

# The Blood Chemistry Panel Explained

## The Senior Profile

(for senior and geriatric patients)

As our dogs and cats enter their senior years, we recognize that they are more likely to have health problems than when they were younger. Their systems are not as resilient. They do not recover as quickly from trauma or disease. It is important to try to “stay ahead” of their problems by aggressively screening them for disease. Part of that screening is certainly checking chemistries. We also recommend checking a CBC, complete blood count, and a urinalysis once or twice yearly in senior pets as a routine.

- **Albumin**: Albumin is a serum protein made exclusively by the liver. It is responsible for maintenance of oncotic pressure in the bloodstream which is necessary for delivery of blood and oxygen to tissues and removal of wastes. Albumin is also a “storage” protein that the body uses to build other proteins necessary for life functions. A high albumin level indicates dehydration. A low albumin level can be associated with liver disease, kidney disease, gastrointestinal disease, or severe dermatitis. When albumin is low from any cause, it changes the way the body handles medications. Many drugs are bound, chemically, to albumin. When albumin is low, more drug is floating free in the blood where it is more active. Consequently, normal doses of drugs in patients with low albumin may actually be toxic.
- **Alkaline Phosphatase**: Alkaline phosphatase, Alkp, is an enzyme that is made primarily by the liver and secondarily by the bone. It may be elevated in normal pediatric patients from bone growth. It tends to be elevated with conditions that cause swelling in the liver. Disease conditions associated with increased Alkp include osteomyelitis, bone cancer, portosystemic shunt, hepatitis, hyperthyroidism, pancreatitis, severe enteritis, cholecystitis, diabetes mellitus, hyperadrenocorticism, bile duct obstruction, and hepatic lipidosis. Low Alkp is not significant. If the Alkp is elevated due to liver dysfunction, this will change the way the body metabolizes drugs. Drugs metabolized by the liver will remain active much longer than expected. Normal drug doses may be toxic to patients with liver dysfunction.
- **ALT**: ALT stands for alanine aminotransferase. This is an enzyme made by the liver. It can also be found in muscle. It is elevated in cases of liver damage rather than swelling. The liver can be damaged by toxins, inflammation, overheating, trauma, or cancer.
- **BUN**: BUN stands for blood urea nitrogen. It is a byproduct of protein metabolism. The liver catabolizes proteins into BUN which is then excreted by the kidney. When BUN is elevated, it means either the patient is dehydrated or has compromised kidney function. These two conditions are easily differentiated by checking the concentration of the urine concurrent with the BUN. If the urine is very concentrated in the face of an elevated BUN, the patient is dehydrated. If

the urine is dilute, then the patient has compromised kidney function. Another potential source of BUN is the gastrointestinal tract. Blood in the gastrointestinal tract is digested by bacteria into BUN. A chronically elevated BUN in a patient with adequate hydration, good ability to concentrate urine and a low red cell count may be related to gastric or intestinal ulcers or severe intestinal inflammation. A low BUN may indicate liver dysfunction as the liver is responsible for making BUN.

- **Creatinine**: Creatinine is also a byproduct of protein metabolism. It is interpreted in the same way as BUN with a few exceptions. It is common for the creatinine to be elevated in early kidney disease when the BUN is normal. Creatinine does not tend to rise with gastrointestinal bleeding. Low creatinine does not indicate liver dysfunction. Creatinine does not tend to elevate substantially with dehydration. Because of this, creatinine is often considered a more accurate indicator of kidney dysfunction than BUN.
- **Globulin**: Globulins are serum proteins. They are primarily immunoglobulins or antibodies. Globulin levels may be elevated in dehydration or any condition causing the production of antibodies, including infection, immune mediated disorders, or allergies. Low globulins may indicate failure of passive transfer of immunity in neonatal patients. Some cancers will also increase globulin levels, such as plasma cell myelomas.
- **Hematocrit**: The hematocrit, also called packed cell volume or PCV, is a measurement of red blood cells. Specifically it is the volume of blood that is occupied by red cell mass as opposed to serum. A hematocrit of 40% means that the blood is 40% red cell mass and 60% serum. A low hematocrit indicates anemia. An elevated hematocrit indicates dehydration or polycythemia.
- **Total Protein**: Total protein is simply the sum of albumin and globulins. It can be elevated or decreased for the same reasons that albumin and globulins are elevated or decreased.
- **Bilirubin**: This is a pigment made by the liver. It's what makes vomit yellow. It's what makes the skin and eyes yellow in jaundiced patients. It is elevated in patients with liver disease, red blood cell disorders, or infections. Liver diseases causing elevated bilirubin levels include hepatitis, cholangiohepatitis, hepatic lipidosis, and bile duct obstruction. Pancreatitis can cause elevated bilirubin levels due to its proximity to the liver. Patients with hemolytic, or autodestruct, anemias will have an elevated bilirubin because hemoglobin is released into circulation once the red blood cell breaks open and is converted into bilirubin as part of its metabolism. Pennies made before 1986 contain enough zinc to cause patients who ingest them to have hemolytic anemia and high serum bilirubin concentrations. Serious infections anywhere in the body, such as prostatitis, can elevate the bilirubin mildly. Low bilirubin has no significance.
- **Calcium**: Calcium is one of the main minerals of bone. It exists in the blood stream as an ion or bound to other molecules. Calcium is necessary for normal muscle function, including the heart muscle. High calcium levels are associated with oversupplementation of Vitamin D, hypoadrenocorticism, lymphosarcoma, anal sac adenocarcinoma, some systemic fungal infections, hyperparathyroidism and renal failure. High calcium will cause seizures, renal failure, and cardiac

- arrhythmias, regardless of the cause. Low calcium is associated with hypoparathyroidism and lactation. Nursing mothers frequently start tremoring and become weak due to low calcium.
- **Chloride**: Chloride is an electrolyte. It can be low due to vomiting, diarrhea, chronic respiratory disorders, or diuretic administration. It can be high due to diarrhea (yes, again) or salt poisoning (dogs who eat Playdough). Chloride levels often follow sodium levels. It is often easier to determine the cause of sodium imbalances than chloride.
  - **Cholesterol**: Cholesterol is most commonly elevated due to recent feeding. This is considered normal. High cholesterol after a 12 hour fast is not normal. This can be due to hypothyroidism, hyperadrenocorticism, or conditions that cause protein leakage through the kidneys. High cholesterol can cause corneal lipid deposits. High cholesterol is not associated with heart disease as it is in people.
  - **CPK**: CPK stands for creatine phosphokinase. This is an enzyme commonly associated with muscle injury. Even mild muscle injury can make this enzyme become substantially elevated in muscular breeds of dogs. When CPK is elevated concurrently with ALT, the ALT is interpreted to be from muscle origin and not liver origin. Rarely, CPK is an indicator of myositis or inflammation of the muscle.
  - **Phosphorus**: Phosphorus is the other major mineral component of bone. Its metabolism is integrally associated with calcium. Low phosphorus may be caused by diabetes mellitus, hyperparathyroidism, lymphosarcoma, or anal sac adenocarcinoma. Low phosphorus levels will cause hemolysis of red blood cells, regardless of cause. High phosphorus levels are associated with renal failure, hypoparathyroidism, Fleet enema toxicity, oversupplementation of vitamin D, and growth (normal cause). High phosphorus causes nausea, vomiting, and diarrhea, regardless of the cause.
  - **Potassium**: Potassium, K, is an electrolyte. Potassium influences muscle function and cardiac rhythm. Low potassium is associated with anorexia, chronic renal failure, vomiting, and diarrhea. Low potassium can cause cardiac arrhythmias and generalized weakness. High potassium levels are caused by acute renal failure, hypoadrenocorticism, and urinary tract obstruction. High potassium causes cardiac arrhythmias and muscle tremors.
  - **Sodium**: Sodium, Na, is an electrolyte. It is the major positive ion of the body. It is responsible for maintaining normal blood volume. It is necessary for all life functions. Low sodium is caused by diabetes mellitus, chronic renal failure, hypoadrenocorticism, vomiting, and diarrhea. High sodium levels are associated with diabetes insipidus, salt toxicity (Playdough), water restriction, and brain tumors. Rapid changes in sodium levels, either up or down, are likely to cause seizures or other neurologic dysfunction.
  - **Total T4**: Total T4 is a measurement of the sum of protein-bound thyroxine and nonprotein-bound thyroxine in the bloodstream. It is used as a screening test for hypothyroidism and hyperthyroidism. Hypothyroidism is an endocrine disorder where the thyroid glands do not make enough thyroid hormone for normal life functions. Signs of low thyroid are poor hair coat, bilaterally symmetric hair loss, skin and ear infections, thick looking face, decreased activity, decreased

mentation, heat-seeking behavior, and weight gain. This level is checked when there are symptoms present to suggest hypothyroidism. It is a screening test only because the total t4 is commonly low for reasons other than hypothyroidism. If the result is low, a complete thyroid panel is needed for confirmation that the patient actually needs lifelong thyroid supplementation. Low thyroid over time can lead to myxedema in the brain which will cause seizures. Once this starts, thyroid supplementation will no longer work to prevent seizures.

Hyperthyroidism is primarily a disease of cats. It occurs in older cats and is slow and subtle in progression. Symptoms of high thyroid are rapid heart rate, increased activity, loss of normal sleeping patterns, vomiting, weight loss, increased or decreased appetite, and behavior changes. High thyroid levels cause hypertension, heart disease, and renal failure.

- **Triglycerides-** Triglycerides are a form of fat. Dietary fat is converted into triglycerides for transport to the liver. The liver repackages triglycerides received from the small intestine into a form usable by tissues for energy. As patients age, their bodies frequently become less able to handle a large fat load, as is contained in many pet foods. High triglycerides in the blood stream can cause seizures, nerve paralysis, nausea, vomiting, diarrhea, cramping and abdominal discomfort. High triglycerides are caused by diabetes mellitus, hypothyroidism, pancreatitis, as well as loss of the ability to handle a normal dietary fat load.
- **AST-** AST stands for Aspartate transferase. It is primarily found in the liver and secondarily in muscle. It is interpreted very similarly to ALT. AST may be a more sensitive indicator of liver damage in the cat than ALT. AST may be elevated in muscle disease or with destruction, hemolysis, of the red blood cells.
- **GGT-** GGT stands for Gamma-glutamyl transpeptidase. It is a liver enzyme that is interpreted similarly to alpk. GGT is more likely to be elevated in more serious liver disease, whereas alpk may be elevated for mildly liver conditions. In dogs, alpk is commonly elevated due to hyperactive adrenal glands but not GGT. In cats, alpk is often elevated in hepatic lipidosis but not GGT. When both alpk and GGT are elevated, it prompts a more aggressive search the cause than when alpk is elevated by itself.
- **Amylase/Lipase-** These are pancreatic enzymes. They may be elevated in the face of pancreatitis, pancreatic cancer, or pancreatic abscessation. Unfortunately they are not very sensitive or specific for pancreatic disease. Amylase is frequently elevated in kidney disease due to lack of excretion by the kidney. When these values are dramatically elevated, it may prompt a more specific evaluation of kidneys and/or pancreas.
- **Magnesium-** Magnesium is an electrolyte. It may be low with vomiting, diarrhea, pancreatitis, liver swelling, kidney disease, diabetes mellitus, hyperthyroidism, or hypercalcemia. Low magnesium can cause cardiac arrhythmias, muscle weakness, tremor, and seizures. High magnesium isn't a common clinical problem in dogs and cats. If the magnesium is high enough to cause problem, it is usually due to an overdose of magnesium containing intravenous fluids.
- **CBC-** A CBC is a white blood cell, red blood cell, and platelet count. There are numerous causes of change in the number, size, and appearance of white cells, red

cells, and platelets. Several types of leukemias may be diagnosed by the CBC. Infection, inflammation, immune mediated disease, liver disease, kidney disease, chronic viral infection, and clotting disorders may all be shown by the CBC.

Individual components of the CBC are as follows.

- **WBC-** WBC stands for white blood cells. WBC indicates the number of white blood cells per unit of blood. When the white cell count is elevated, it may indicate infection, inflammation, or immune mediated disease. When the white cell count is low, it may indicate septic shock or bone marrow suppression.
- **Neutrophils-** Neutrophils are a type of white blood cell. They tend to be the first to respond to infectious or inflammatory disease. The neutrophil count may be mildly elevated with an ear infection, dermatitis, or allergies or dramatically elevated with a pyometra, or uterine infection. Neutrophil numbers will drop to below normal in with bone marrow suppression or very serious infection.
- **Monocytes-** Monocytes are another type of white blood cell. Monocytes move into sites of infection or inflammation after neutrophils. They are usually present in smaller numbers. They tend to be elevated more than neutrophils in fungal infections or in disease processes that form granulomas. Monocytic leukemia may be diagnosed by means of a CBC.
- **Lymphocytes-** Lymphocytes are usually the last cell to be involved in infection or inflammation. Their presence indicates a long standing process. Lymphocytes are the cell type involved in the most common tumor of dogs and cats, lymphosarcoma. Steroid administration or stress may lower the lymphocyte count in the blood stream.
- **Eosinophils-** Eosinophils are a special type of white blood cell common associated with allergies, parasitism, or foreign body reactions. Interestingly, they may also be elevated in Addison's disease.
- **Basophils-** Basophils are a rare type of white blood cell that function much like eosinophils. They are elevated in parasitic infections such as heartworms and hypersensitivity reactions.
- **Nucleated Red Blood Cell-** Normally red blood cells have no nucleus in circulation. They do have a nucleus when they are being made inside the bone marrow. In severe anemia, the bone marrow may release nucleated red blood cells, ie immature red blood cells, due to need. Nucleated red blood cells may show up in Feline Leukemia virus infected cats without concurrent anemia.
- **RBC-** RBC stands for red blood cell. RBC's are measured in cells per unit of blood. Red blood cell, erythrocyte, red corpuscle are all synonyms. Low red cells indicate anemia. A high red blood cell count may indicate dehydration, chronic respiratory disease, or polycythemia.
- **HCT/PCV-** HCT stands for hematocrits. PCV stands for packed cell volume. Both are interpreted the same. The number is a percent of whole blood that is red cell versus plasma. If the PCV is 40% that means that 40% of the blood is occupied by red blood cell mass and 60% is occupied by plasma.

- **HGB-** HGB stands for hemoglobin. This is the oxygen carrying molecule within red bloods. It is made of protein and iron. The iron in hemoglobin is what gives blood its red color.
  - **MCH-** MCH stands for mean corpuscular hemoglobin. This is the amount of hemoglobin in each red blood cell. MCH is low in iron deficiency because iron is required to make hemoglobin.
  - **MCHC-** MCHC stands for mean corpuscular hemoglobin concentration. This is the amount of hemoglobin per volume of cell cytoplasm. It is different from MCH in that it is a concentration of hemoglobin rather than an amount. A large red blood cell will have a higher MCH than a smaller one, but may have the same MCHC. MCHC is decreased in most anemias, especially iron deficiency. An increased MCHC indicates hemolysis or destruction of red blood cells.
  - **MCV-** MCV stands for mean corpuscular volume. This refers to the size of the red blood cell. In anemic patients, it should be elevated because less mature reds cells being turned out by the bone marrow are bigger than normal cells. Anemic patients without an increase in MCV may have a problem with bone marrow suppression.
  - **Platelets-** Platelets are bits of cytoplasm and protein in the blood that function in clotting. They are made by the bone marrow. They are the first part of the clotting process. Platelets will stop bleeding within a few minutes. Low platelets are caused by a number of disease processes. When platelets get too low, the patient will spontaneously bleed. High platelets occur in rare bone marrow diseases.
- **Urinalysis-** The urinalysis screens for diabetes mellitus, kidney disease, and urinary tract infections. Often the blood tests and the urine test results must be combined for the “big picture”. For instance, a high glucose in the blood with no glucose in the urine is likely a stress response. High blood and urine glucose is consistent with diabetes mellitus. The urinalysis also screens for other abnormalities in the urine such as crystals, excessive protein, mucus, abnormal cells, microbial organisms, blood, white cells, nitrates, and bilirubin.