Use of the Laboratory in Diagnosis & Therapy

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Many veterinarians have been engrained with a philosophy that laboratory tests are only ancillary aids in diagnosis; the main components being a good history and a thorough physical examination. This philosophy, while not incorrect, can be misleading since many body systems do not lend themselves to good physical examination, i.e., the hemopoietic and urinary systems. Physicians and to some extent our small animal colleagues have shifted away from this thinking and have adopted the problem-oriented approach to diagnosis. This system has broadened the scope of the data base to include the routine collection of certain laboratory tests such as hemogram, BUN, or urinalysis in addition to the history and physical examination.

The hemogram is the most widely used laboratory test. When evaluated along with the history and physical findings, an increased amount of diagnostic, prognostic, and therapeutic information can be attained. It is important to correlate the physical findings with the hemogram, since certain physiologic states such as dehydration, shock, or stress can create abnormal values.

The packed cell volume (PCV) and the total plasma proteins (TPP) are parameters which are usually not well evaluated by the practitioner. Individually and together, these parameters are used to monitor hydration, nutritive status, and the state of the patient's erythron. Table 1 lists some disease and physiologic states and their effect on PCV and TPP. The table is by no means complete, but its purpose is to point out how various disease processes can effect these parameters. Knowledge of this information can be beneficial in helping to diagnose vague disease problems.

A low TPP indicates either a problem in protein production or increased body loss. Pathologic losses usually are the result of renal lesions (leptospirosis, pyelonephritis), intestinal lesions (johnes, ostertagiasis), or blood loss (abomasal ulcers). A falling TPP accompanied by a rising PCV is an especially grave sign. This indicates protein leakage in the presence of shock. Conditions such as severe volvulus, strangulation of intestine, intussusception, or long-standing abomasal torsion can produce such data. This is due to compromised blood flow and distension of the affected intestinal segment leading to a loss of vascular integrity. Impaired protein production is commonly associated with liver disease although nutritional deficiences (malnutrition) will also lead to low TPP values (9).

Table 1

	PCV	TPP
Dehydration/ Shock	⇧	⇧
Chronic Infect.	⇧	
Johnes/Liver Disease	⇧	
Pneumonia with Polycythemia	⇧	⇧
Acute Blood Loss	⇩	⇩
Starvation	⇩	⇩

Increased TPP is often difficult to interpret unless the clinician has carefully evaluated the animal's state of hydration. Elevations in TPP which result from dehydration or shock are relative rises reflecting water loss and protein conservation within the vascular system. In those conditions the PCV will rise proportionally to the TPP. Absolute elevations in the TPP are most commonly observed in the globulin fraction, specifically the gamma fraction. These elevations are associated with infections (viral and bacterial), parasitism, liver disease, and certain neoplasms (5).

Elevations in packed cell volume can be seen in cases of dehydration and polycythemia. With dehydration, the increase is a relative rise dependent on fluctuations in plasma volume while with polycythemia there is an absolute increase in the number of erythrocytes. A transient polycythemia is occasionally seen in animals moved from low- to high-altitude areas (high mountain disease) (3). This is caused by the body's effort to maintain tissue oxygen levels in a low-oxygen atmosphere. Chronic pneumonia on rare occasions may cause a polycythemia via a similar pattern. Here, the presence of diseased lung prevents adequate oxygenation and causes an outpouring of erythrocytes in an attempt to keep tissue oxygen levels up. Decreases in PCV can be caused by nutritional deficiences, chronic infections, blood loss, or overzealous rehydration.

The total white count and the differential white count are the parameters utilized most fully by the practitioners. To understand the significance of this data, one must understand the sequence of events in the white cell response. In acute bacterial infections such as pasteurellosis, mastitis, or metritis, the initial

response seen in the circulating white count is a leukopenia. The leukopenia is due to the pooling of neutrophils at the site of inflammation. Due to the limited marrow reserves of the cow, the leukopenia is more pronounced and of a longer duration than in other species (5). At about 48-72 hours post-infection, the count begins to rise. Counts of greater than 20,000 white cells/ul are seldom seen in the cow except for a few disease processes such as endocarditis, pericarditis, or closed cavity infections, i.e., lung, liver, and abdominal abscesses. A white cell response in the range of 10,000-12,000 wbc/ul is more the rule than the exception in the mature cow.

Persistent leukopenias are more diagnostic and prognostic than are the leukophilias. Viral diseases, like BVD, are characterized by a leukopenia. With BVD the low total white count is due principally to a neutropenia, although the number of lymphocytes may also be depressed. The total white count in many cases of BVD will fall to less than 2,000 cells/ul. Because the virus suppresses the neutrophils at the marrow level, the majority of the circulating cells should be mature. This feature can be important in differentiating a viral diarrhea like BVD or MCF from an acute salmonella diarrhea or one due to toxemia. In both of these conditions, the neutropenia is accompanied by a left shift. The cow's ability to respond to severe infection and toxemias such as those mentioned is greatly limited. This limitation is due to the longer neutrophil maturation time (6 days) and the smaller neutrophil reserve of the cow compared to other domestic species (5). Therefore it is relatively easy to get increased numbers of immature neutrophils in severe infections.

The relative and absolute number of white cells in the differential count should be assessed for their prognostic value. Normally very few band neutrophils are found in the circulation (less than 100/ul). Conditions in which increased numbers of immature forms are seen will have varying prognoses depending on 1) whether the total white count is rising or falling and 2) how the relative distribution of these cells is being changed. Disease processes in which large numbers of immature forms are found, or in which the number of immature forms exceed the number of mature forms are indicative of an overwhelming disease. A grave prognosis is associated with diseases resulting in below-average total white cell numbers or whenever shifts toward neutrophilic metamyelocytes or myelocytes are observed. Severe left shifts have been observed immediately post-operatively in cows in which either extensive manipulation of the viscera has taken place, or in which some contamination of the abdomen has occurred. These left shifts which result from a single insult do not have the same prognostic significance as those arising as a result of continuous infection. In most cases, the cow will respond favorably despite the severe left shift if appropriate treatment is instituted.

Lymphocytosis is a relative term in cattle depending on the age of the animal. Counts of up to 10,000/ul can be normal in a calf less than 6 months of age (3); however, this count in a mature cow is a definite elevation above normal, usually suggesting lymphosarcoma. The only infectious disease which regularly causes a lymphocytosis is trypanosomiasis (2) which is very rarely seen in the U.S. The form of trypanosomiasis found in the U.S. is not considered pathogenic (1). Therapy with corticosteroids will induce a lymphopenia. However, lymphopenias are more often associated with viral diseases, like BVD, and overwhelming infections. A lymphopenia which persists despite treatment should be considered a grave prognostic sign (5).

The total and differential white count from a single hemogram may be indicative of the trends of disease within an animal. However, a more accurate prognosis can be obtained through the use of serial hemograms. Improvement in the animal's condition is often hard to assess clinically and certain medications may mask the clinical symptoms; however, changes in the hemogram, whether favorable or degenerative, are often evident ahead of physical change.

Profiles

The advantages of profile testing have been alluded to previously: 1) the cost per test is greatly reduced, 2) the additional tests often give information of use in the treatment, and 3) time can be saved in arriving at a diagnosis'especially in difficult cases. The profile should contain only those tests whose data has clinical significance in the bovine. Tests such as alkaline phosphatase, SGPT, cholesterol, and amylase have almost no diagnostic value in cattle. At the Ohio State University Veterinary Hospital, the large animal profile consists of a serum CO_2 calcium, phosphorus, blood glucose, creatinine, BUN, total bilirubin, SGOT, albumin, sorbitol dehydrogenase, and the serum electrolytes, sodium, potassium, and chloride. The cost to the client is $10.00, which represents less than the cost of any two of the tests run individually. The tests used in the profile were selected for their ability to 1) screen for liver, kidney, and muscle degeneration and 2) monitor acid-base and electrolyte balance.

Having the profile available but not being able to interpret the results is no better than not having the profile at all. Consider what each of these tests has to offer. Serum CO_2 recorded in mEq/l, closely correlates with the bicarbonate level in the blood. The normal range of CO_2 levels for our laboratory is between 23-31 mEq/l. This range is 2-3 mEq/l above the corresponding blood bicarbonate level in the higher range; however, since the difference is constant beyond this point, this measurement is still a reliable indicator of the animal's metabolic acid-base status. CO_2 levels above 31 mEq/l are indications of a metabolic alkalosis.

Abomasal torsions, vagal indigestion, and high intestinal obstructions are conditions producing metabolic alkalosis in cattle. The alkalosis produced

results from the sequestration of hydrogen ions in the abomasum, making them unavailable to the rest of the body. Low serum CO_2 levels (less than 20 mEq/l) indicate a metabolic acidosis. Diarrheal disease can create a metabolic acidosis through loss of base while conditions such as shock cause a metabolic acidosis by shifting cellular metabolism and liberating lactic acid.

The importance of serum calcium and phosphorus levels to the bovine practitioner needs little explanation. Depressions in calcium are associated with muscular weakness and neurologic signs as are seen in milk fever and transport tetani. Pathologic elevations in calcium are infrequently reported in cattle unless connected with overzealous vitamin D therapy (8). Certain plants such as *Solanum malacocylon* and *Cetrum diurnum* contain a substance similar to vitamin D_3 which can also elevate serum calcium and cause calcification of vessels (6). The only reports of these diseases within the U.S. are in Florida (10) and Hawaii (3) and are rare even in these areas. Elevation in calcium secondary to lymphosarcoma as seen in dogs and horses (7) has not been reported in cattle.

Elevations in phosphorus levels frequently are seen accompanying a fall in serum calcium levels related to decreased intake. Greater elevations in serum phosphorus occur with renal disease due to impaired excretion of this mineral. Excessive phosphorus levels themselves are not pathologic, however, they certainly suggest a problem elsewhere. It has been observed that many seriously ill cattle treated at the Ohio State University Hospital have phosphorus levels in excess of their calcium levels, not thought to result from renal disease or calcium deficiency. Although no explanation for this phenomena can be given, the elevated phosphorus level has proven to be a grave prognostic sign. Low phosphorus levels (less than 4.0 mg%) are usually diet-related and may be accompanied by clinical symptoms of reproductive failure, pica, poor growth, and post-parturient hemoglobinuria (3).

Blood glucose determinations can be very useful in evaluating the valuable calf suffering from systemic colibacillosis or in the mature cow with toxemia or bacteremia. In both the cow and the calf, subnormal glucose levels may result from bacteria utilizing the plasma glucose. The bovine, although it does not rely heavily on blood glucose for energy, must maintain a level of at least 40 mg/dl to supply the energy needs of the nervous system, especially the brain. Levels less than those mentioned may lead to the manifestation of neurologic signs such as convulsions, opisthotonus. Often calves which appear to have colimeningitis respond favorably to glucose therapy; the same holds true for the toxic cow.

Elevations in blood glucose are often observed in animals under severe stress. Levels over 80 mg/dl are abnormally high and the reason behind such elevations should be sought. Corticosteroids will induce a significant hyperglycemia which can easily exceed the renal threshold for glucose of 100 mg/dl. These elevations may be maintained for 36-48 hours following administration (4). Although the condition diabetes mellitus is not commonly found in the ruminant, it has been described (9) and should be considered when no other cause for the hyperglycemia can be found.

Creatinine and BUN are parameters of glomerular filtration and are commonly used to indicate renal disease. Both of these tests require adequate kidney perfusion to give reliable results. Shock or dehydration resulting in decreased perfusion will give elevations in both parameters without necessarily indicating renal disease. This is called prerenal uremia. High fevers or toxemias may result in elevations of the BUN due to catabolic breakdown of tissues (5). Creatinine is not affected by this process and consequently is held by some to be a better indicator of true renal function. Obstructions in the urinary system posterior to the kidney (urethral obstruction, ureteral obstruction) will cause increased values in creatinine and BUN. These elevations are the result of the increased pressure within the kidney caused by ruine backup. The true prognostic significance of elevations in BUN and creatinine can only be ascertained with serial testing since therapy (re-hydration or relief of the obstruction) may reduce these figures.

Abnormally low BUNs (less than 5 mg/dl) can be seen in cases of protein malnutrition (either deficiency in intake or absorption) and in severe hepatic failure. In the case of liver failure the low BUN is the result of the liver's inability to form urea. This is one of the last functions of the liver to fail and thus indicates extensive hepatocellular damage. Creatinine, because it is produced at a constant rate by muscle metabolism, should not fall below the normal range of 0.9-2.1 mg/dl.

Total bilirubin, SGOT, SDH, and albumin can all be used as parameters of liver disease. Of these tests only elevations in sorbitol dehydrogenase (SDH) can be said to arise exclusively from the liver. SDH is an enzyme found in liver cells which is released upon the death of the cell. Unlike other enzymes yet to be discussed, SDH has a short serum half-life (less than 2-3 days) and elevates rapidly in the serum following hepatic necrosis. Because of this enzyme's ability to rapidly rise and fall, SDH is an excellent test to monitor the course of hepatic disease.

Serum glutamic oxalacetic transaminase (SGOT), or as it is more properly known, aspartate aminotransferase, is an enzyme present in all the body's tissues. Highest concentrations of this enzyme are found in both skeletal and cardiac muscle in addition to the liver (5,9). Elevations in SGOT should only be considered indicative of liver disease when degenerative changes in other body systems can be eliminated. Cows having LDA with SGOT levels of over 500 units are poor surgical risks. If surgery is to be attempted, it is usually wise to spend a few days treating the animal and following the SGOT to determine whether the liver has improved sufficiently to warrant the cost of the surgery. Unlike SDH, the

SGOT takes several days to rise and up to two weeks to fall to normal following one insult to the liver.

Bilirubin is the pigment derived from the degradation of hemoglobin. It is normally taken up from the blood stream by the liver where it is conjugated with gluronic acid then excreted in the bile. Elevations in total bilirubin can originate from either hemolytic disease or from liver obstruction. Therefore, it is often necessary to quantitate the conjugated and the unconjugated fractions to determine the cause of the rise. Unconjugated or free bilirubin is the direct product of hemoglobulin breakdown and is the portion elevated with hemolytic diseases (bracken fern). Conjugated bilirubin accumulates in the blood stream when the outflow of bile from liver is impaired as in aflatoxicosis and fascioliasis. In the bovine, the measurement of serum bilirubin should not be considered a sensitive indicator of hepatic dysfunction since only mild elevations have been recorded in known cases of severe hepatic degeneration (5).

Chronic liver disease can also be reflected in the level of serum albumin, which is produced in the liver. Other diseases such as renal disease and certain enteropathies (johnes) also cause a lowered albumin level by increasing the body's loss of this protein. Normally, about 50% of the total serum proteins is albumin. The absolute value for albumin should range between 3.0-3.6 gm/dl. Values less than 2.5 gm/dl are definitely pathologic, indicating either increased loss or decreased production. Hyperaluminemias exist only in states of intravascular dehydration (shock, dehydration) and are not associated with any specific disease processes in cattle.

Tests like SGOT and SDH measure only enzyme levels associated with hepatocellular disease and do not define to what degree hepatic function is affected. The most practical test to determine hepatic function in the bovine is the BSP (sulfobromophtalein) test. This is a colorimetric test based on the liver's ability to rapidly clear the BSP dye from the blood stream, concentrate it within the liver, and excrete it into the bile. The principle of this test is quite similar to the normal excretion of bilirubin, however, the BSP test is much more sensitive to changes within the liver than is a bilirubin determination.

The technique for the test as used at the Ohio State University Veterinary Hospital involves the intravenous injection of 1 mg/lb BSP. Two 10 ml heparinized blood samples are collected at 5 and 9 minutes post-injection. The exact time of collection must be known because the test is based on the half-life of the dye. BSP is rapidly cleared in the bovine and errors of as little as 30 seconds in the assumed time of collection versus the actual time of collection can make significant differences in the interpretation of the test.

Care must always be taken to avoid any contamination of the samples with any extraneous dye. This can occur if the syringe used to inject the dye is also used to collect the samples. Even minute quantities of the dye, such as a drop left in the needle, will adversely affect the results. To insure valid results, it is recommended that the vein used for the injection of the BSP not be used for the collection of the samples. This is because the dye has a tendency to cling to the vessel wall so collection from this vein can yield artificially prolonged times.

The normal T/2 for the mature cow is 3.3 $\pm$ 0.5 minutes. Significant prolongations in the T/2 to about 8 minutes can frequently be found in dairy cows suffering from mild cases of hepatic lipidosis. Conditions such as toxic hepatitis, multiple liver abscesses, and severe cases of lipidosis give T/2 values of 12-15 minutes or greater. Values in this range are significant in that they indicate a poor-to-grave prognosis for the animal.

The serum electrolytes give valuable diagnostic, prognostic and therapeutic information. Conditions such as high intestinal obstructions and abomasal torsions can almost be diagnosed on the basis of the electrolyte changes alone. The classic changes seen in these conditions are a hypochloremia and a hypokalemia. Often the chloride value will dip from its normal level of 94-104 mEq/l to less than 70 mEq/l and the potassium level will fall to 2.5 mEq/l or less. Elevations in serum potassium are usually an indication of acidosis with values reaching 8.0 mEq/l or greater in cases of severe diarrhea.

Following electrolyte levels can be important in prognosing and treating cases. Cows presented to the OSU Veterinary Hospital with abomasal torsions which presurgically had serum chloride values of less than 80 mEq/l had a poorer prognosis following surgery than those that maintain values of greater than 80 mEq/l. Electrolyte values are also important to the veterinarian in prescribing treatment to these cows post-operatively. If large amounts of abomasal contents are removed at surgery, a good deal of the animal's chloride is lost and should be replaced. By following the electrolyte values in the cow post-operatively, deficiencies which would slow recovery can be quickly found and corrected.

The calf with colibacillosis is another example of a case which can benefit from the monitoring of electrolytes. In many instances, it is the electrolyte imbalances and not the infection that kills the calf. Persistent diarrhea can lead to a severe acidosis due to the loss of bicarbonate in the feces. This can drive potassium into the extracellular spaces where the elevated potassium level can exert its pathologic action (arryhthmias).

Serial electrolyte evaluation can be useful in determining the outcome in the case of vagal indigestion or atony. Animals in which low chloride and potassium levels persist despite treatment, usually will not do well. By recommending salvage early in the course of an untreatable condition, the veterinarian can show the owner his concern for the dairyman's economic welfare.

The laboratory tests mentioned thus far have been those limited to evaluation through the blood sampling. Certain body systems do not lend themselves to

thorough examination through the blood stream and so other means must be used. Cerebrospinal fluid (CSF) taps can be done with minimal risk to the patient showing neurological signs. Two sites are available in the ruminant to obtain CSF: the cisterna magna and the lumbosacral junction. To get CSF from the cisterna magna, the patient should be restrained with the head severely flexed in order to widen the space. Since this is an uncomfortable position, the animal may struggle unless anesthetized. The necessity of anesthesia makes cisterna magna punctures impractical to perform in the adult dairy cow still able to stand.

The lumbosacral tap can be accomplished with minimal restraint on the standing animal. In the adult cow, a needle 3-6 in. long is sufficient to reach the subarachnoid space. The needle must be placed aseptically to prevent causing meningitis. It is usually possible to tell when entering the subarachnoid space with the needle, since the cow will flinch. If fluid does not flow when the stylette is removed, occlusion of the jugular veins should sufficiently elevate the pressure in the CSF to cause flow.

Table 2
Cerebrospinal Fluid

	Cells/ul	Cell Type	Pandy
Normal	0-25	lymphocyte	-
Poliocencephalomalcia	0-100	lymphocyte	- to +
TEME	200+	neutrophil	++
Listeria	1-200	lymphocyte	- to +
Meningitis	200+	neutrophil	+

Evaluation of the number and type of cells present, and the Pandy reaction can help in the differentiation of many common neurological problems. Table 2 lists four of the frequently encountered neurological diseases and shows how these parameters are affected in each. Examination of the cerebrospinal fluid can be done to some extent right beside the cow. Perceivable turbidity in the fluid is an indication of a cell count of at least 300-700 cells/ul (5). These increased counts may be the result of inflammation or irritation of either the meninges, brain, or cord. Problems such as brain abscesses, meningitis, and TEME can all reach cell counts in this range. The Pandy test is both a quantitative and qualitative test for the presence of globulin in the CSF. Only a small amount of the reagent, a clean test tube and CSF is needed to run the test. The reagent is added to the test tube first and is then covered by a layer of CSF. The formation of a layer of turbidity at the interface of the CSF-Pandy reagent is a positive reaction. The reaction should occur within 2-3 minutes if it is positive. Many samples will become increasingly positive with time, including that obtained from normal cows, so time is somewhat critical. If the CSF withdrawn appears hemorrhagic, centrifugation should clear the fluid color if it is the result of the tap. This is because hemolysis does not occur for about 4 hours following hemorrhage. Reddish CSF following centrifugation indicates true subarachnoid hemorrhage as is associated with trauma.

Abdominal paracentesis, thoracocentesis, and pericardiocentesis are three other means of gathering additional information about the patient. Most veterinarians have been reluctant to use these techniques because 1) they felt the procedures represented an undue risk to the patient, or 2) they were unaware of the value of the procedures. First, there is some risk; however, with some forethought and with good technique on the part of the veterinarian, this risk is minimal and is far outweighed by the value of the information gathered.

Abdominal paracentesis in cattle can be beneficial in differentiating various disease processes without the aid of exploratory laparotomy. Inflammatory diseases within the abdomen such as peritonitis will cause the exudation of fluid and cells into the cavity. Differentiating infections from non-infectious abdominal disease can often be difficult to accomplish on the basis of clinical signs or changes within the hemogram; however, differences in the composition of the peritoneal fluid may be beneficial in making such a determination. Table 3 lists some of the differences between exudates and transudates. These 4 criteria are definite enough to readily allow differentiation of infectious or inflammatory conditions from the passive causes of abdominal fluid accumulation (liver disease).

Table 3

	Transudate	Exudate
Appearance	clear	clear, cloudy
Sp. Gr.	▼ below 0.107	▲ 1.017
Cells	epithelial lymphocytes	neutrophils lymphocytes
Protein	<3 gms/dl	>3 gms/dl
Coagulation	poor if at all	clots readily

The procedure itself is easily performed requiring a minimum of equipment; local anesthetic agent, scalpel blade, side-opening teat cannula. The site for paracentesis is the area 4-6 in. immediately posterior to the xiphoid and 2-4 in. on either side of the midline. The area should be clipped and surgically scrubbed. 1 to 2 mls of local anesthetic infiltrated subcutaneously is advantageous for making the small stab incision (1/2") through the skin through which the cannula will be placed. The teat cannula is used because of its blunt end which makes perforation of abdominal structures less likely to occur. The teat cannula should be "popped" sharply through the musculature in order to penetrate the peritoneum. If fluid does not drop from the end of the cannula, 5-10 ml of air may be injected through the cannula to insure patency. The normal cow has only a small quantity of peritoneal fluid (less than 5 ml) which may be recovered. Volumes of greater than 5-10 ml are

definitely abnormal even when the fluid appears clear and has no odor. Collection of fluid for cytology should be preserved with EDTA to prevent the formation of a clot which could sequester cells and also to maintain cellular morphology. If the paracentesis appears to be negative,it is often worthwhile to repeat the cannula placement either at the same site or at a different site. Localized peritonitis as occurs in TRP is often difficult to diagnose by paracentesis unless the tap is performed within the first day or so following the insult. This is due to the cow's great ability to wall off infection, making it relatively inaccessible via the tap.

Thoracocentesis is a valuable tool in differentiating pleuritis, pleural effusion, pericarditis, and pericardial effusion. The only difference in the procedure from abdominal paracentesis is the necessity of having some means of preventing the formation of a pneumothorax. The cow, although it has a complete mediastinum, can still be distressed by having half the lung collapsed. This problem can easily be prevented by using a three-way stopcock on the end of the cannula. The site for the procedure is variable, however, tapping at the level of the costo-chrondral border has the advantage of being sufficiently low in the chest to allow most complete drainage should that be deemed necessary. Recovery of fluid is significant since the small amount normally present is rarely accessible.

Pericardiocentesis is not routinely performed because both of the disease processes commonly involved in the production of fluid or the exudation of cells into the pericardial sac have a grave prognosis. On occasion, such as the expensive cow where the owner wants to do everything possible, you may be asked to differentiate traumatic pericarditis from lymphosarcoma. This procedure allows examination of the fluid. The pericardial sac is best approached from the left side at the 5th or 6th intercostal space at the level of the elbow. After preparing the site as in the previously mentioned procedures, a styletted 6" needle is advanced into the chest until the end of the needle waves rhythmically with the heart beat. This indicates the needle is in the pericardium. If fluid is not recovered when the stylette is removed, the needle should be advanced slowly since the needle may not have penetrated through the sac. If the fluid removed is odoriferous, this indicates an infectious cause such as TRP. In the event that hemorrhage is encountered, no further advancement should be made and the needle should be withdrawn. If the fluid appears clear on removal, a cytologic examination should be done to differentiate lymphosarcoma from the pericardial effusion associated with heart failure.

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