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LIQUID GOLD PART 1 – THE PHYSICAL AND CHEMICAL EXAMINATION OF URINE PROVIDES INFORMATION FOR MUCH MORE THAN JUST THE URINARY SYSTEM

Introduction

Complete urinalysis should be performed every time a need to evaluate the renal system exists. However, the complete urinalysis is not only of value for evaluation of the renal system. The urinalysis can provide information about other body organ systems like the liver as well as help characterize underlying systemic acid-base abnormalities, the severity of diabetes and diabetic ketoacidosis as well as assisting in characterizing various hematologic abnormalities like hemolytic disease.

Routine urinalysis can easily and accurately be performed in a veterinary practice. There are different components of a complete urinalysis. The physical examination of the urine collected includes crude but important gross inspection of the urine. The chemical examination primarily consists of multiple tests performed on the classic dry reagent strip testing commonly known as the "Dip Stick" test. The microscopic examination consists of evaluation of the formed elements of a urine specimen and is something that should be performed in a short time following the collection of the urine specimen.

Urinalysis - physical examanation

The gross inspection of a urine specimen can provide significant information regarding any identifiable disease process involving the urinary system. Some of the more common or useful physical features of urine specimens are outlined briefly below.

Color: Color of the urine can provide potential insight into the various formed elements of the urine. For example, a red urine is most commonly seen when erythrocyte associated pigment, hemoglobin, is present in the specimen. This could include either cell-free hemoglobin present because of severe hemoglobinemia with subsequent hemoglobinuria or due to hemolysis of any formed erythrocytes present in the urine specimen. Additionally, red urine could merely be colored because of the presence of intact erythrocytes. In this latter situation, the supernatant of the urine should be clear following centrifugation where erythrocytes are forced into a pellet in the centrifuge tube. Brown-red colored urine may be seen associated with myoglobinuria or oxidized hemoglobinuria. Dark yellow colored urine may be seen associated with marked bilirubinuria.

Turbidity: Turbidity of any type of a fluid specimen is related to particular matter in that specimen. This particular matter could be lipid droplets in something like a lipemic serum or plasma specimen, intact cells like a whole blood specimen, or any other type of particular matter. Normal urine specimens typically are clear. With turbid urine specimens, the more commonly particles that give the urine a turbid appearance include bacteria, inflammatory cells, erythrocytes, and crystals.

Odor: A strong ammonia odor to a urine specimen may suggest breakdown of urea, which should be in relatively high concentrations in a normal urine specimen, into ammonia by urea splitting bacteria. This simple physical feature of a urine specimen may provide immediate information regarding underlying bacterial infection of the urinary tract.

Specific Gravity: Specific gravity is commonly estimated from the refractive index of a urine specimen with the use of a refractometer. The specific gravity is predicated upon the presence of a concentration of small solutes. It is used as a simple measure of the ability of the kidney to concentrate or dilute a urine specimen and in conjunction with the measurement of serum urea nitrogen or creatinine, proves essential in the classification / identification of "renal failure". Selected solutes in high concentration that normally should not be present in typical urine specimens may contribute slightly to the specific gravity / refractive index of the urine. The more commonly encountered "abnormal" solutes that may play this role include glucose and protein in relatively high concentrations.

Urinalysis - chemical examanation

Almost anything that can be measured in the serum or plasma of an animal with routing laboratory clinical chemistry methodologies can be measured in urine specimens. The most commonly performed chemical test in veterinary medicine is the simple dry chemistry reagent strip (Dip Stick). At first glance, this methodology appears to be quite crude. However, if one examines the technology closely and follows the instructions carefully, the volume of urine collecting on each of the reagent pad is very precise and the results obtained are relatively accurate. It is critical for some of the tests to read the color change result precisely on time suggested by the manufacturer for that particular test. If the reagent strips were maintained in a desiccant at room temperature as is suggested by the manufacturer and if the dipping process is followed correctly as the manufacturer suggests, the results are extremely valid. The primary problem that most people will encounter is when they are working with a urine specimen that is darkly colored red or brown-red. This coloration of the urine often interferes with accurate characterization of the color change taking place on the reagent strip. In this case, one must rely on back-up chemical testing procedures that are more labor intensive and more expensive than the reagent strip. These specialized chemical tests are not routine performed in a veterinary practice. These along with any other chemical testing of urine (urine creatinine, urine protein, electrolyte excretion, etc.) can be performed in most reference laboratory facilities. Some of the more common dry chemistry reagent strip tests are listed below with abbreviated comments on interpretation. Detailed information is typically provided with the individual strip information inserts to include comments regarding interfering substances and overall interpretation; review of this information is recommended.

pH – Multiple factors influence the pH of a urine specimen. Some of these include rate of renal excretion of hydrogen ions (H+), renal resorption of bicarbonate (HCO3-), sample age, and the presence of urea splitting bacteria causing an increase in pH. Knowledge of the urine pH may give insight into the overall metabolic acid-base status of an animal if electrolyte distributions in the plasma are not seriously abnormal; however, detailed evaluation of the acid-base status of an animal must depend upon plasma electrolyte concentrations and possible blood gas analyses. Knowledge of the urine pH may also be helpful in interpreting other components of the urine. For example, severely alkalotic urine samples with a pH > 8.0 may have significant disintegration of RBCs, WBCs and casts, which will make it difficult to identify these abnormal formed elements in a urine specimen. Crystal identification may be aided with the knowledge of the pH also. For example, struvite crystals will precipitate in alkaline urine but not acidic urine. If these crystals are suggested during a microscopic evaluation of the urine and the urine is acidic, it is extremely unlikely that the crystals are struvite and further investigation is required.

Protein – Protein determination in a urine specimen can be accomplished by different methods. The Dipstick pad for protein is extremely sensitive for albumin but relatively insensitive to globulins and for some globulins such as Bence-Jones proteins (light chains of immunoglobulins) the pads are almost completely insensitive. The test pad is dependent upon reaction of the amino groups of proteins to react with the color of the acid-base indicators in the pads. False positives are reported for significantly alkaline urine samples. Certain types of detergents (quaternary ammonium compounds) may cause false positive reactions also. False negatives are commonly seen with Bence-Jones proteinuria as was noted above. Interpretation of the dipstick protein pad must be made in light of other information about the urine. Conditions like inflammation of the urinary tract and hematuria may result in significant proteinuria but are not primary renal related conditions. The dipstick protein pad is used as a preliminary screen for proteinuria related to renal causes (glomerular or tubular). If the urine is not concentrated (or dilute), a 1+ protein result is considered significant; however, if the urine is concentrated, a 2+ protein result is required before any significance is suggested. Sulfosalicylic acid (SSA) precipitation test is commonly used in most reference laboratories to confirm proteinuria suggested by the dipstick result. There is some controversy regarding the sensitivity and specificity of both the dipstick protein pad and the SSA precipitation test; both should be considered screen semi-quantitative tests. True chemical determinations can be performed for more accurate protein quantitation and determination of the urine protein:urine creatinine ratio can help in assessing the degree of proteinuria present.

Glucose – Because of the ability of the proximal renal tubules for resorption of any plasma glucose that might make it through the glomerular filtrate, glucose

concentrations in urine in a clinically normal animal are extremely low and below the level of sensitivity for detection by the dipstick dry pad for glucose. True persistent hyperglycemia is associated with persistent or prolonged hyperglycemia in most cases; some cases of tubular dysfunction (Fanconi syndrome) may result in glycosuria without persistent hyperglycemia. False positive reactions with the dipstick pad for glucose may happen with exposure to formaldehyde, the use of outdated pads or the presence of hydrogen peroxide. False negative reactions can occur with high concentrations of ascorbic acid (inhibits the reaction pad) or some selected drugs like salicylates or tetracyclines.

Ketones – The ketone dipstick pad primarily measures the presence of acetoacetic acid and acetone; beta-hydroxybutyrate is not detected. The presence of measurable ketones in the urine indicates abnormalities in metabolism of fat (starvation or malnutrition, unregulated diabetes mellitus, sheep pregnancy toxemia, bovine ketosis, etc.). More sensitive qualitative tests for ketones are available if there is any slight or questionable result.

Bilirubin – Accurate measurement of the Bilirubin pad on the dipstick is often difficult because the degree of change in color is relatively subtle and the yellow discoloration of the urine sample with Bilirubin interferes with accurate detection of these subtle changes. Interpretation is different with different species. The dog has a low renal threshold for Bilirubin; therefore, Bilirubin is present and identified as a trace to 1+ result in most canine urine samples. Significantly concentrated canine urine samples have 2+ bilirubinuria as well as the presence of Bilirubin crystals in the urine even when there is no Hyperbilirubinemia. The cat on the other hand has a high threshold for Bilirubin and essentially any detection of Bilirubin in the urine of cats is significant. Significant bilirubinuria is used to support cholestasis or hemolytic disease. False negative Bilirubin results are possible with old urine samples because of degradation (hydrolysis) of conjugated Bilirubin or because of conversion of Bilirubin to Biliverdin when exposed to UV light. Also, high concentrations of vitamin C can inhibit the reaction pad giving a false negative result. Back-up qualitative tests for Bilirubin are available if there is any question in the result from the dipstick.