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**Lecture Title : Examination of Urine : Physical, Chemical**

## Introduction

Hello and welcome to yet another module on physical education. Today we will be discussing about the physical characteristics of urine and how one can learn more about the state of the body by examination of the urine.

Clinical urine tests are various tests of urine for diagnostic purposes. The most common is a urinalysis (UA), one of the most common methods of medical diagnosis. The word is a portmanteau of the words urine and analysis. Other tests are urine culture (a microbiological culture of urine) and urine electrolyte levels.

The target parameters that can be measured or quantified in urinalysis include naked-eye (gross) examination for color and smell plus analysis for many substances and cells, as well as other properties, such as specific gravity.

A part of a urinalysis can be performed by using urine test strips, in which the test results can be read as color changes. Another method is light microscopy of urine samples.

## The Visual Examination

During the visual examination of the urine, the laboratorian observes the urine's color and clarity. These can be signs of what substances may be present in the urine. They are interpreted in conjunction with results obtained during the chemical and microscopic examinations to confirm what substances are present.

Urine test results should always be interpreted using the reference range provided by the laboratory that performed the test, or using information provided by the test strip/device manufacturer.

In addition to various substances, other tests include a description of color and appearance.

Color

The following are examples of color change causes and not a complete listing.

Nearly colorless: Excessive fluid intake for conditions; untreated diabetes mellitus, diabetes insipidus, and certain types of nephritis.

Yellow: Distinctly yellow urine may indicate excessive riboflavin (vitamin B2) intake.

Yellow-amber: Normal.

Yellow-cloudy: excessive crystals (crystalluria) and/or excessive pus (pyuria).

Orange: Insufficient fluid intake for conditions; intake of orange substances; intake of phenazopyridine for urinary symptoms.

Red: Leakage of red blood cells or of hemoglobin from such cells; intake of red substances.

Dark Reddish-orange: Intake of certain medications or other substances.

Rusty-yellow to reddish-brown: Intake of certain medications or other substances.

Dark brown: Intake of certain medications or other substances; damaged muscle (myoglobinuria) from extreme exercise or other widespread damage; altered blood; intake of phenolic substances; inadequate porphyrin metabolism; melanin from melanocytic tumors.

Brown black to black: Intake of substances or medications; altered blood; a problem with homogentisic acid metabolism (alkaptonuria), which can also cause dark whites of the eyes and dark-colored internal organs and tissues (ochronosis); Lysol (a product that contains phenols) poisoning; melanin from melanocytic tumors); paraphenylenediamine is a highly toxic ingredient of hair dye

formulations that can cause acute kidney injury and result in black urine.

Magenta to purple-red: Presence of phenolphthalein, a stimulant laxative previously found in Ex-Lax.

Green, or dark with a greenish hue: Jaundice (bilirubinuria); problem with bile metabolism. Recent surgery requiring high doses of propofol infusion. The use of a medication (Uribel) that is similar to phenazopyridine for the relief of urinary symptoms.

Other colors: Various substances ingested in food or drink, particularly up to 48 hours prior to the presence of colored urine.

Urine can be a variety of colors, most often shades of yellow, from very pale or colorless to very dark or amber. Unusual or abnormal urine colors can be the result of a disease process, several medications (e.g., multivitamins can turn urine bright yellow), or the result of eating certain foods. For example, some people can have red-colored urine after eating beets; the color is from the natural pigment of beets and is not a cause for worry. However, red-colored urine can also occur when blood is present in the urine and can be an indicator of disease or damage to some part of the urinary system. Another example is yellow-brown or greenish-brown urine that may be a sign of bilirubin in the urine

Odor

The odor (scent) of urine can normally vary from odorless (when very light colored and dilute) to a much stronger odor when the person is dehydrated and the urine is concentrated. Brief changes in odor are usually merely interesting and not medically significant. (Example: the abnormal smell many people can detect after eating asparagus.) The urine of diabetics experiencing ketoacidosis (urine contains high levels of ketone bodies) also may also have an abnormal odor.

Clarity

urine clarity refers to how clear the urine is. Usually, laboratories report the clarity of the urine using one of the following terms: clear, slightly cloudy, cloudy, or turbid. "Normal" urine can be clear or cloudy. Substances that cause cloudiness but that are not considered unhealthy include mucus, sperm and prostatic fluid, cells

from the skin, normal urine crystals, and contaminants such as body lotions and powders. Other substances that can make urine cloudy, like red blood cells, white blood cells, or bacteria, indicate a condition that requires attention.

## The Chemical Examination

To perform the chemical examination, most clinical laboratories use commercially prepared test strips with test pads that have chemicals impregnated into them. The laboratorian dips the strip into urine, chemical reactions change the colors of the pads within seconds to minutes, and the laboratorian determines the result for each test. To reduce timing errors and eliminate variations in color interpretation, automated instruments are frequently used to "read" the results of the test strip.

The degree of color change on a test pad can give an estimate of the amount of substance present. For example, a slight color change in the test pad for protein may indicate a small amount of protein present in the urine whereas a deep color change may indicate a large amount.

The chemical examination is often done in conjunction with or may be followed by a microscopic examination of the urine if there are any abnormal results. Results from both sets of tests are then considered together for interpretation. Abnormal findings may be followed by additional urine and/or blood tests.

The most frequently performed chemical tests using reagent test strips are:

Specific Gravity (SG)

pH

Protein

Glucose

Ketones

Blood (hemoglobin) and Myoglobin

Leukocyte Esterase

Nitrite

Bilirubin

Urobilinogen

Some reagent test strips also have a test pad for ascorbic acid (vitamin C).

Specific Gravity (SG): Specific gravity is a measure of urine concentration. This test simply indicates how concentrated the urine is. Specific gravity measurements are a comparison of the amount of substances dissolved in urine as compared to pure water. If there were no substances present, the specific gravity of the urine would be 1.000 (the same as pure water). Since all urine has some substances in it, a urine SG of 1.000 is not possible. If a person drinks excessive quantities of water in a short period of time or gets an intravenous (IV) infusion of large volumes of fluid, then the urine specific gravity may be very close to that of water. The upper limit of the test pad, a specific gravity of 1.035, indicates concentrated urine, one with many substances in a limited amount of water.

Knowing the urine concentration helps healthcare practitioners understand whether a urine specimen they are evaluating is the best one to detect a particular substance. For example, if they are looking for very small amounts of protein, a concentrated morning urine specimen would be the best sample.

pH: As with specific gravity, there are typical but not "abnormal" pH values. The urine is slightly acidic, about pH 6, but can range from 4.5-8. The kidneys play an important role in maintaining the acid-base balance of the body. Therefore, any condition that produces acids or bases in the body, such as the acidosis or alkalosis, or the ingestion of acidic or basic foods can directly affect urine pH.

Some of the substances dissolved in urine will precipitate out to form crystals when the urine is acidic; others will form crystals when the urine is basic. If crystals form while the urine is being produced in the kidneys, a kidney stone or "calculus" can develop. By modifying urine pH through diet or medications, the formation of these crystals can be reduced or eliminated.

Protein:The protein test pad provides a rough estimate of the amount of albumin in the urine. Albumin makes up about 60% of the total protein in the blood. Normally, there will be no protein or a small amount of protein in the urine. When urine protein is elevated, a person has a condition called proteinuria.

Proteinuria may occasionally be seen in healthy individuals. Healthy people can have temporary or persistent proteinuria due to stress, exercise, fever, aspirin therapy, or exposure to cold, for example. Repeat testing may be done once these conditions have resolved to determine whether the proteinuria is persistent.

If trace amounts of protein are detected, and depending on the person's signs, symptoms and medical history, a repeat urinalysis and dipstick protein may be performed at a later time to see if there is still protein in the urine or if it has dropped back to undetectable levels.

If a large amount of protein is detected on a urinalysis and/or if the protein persists in repeated tests, a 24-hour urine protein test may be used as a follow-up test. Since the dipstick primarily measures albumin, the 24-hour urine protein test also may be ordered if a healthcare practitioner suspects that proteins other than albumin are being released into the urine.

Protein in the urine may be a sign of kidney disease. Small amounts of albumin may be found in the urine when kidney dysfunction begins to develop. A different test called a urine albumin test detects and measures small amounts of albumin in the urine. The urine albumin test is more sensitive than a dipstick urinalysis and is routinely used to screen people with chronic conditions that put them at risk for kidney disease, such as diabetes and high blood pressure.

Proteinuria may also be associated with many other diseases and conditions. A healthcare practitioner may order other types of follow-up tests to help determine the cause of protein in the urine.

Glucose: Glucose is normally not present in urine. When glucose is present, the condition is called glucosuria. It results from either:

An excessively high glucose level in the blood, such as may be seen with people who have uncontrolled diabetes

A reduction in the "renal threshold;" when blood glucose levels reach a certain concentration, the kidneys begin to eliminate glucose into the urine to decrease blood concentrations. Sometimes the threshold concentration is reduced and glucose enters the urine sooner, at a lower blood glucose concentration.

Some other conditions that can cause glucosuria include hormonal disorders, liver disease, medications, and pregnancy. When glucosuria occurs, other tests such as a fasting blood glucose are usually performed to further identify the specific cause.

Ketones: Ketones are not normally found in the urine. They are intermediate products of fat metabolism. They are produced when glucose is not available to the body's cells as an energy source. They can form when a person does not eat enough carbohydrates (for example, in cases of fasting, starvation, or high-protein diets) or when a person's body cannot use carbohydrates properly. When carbohydrates are not available, the body metabolizes fat instead to get the energy it needs to keep functioning. Strenuous exercise, exposure to cold, frequent, prolonged vomiting, and several digestive system diseases can also increase fat metabolism, resulting in ketonuria.

In a person who has diabetes, ketones in urine may also be an early indication of insufficient insulin. With insufficient insulin, a diabetic cannot process glucose and instead metabolizes fat. This can cause ketones to build up in the blood, resulting first in ketosis and then progressing to ketoacidosis, a form of metabolic acidosis. Excess ketones and glucose are dumped into the urine by the kidneys in an effort to flush them from the body. This condition, called diabetic ketoacidosis (DKA), is most frequently seen with uncontrolled type 1 diabetes and can be a medical emergency.

### Blood (Hemoglobin) and Myoglobin

This test is used to detect hemoglobin in the urine (hemoglobinuria). Hemoglobin is an oxygen-transporting protein found inside red blood cells (RBCs). Its presence in the urine indicates blood in the urine (known as hematuria).

A small number of RBCs are normally present in urine and usually result in a "negative" chemical test. An increased amount of hemoglobin and/or increased number of RBCs are detected as a "positive" chemical test result. Results of this test are typically interpreted along with those from the microscopic examination of the urine to determine whether RBCs are present in the urine. A positive result on this test with no RBCs present may indicate the presence of hemoglobin in the urine (which can occur when RBCs have broken apart) or myoglobin from muscle injury.

Blood in the urine is not a normal finding, but it is not uncommon and not necessarily a cause for alarm. Your healthcare practitioner will investigate further to try to determine the source and underlying cause of the blood and may request repeat testing to determine whether the blood is persistent.

## Conclusion

So in this episode we have done a detailed  demonstration of the various chemical properties of urine, the various physical properties of urine and how the various examination techniques can give an insight into the health of a person. I hope the information that was provided in this module was of some use to all of you. Thank you so much for watching.