomegaly is common in chronic hemolytic conditions.

The microhematocrit or packed cell volume (PCV) is a simple, quick and accurate method for detecting anemia. Furthermore hemoglobin levels can be quite accurately estimated by dividing the PCV by 3. This rule of thumb is satisfactory except in the most severely anemic patient.

Normal ranges of PCVs and hemoglobin (Schalm)[3]

	PCV	Hemoglobin
Dog	37–55%	12–18 gm%
Horse	32–52%	12–18 gm%
Pig	32–50%	10–16 gm%
Cat	24–45%	8–15 gm%
Cow	24–46%	8–15 gm%
Sheep	24–50%	8–16 gm%

A patient should be considered anemic if the PCV is below the minimal normal whether or not clinical signs of anemia are present. Dehydration will falsely elevate the PCV and must be taken into account on any patient with a low normal PCV.

Once you have established that the patient is anemic, the next step is to evaluate the bone marrow response. If the bone marrow is releasing young erythrocytes into the peripheral blood it is a regenerative anemia. If no young cells are being released it is a non-regenerative anemia. This determination, regenerative or non-regenerative, is made by examining a stained blood smear. The presence of anisocytosis (variation in size), polychromasia (grey staining cells) and nu-

* Dr. Ledet is an Associate Professor in the Department of Veterinary Pathology, Iowa State University.

cleated red blood cells all indicate a regenerative anemia. The presence of only mature red cells indicates a non-regenerative anemia.

The following scheme should be used for pathophysiologic classification of anemia:

Schematic Outline of
Pathophysiologic Classification[2]
Anemia

A. Non-Regenerative
   I. Depression or Secondary
   II. Aplastic
   III. Acute Blood Loss 1st & 2nd day
B. Regenerative
   I. Chronic Blood Loss
   II. Hemolytic Anemia—Intravascular Hemolysis
   III. Hemolytic Anemia—Extravascular Hemolysis
   IV. Acute Blood Loss 3rd or 4th day

A. Non-regenerative Anemia

Anemia with normal red blood cell morphology as determined by a stained smear of peripheral blood. The horse will have normal red cell morphology even in severe anemias, thus a bone marrow biopsy is required to evaluate equine bone marrow response.

I. Depression or Secondary Anemia

Most of the anemias seen in domestic animals are of this type. Clinically, hemoglobin and PCV values are just below the normal range. Clinical signs of anemia are usually vague or absent. The anemia is secondary to some other disease condition. If the primary disease is corrected the bone marrow will be able to overcome the anemia.

The following list of primary diseases which may depress the bone marrow is incomplete but should serve as a guide:

1. Chronic nephritis
2. Chronic hepatitis
3. Chronic pancreatitis
4. Chronic parasitism
5. Malignant neoplasms
6. Chronic mycotic infection
7. Chronic suppuration
8. Endocrine disorders

II. Aplastic Anemia

This is a rare condition in domestic animals and requires a bone marrow biopsy for confirmation. It should be suspected when a non-regenerative anemia is present along with persistent below normal numbers of neutrophils and platelets. There is usually a gradual onset of the anemia, no response to therapy and the prognosis is grave.

The etiology of aplastic anemia is seldom determined. Drugs, irradiation, viruses, chronic diseases and malignancy has been suspected.

III. Acute Blood Loss Anemia (1st and 2nd day)

Acute clinical signs of shock caused by decreased blood volume preceed this condition. It is classified as non-regenerative only because the bone marrow has not had sufficient time to respond.

Etiology is severe hemorrhaging following a surgical procedure or accidental trauma.

B. Regenerative Anemia

Anemia with a bone marrow response as evidenced by the presence of anisocytosis, polychromasia and nucleated erythrocytes in peripheral blood.

I. Chronic Blood Loss Anemia

This is the second most common anemia of domestic animals. Clinical picture is variable depending upon the duration and rate of blood loss. Anemia develops slowly so that the fluid portion of the blood is replaced and the animal does not suffer from lack of blood volume as in acute blood loss. Clinically there is a regenerative anemia with no evidence of icterus, hyperbilirubinemia, bilirubinuria or hemoglobinuria.

Common etiologies are as follows:

a. Hookworms—Dog, Cat
b. Strongyles—Horse
c. Gastrointestinal Nematodes —Sheep, Cattle
d. Lice—Cattle, Hogs
e. Fleas—Cat, Dog
f. Ticks—any animal
g. Chronic Hemorrhage—any animal

II. Hemolytic Anemia—Intravascular Hemolysis

This is a regenerative anemia accompanied by icterus, hyperbilirubinemia, hemoglobinemia and hemoglobinuria. Hemoglobinuria may not be obvious on visual inspection, therefore an occult-blood-test should be performed on the urine.

Clinically these animals can have elevated temperatures, neutrophilia with a left shift and may show vomiting and diarrhea. Detection of the causative agent or lesions attributable to the causative agent is essential to confirm a diagnosis.

The following list includes the more common causes of intravascular hemolysis.

1. Chronic Copper Poisoning (Sheep, Swine, Calves)
2. Phenathiazine Poisoning (Horse, Sheep)
3. *Leptospira species* (Cattle)
4. *Babesia canis* (Dog)
5. *Babesia bigemina* (Texas cattle fever)
6. *Clostridium hemolyticum* (Bacillary hemoglobinuria)
7. *Clostridium perfringens* type A
8. Plants—Kale, Rape (Sheep, Cattle)
9. Postparturient hemoglobinuria (Cattle)

III. Hemolytic Anemia—Extravascular Hemolysis

This is a regenerative anemia accompanied by hyperbilirubinemia, occasionally icterus but no hemoglobinuria. This condition is characterized by a shortened erythrocyte life span due to changes in the cell's surface which cause it to be destroyed by reticuloendothelial cells in the spleen, bone marrow and liver.

The clinical picture may be one of a rapid onset, fever, vomiting and diarrhea. Neutrophilia with a left shift usually correlates with an acute hemolytic crisis and fever. Detection of the causative agent or factor is essential for a confirmed diagnosis.

Common causes of extravascular hemolysis include:

1. *Anaplasma marginale*—(Cattle)
2. *Eperythrozoon suis*—(Swine)
3. *Hemobartonella felis*—(Cat)
4. Equine Infectious Anemia Virus (Horse)
5. Autoimmune Hemolytic Anemia (Dog)
6. Neonatal Isoerythrolysis
7. Blood Transfusion Reaction

IV. Acute Blood Loss Anemia (3rd–4th day+)

This is a regenerative anemia following an acute loss of blood. There is a 3 to 4 day delay before a bone marrow response can be detected in the peripheral blood smear.

Clinically this condition and its cause should be obvious.

SUMMARY

A simple workable outline of the most common anemias of domestic animals has been presented. The pathophysiologic approach to the diagnosis of anemia can readily be adapted to either large animal, small animal or mixed practices. Only a minimum of laboratory instrumentation, microscope and microhematocrit centrifuge, are required.

Nutritional anemias were not included

in the outline as they fit a morphological classification scheme and require more sophisticated laboratory procedures for accurate diagnosis. The outline presented here was not intended to be complete but rather should be used in conjunction with a current text of veterinary clinical pathology.

REFERENCES

1. Medway, W., Prier, J. E., Wilkinson, J.S.: *A Textbook of Veterinary Clinical Pathology.* 1st ed. Williams and Wilkins Co., Baltimore, 1969.
2. Prasse, K. W.: Personal Communications. Department of Veterinary Pathology, College of Veterinary Medicine, University of Georgia, Athens, Georgia. June, 1973.
3. Schalm, O. W.: *Veterinary Hematology.* 2nd ed. Lea and Febiger, Philadelphia, 1965.
4. Williams, W. J., Beutler, E., Erslev, A. J., Rundles, R. W.: *Hematology.* 1st ed. McGraw-Hill, Inc., 1972.

A New Method of Early Detection of Pregnancy In The Sow

by
John Berthelsen, D.V.M., M.S.*
Emmett Stevermer, Ph.D.†

Conclusion

A portable, compact electronic device has been developed to detect pregnancy in the sow. Accuracy has been reported to be 90–95 percent in the 30 to 80 day post conception sow or gilt. The instrument is able to detect fluid in the gravid uterus with ultra-sound waves. Diagnosis is rapid and can be made on the farm.

Discussion

Recently a new electronic device has become available commercially in the U.S. that will accurately determine pregnancy in the sow. Accuracy has been estimated at 90 to 95 percent at 30 to 80 days after conception. Pregnancy can be determined in a matter of a few seconds per sow "on-the-spot" thus eliminating the need for positive sow identification.

The *Pregnosticator*[a] is a compact, portable instrument that determines pregnancy by detecting the increase in fluid content of the uterus. It operates on the principal of ultra-sound transmitted through the body tissues via a thumb-sized probe. The probe, which is attached to the machine by a 10-foot extension cord, also receives the ultra-sound waves bounced back as they pass through each tissue interface. An oscilloscope in the instrument then indicates if the ultra-sound waves have passed through a fluid filled uterus.

The use of this machine offers the following advantages in a swine operation:

1. Early diagnosis of pregnancy enables the owner to eliminate the nonpregnant gilts or sows, thus, saving feed costs.
2. Closer grouping of a given number of females for a farrowing period.
3. Enables a producer to more nearly have the desired number of sows to farrow at one time by breeding extra sows and culling to a given number.
4. Aid in diagnosis of reproductive problems by determining percentage of pregnancy.

[a] Manufactured by Mextric Corporation, Denver, Colorado.

* Dr. Berthelsen is a swine extension veterinarian, Iowa State University.
† Dr. Stevermer is a swine extension specialist, Iowa State University.