Hematology and Urinalysis: Optimize Your In-Clinic and Reference Laboratory Testing

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Introduction

Complicated medicine disease and diagnostic testing can be challenging for pet owners. It can be frustrating for owners when they don't understand the VALUE of testing. They will often decline an option that is not understood. This is particularly true if the veterinarian has not clearly and concisely outlined what they think the problem or problems might be, the potential disease(s) causing the problem(s) and the diagnostic tests needed to rule-in or out those potential diseases.

"Enough tests already just treat" owners say. Or one may hear from an owner: "They are just going to do a bunch of tests" when a friend suggests a visit to the veterinarian for an ill pet. The veterinarian may or may not do a "bunch of tests" but how does the veterinarian know how to treat the patient if they don't know what is wrong? The most direct way to achieve lasting relief and return to health is by uncovering what the problem really is, by diagnosing the disease, so that treatment can be definitive and not simply empirical. Diagnosing disease also makes financial sense. Money is not wasted on treatments for diseases the pet does not have.

As we move through these sections on diagnostic laboratory testing, continue to think of how you would describe testing to an owner to optimize their understanding of what can often be a complicated process. Understanding will help them make the best choices for their pet.

The tests: A Practical Guide

Generally, we start diagnostic testing with screening blood work which most often includes a Complete Blood Count (CBC), blood chemistry profile and (ideally) a urinalysis. The blood chemistry profiles differ only slightly between diagnostic laboratories. The screening panel provides the most information cost effectively. Depending on the initial results and the pets response to our supportive therapy, we may order more specific blood tests.

Below are the most common tests included in a general panel, a brief description of the test, and why we use it. I have also included a few more specific blood tests that we may order depending on the results of the screening tests.

Complete Blood Count (CBC)

A CBC is performed to assess for disorders of the red cells anemia and polycythemia (too many red cells), disorders of the WBC's including infection, non-infectious inflammation, cancers like leukemia, allergies and parasitic infections, and disorders of platelets the main one being thrombocytopenia, or low platelet count.

Red Blood Cell Count (RBC) – number of red cells per volume of blood (/UL)

Hematocrit (HCT) or Packed Cell Volume (PCV) - calculated percentage of red blood cells in the circulation. It is either determined by the hematology analyzer as hematocrit or HCT, by multiplying the RBC count by the MCV or by centrifugation of a small blood sample to pack the RBC's and determine a Packed Cell Volume or PCV. The HCT and PCV should agree.

Hemoglobin (Hgb) - essential oxygen carrying molecule within RBC's
Note: Although RBC, HCT/PCV and Hgb all equally measure RBC mass, we tend to use HCT or PCV to assess for anemia or polycythemia.

Mean Corpuscular Volume (MCV) - average size of the red blood cells. A high MCV may indicate certain vitamin deficiencies. A low MCV consistent with microcytosis on a slide review often supports iron deficiency

most often attributed to chronic blood loss or hepatic disease. Poodles and poodle mixes can have a hereditary macrocytosis.

Mean Corpuscular hemoglobin Concentration (MCHC) – average concentration of hemoglobin in each red blood cell. We most often see a low MCHC in iron deficiency which appears as hypochromasia on a slide review

Reticulocytes - immature red blood cells. A regenerative anemia has an increased number of reticulocytes meaning that the bone marrow is responding. Regenerative anemias are seen with acute hemorrhage or coagulation disorders and immune-destruction of RBCs. Nonregenerative anemias reflect anemias due to chronic disease such as kidney disease, cancer, and bone marrow disorders and a more chronic, protracted hemorrhage resulting in iron deficiency. After an acute hemorrhage, it can take up to 3-5 days to result in an adequate regenerative response.
Note: MCV and MCHC help us to classify the type of anemia and determine its cause.

White Blood Cell Count (WBC) – number of total white blood cells per volume of blood (/UL)

Differential
The differential provides an analysis of the different types of white blood cells that make up the total WBC count. The differential can be done manually by counting the number of each cell type in a total count of 100 cells; this provides a percentage of each cell type. The absolute number of each white blood cell type is calculated by multiplying the percentage of each type by the total white blood cell count. It is the absolute value and not the percentage that we use to identify how or low cell counts. Automated hematology cell counters provide a differential. The accuracy of the machine differential depends on the type of analyzer and essentially the normality of the CBC. Automated analyzers will hint at the presence of abnormal white cells such as bands, toxic change, neoplastic lymphocytes, mast cells, etc. Only a manual slide review can confirm the accuracy of an automated differential and detect the presence of these significant morphological changes.

Neutrophils - primary white blood cells responsible for fighting infections. Neutrophils increase in inflammation due to causes such as infection and neoplasia. Low neutrophil counts can indicate a severe overwhelming infection, viral disease or a bone marrow disorder.

Lymphocytes – component of the immune-system that produces antibodies and other substances involved in immunity. Low lymphocyte numbers, termed lymphopenia, can occur in viral infections and with metabolic stress. High numbers, lymphocytosis, can occur with certain endocrine diseases, rickettsial diseases and with tumors/leukemias of lymphoid tissues..

Monocytes – circulating form of tissue macrophages, that are phagocytic. They ingest large particles including bacteria and work to clean up inflammation. Their numbers increase with inflammation, tissue and tumor necrosis. Low numbers have no clinical significance.

Eosinophils - primarily involved in allergic reactions and parasitic infections. Eosinophilia can occur in allergic and hypersensitivity conditions, parasitism, and as a paraneoplastic syndrome. Eosinophilia has no clinical significance.

Basophils - uncommon WBC but can be seen in certain parasitic infections including heartworm and with allergic conditions. Similar to eosinopenia and monocytopenia, low numbers have no clinical significance.

Platelets - play an important role in blood clotting. Platelets in a blood sample may clump falsely decreasing the analyzer count. When the analyzer cound is low a blood smear review is required to assess and estimate platelet numbers. Increased platelet numbers, termed thrombocytosis, can occur from a variety of problems most

commonly inflammation. Low platelet numbers, termed thrombocytopenia, can indicate immune-destruction of platelets, rickettsial disease or a coagulation disorder.

Urinalysis
The urinalysis includes the physical, chemical and microscopic evaluation of the urine. Clean free catch urine samples are fine for the analysis of most components. Culture of a free catch sample often yields bacterial growth due to contaminants thus urine collected by cystocentesis is preferred for urine culture. A urinalysis is essential for determining whether azotemia (increased BUN and creatinine) is due to dehydration or kidney disease. A urinalysis is also crucial to the diagnosis of endocrine disease causing polyuria/polydipsia such as diabetes mellitus and Cushing's Disease causes of hematuria and urinary tract inflammation including infection and urolithiasis and prostatic disease and urinary tract neoplasia.

Parts of the Urinalysis:
Color and Turbidity - urine is yellow in color, the depth of color varying with the urine concentration. Hematuria, hemoglobinuria, and bilirubinuria are the most common causes of discolored urine; the former two making the urine red, the latter, more orange. The most common causes of increased turbidity are pyuria (increased WBC's), crystalluria, and lipiduria (increased fat).

Specific Gravity - determined by refractometer, not by dipstick. A measure of urine concentration, and therefore of kidney function. A specific gravity of 1.000 is equivalent to water whereas 1.090 is highly concentrated urine. A specific gravity greater than 1.030 in the dog and 1.035 in the cat indicates that the kidney is functioning to concentrate the urine. Urine specific gravity below 1.008 is termed hyposthenuria, the kidneys are actively diluting the urine, and between 1.008 to 1.012, isosthenuria, in which the kidneys are neither diluting nor concentrating the urine.

Chemical Analysis:
pH - a pH of 7.0 is neutral; most dog and cat urine is acidic with pH ranging from 5.8 to 6.5 but any pH can be normal. Alkaline urine, pH > 8.0, may be due to infection.

Protein - normal urine should not contain protein. Protein in the urine can be due to RBC's, WBC's, bacteria, epithelial cells or in the presence of an inactive sediment (normal sediment), a type of kidney disease called glomerulonephritis.

Glucose - normal urine should not contain glucose. Glucosuria can be seen with diabetes mellitus and a high blood sugar, or with kidney disease when the blood sugar is normal. Cats can become transiently hyperglycemic and glucosuric with stress.

Ketones - normal urine should not contain ketones. Ketones and glucose in the urine support a complication of diabetes called diabetic ketoacidosis. Treatment may involve IV fluids and insulin given IV or IM and a search for an underlying complication to the diabetes.

Bilirubin - bilirubin in the urine can be normal in dogs particularly in concentrated urine. Bilirubin is never normal in cat urine. Bilirubinuria in both the dog and cat can indicate liver disease or a hemolytic anemia.

Blood - positive heme reactive on the dipstick can be due to RBC's in the blood or hematuria, dissolved blood or dissolved myoglobin due to muscle damage. Hematuria is seen with many conditions: bladder inflammation or infection, uroliths or stones, bladder neoplasia, prostatic disease. Bleeding disorders can also cause hematuria.

Hemolysis and RBC lysis such as seen with an immune mediated anemia will also cause a positive heme reactive. (Dipsticks are not accurate for Specific Gravity, Urobilinogen, Nitrate, and WBC's/leukocytes)

Urine Sediment Exam:
RBC's - RBC's occur from conditions similar to those listed under hematuria.

WBC's - WBC's support inflammation which can be due to infection, noninfectious inflammation such as bladder stones, and neoplasia.

Epithelial Cells - Epithelial cells come from the lining of the urinary tract and may originate from the kidneys, ureters, bladder, urethra, prostate (in a male) or external orifice of the urethra/vulva. One cannot determine the origin of the epithelial cells based on their appearance.

Bacteria - Urine is sterile but easily contaminated. Even a sample taken by cytocentesis may contain low number of contaminating bacteria. Bacteria are rods singly or in chains/groups or cocci in pairs or chains. Debris and amorphous crystals can appear to be bacteria. Sediment exam is best done unstained to avoid stain artifact. Air dried slides of urine sediment can be prepared and stained with Dif Quik to better assess for presence of bacteria, epithelial cells, etc.

Crystals - Crystals in the urine (crystalluria) means that the urine is oversaturated with the substances making up crystals. Urine pH and urine concentration can influence crystalluria. Crystalluria may not be clinically significant and must be interpreted with the history and clinical signs. Some crystals, such as calcium oxalate and struvite can form as the urine cools and may not be present in the patient at body temperature. Crystals such as urate and cystine support a metabolic problem in the patient.

Casts - Casts originate in the kidney and are actually microscopic "casts" of the kidney tubules. Their presence supports kidney disease but they are very fragile and not always seen in the urine. Cats occur more often in diseases that cause proteinuria and in cases of renal toxicity such as antifreeze toxicity.