Analysis of urine samples using chemstrips

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Introduction

The urinary system, composed of two kidneys, two ureters, one bladder, and one urethra, plays an important role in removing waste from fluid found in the bloodstream to regulate the volume and composition of blood through the production and excretion of urine. The kidneys filter toxins, metabolic waters, and excess ions to leave the body in urine while returning needed substances to the blood [1] . Kidneys also function to maintain homeostatic balance of water and salts, and acids and bases throughout the body.

Urine formation in the kidneys is a result of three processes: filtration, reabsorption, and secretion [2] . The glomerulus handles the first passive process of filtration. The blood passes from the glomerular bed into the glomerular capsule. Once the blood has been filtered, the filtrate then moves into the convoluted tubule where reabsorption and secretion begin to take place. During reabsorption, parts of the filtrate may move back into the blood through capillaries. There are two main methods to reabsorb parts of the filtrate: passive transport, mainly seen via osmosis, and active transport, most substances reabsorbed using this method. The substances that will be reabsorbed into the bloodstream depends on the specific needs of the body at that time. Secretion is the opposite process of reabsorption. Substances, such as hydrogen, potassium ions, and creatinine [2] move from the bloodstream via capillaries through the tubular cells to be disposed of in the form of urine.

The composition of urine can fluctuates and differs for individuals based on their dietary intake of food and water, as well as their metabolic activity. Urine is composed of mostly water mixed with various substances, such as, but not limited to, urea, uric acid, and creatinine. Testing and analyzing urine, also known as a urinalysis, can provide clues to many diseases and information about your overall heath in a cost effective and non-invasive assessment. Urinalysis may be done during a routine physical examination to screen for disease or infection of the urinary tract, but urinalysis is also used to monitor the treatment of certain conditions such as diabetes, kidney stones, urinary tract infections, and kidney disease.

The goal of this experiment was to analyze three urine samples, one being a normal urine sample and two unknown samples labeled as “ Mr. Black” and “ Mr. Green”, for various macroscopic and chemical characteristics to determine if either unknown sample had any medication conditions. It is hypothesized that “ Mr. Green’s” urine sample will come back with abnormal substance levels based on the physical appearance when compared to the normal sample and “ Mr. Black” will have a urine sample similar to the normal sample.

Materials and Methods

The materials used in the current study were three pre-prepared urine samples, Chemstrips, Clinitest tablets, stopwatch, three test tubes, a test tube rack, pipettes, and gloves. Ten milliliters of each urine sample were collected into labeled test tubes and macroscopic observations of color, transparency, and odor were recorded for each sample. Three Chemstrips, each strip containing ten section with different test reagents, were obtained

and placed on labeled paper towels according to each sample. The Chemstrips tested for the pH, specific gravity which shows the relative proportions of dissolved solids in relationship to the total volume of the urine, nitrites, glucose, albumin (protein), ketone bodies, red blood cells and hemoglobin, bilirubin, leukocytes, and urobilinogen.

Beginning with the normal urine sample, a pipette was used to place one drop of urine on each test section. A stopwatch timed the experiment for sixty seconds to allow ample time for the urine to react with each testing reagent. This procedure was repeated for the “ Mr. Green” and “ Mr. Black” unknown samples. At the end of sixty seconds, the excess urine on the Chemstrips was blotted off and each Chemstrip was analyzed using the accompanying chart. If glucose was found to be present in any sample, a Clinitest was performed. For the Clinitest, a pipette was used to obtain five drops of the sample found to have glucose present using the Chemstrip. These five drops of urine were added to a test tube alone with ten drops of water. A Clinitest tablet was then added to the urine-water mixture and the results were compared to the accompanying chart to determine the exact glucose levels.

Results

Observation/ Test	Normal	Unknown #1 – Mr. Green	Unknown #2 – Mr. Black
Color	Pale yellow	Green-yellow	Clear, very pale
Transparency	Clear	Cloudy	Clear, very pale

Odor	Not much of a smell	A little sulfuric	No smell
pH	7	9	5
Specific Gravity	1. 015	1. 000	1. 025
Nitrites	Absent	Absent	Absent
Glucose	Negative	Negative	Positive – 1, 000 mg/dL
Clinitest	——————————–	——————————–	1% Glucose level (high)
Albumin (protein)	Absent	100 ++	Absent
Ketone	Negative	Negative	Present – Large
RBC/He	Negative	Positive ~250	Negative
Bilirubin	Negative	Negative	Negative
Leukocytes	Absent	Present (trace)	Absent
Urobilinogen	Absent	Absent	Absent

Table 1. Macroscopic and chemical results obtained from three urine samples using Chemstrips.

It was found that “ Mr. Green” had albumin, red blood cells/hemoglobin, and leukocytes present in his urine sample. “ Mr. Black” had glucose and ketones present in his sample.

Conclusions/Clinical Implications

The experimental results support the hypothesis that “ Mr. Green’s” urine sample will come back with abnormal substance levels based on the physical appearance when compared to the normal sample. However, “ Mr. Black’s” urine sample was not similar to the normal urine sample. “ Mr. Green’s” urine sample showed albumin, red blood cells/hemoglobin, and leukocytes, with a slightly below average specific gravity. It can be inferred from his urinalysis that because “ Mr. Green” had albumin (protein) present that he may be suffering from raised blood pressure, renal disease, or a urinary tract infection. Albumin is the most abundant protein found in the blood and its presence in “ Mr. Green’s” urine sample indicates that this large protein has been able to pass through the glomerular filtration membrane. “ Mr. Green” may have suffered from kidney trauma, ingestion of poisons or heavy metals, bacterial toxins, glomerulonephritis, or hypertension, all of which would allow albumin to pass into the urine [2] . The presence of both red blood cells and leukocytes in “ Mr. Green’s” urine indicate infection of the urinary tract because neither molecule should be able to be secreted into the urine due to their large size. Finally, the lower specific gravity found in “ Mr. Green’s” urinalysis occurs because the higher protein levels pushes more water across into the urine, causing the concentration of dissolved solutes to show a lower value.

The experimental results of “ Mr. Black’s” urine sample disagree with the initial hypothesis that his urine would be similar to the normal sample. “ Mr. Black” had high glucose levels and ketones present in his urinalysis. The large presence of glucose found in “ Mr. Black’s” urine indicates a Diabetes Mellitus. Normally, blood sugar levels are maintained between 80 – 100 mg/100 mL of blood. The extremely high glucose seen in “ Mr. Black’s” urine indicate that normal physiological and hormonal mechanisms cannot clear the glucose from the blood quickly enough [2] . A Clinitest confirmed that “ Mr. Black” had 1% glucose levels in his blood. Under these conditions of high glucose levels, “ Mr. Black’s” body will increase its metabolism of fats and the excess glucose is secreted out of the bloodstream and into urine. The presence of ketones in “ Mr. Black’s” urine confirms the diagnosis of Diabetes Mellitus because higher levels of ketone in the urine indicates a condition called Ketonuria, where the intermediate products of fat metabolism are found in abnormal amounts in the urine. Ketonuria coupled with finding glucose in the urine is generally a diagnosis for Diabetes Mellitus [2] .

The methodology of the experiment could leave less room for error or misinterpretation by testing urine samples of individuals that have been confirmed to have the diseases suggested by the Chemstick testing of both “ Mr. Green” and “ Mr. Black” to their original samples. This would allow their clinical diagnosis to be confirmed. Alternatively, an experiment could be developed to test both men’s urine at various points throughout the day to confirm the diseases the two individuals are suggested to have since the composition of urine varies based on diet and metabolic activity.

Works Cited

1. Marieb, E. N. and Hoehn, K. 2009. Human Anatomy & Physiology, 9th edition. Pearson Benjamin Cummings Publishing. 279-292pp.

2. Marieb, E. N. and Hoehn, K. 2009. Human Anatomy & Physiology Laboratory Manual, 10th edition. Pearson Benjamin Cummings Publishing. 236-237pp