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Can we Self-Examine Human Urine? A Non-Invasive Biomarker for Critical Diseases

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ABSTRACT

Critical disease diagnosis often involves invasive procedures like biopsies or blood draws, which are uncomfortable, costly, and carry risks. Routine urinalysis self-test is a non-invasive biomarker and is one of the important diagnostic tools which may indicate or provide informations of some critical issues like infections, kidney disease, nephritis, chronic renal fibrosis, diabetes and cancer for early diagnosis and treatment. Urine-based human papillomavirus (HPV) testing, when combined with advanced DNA purification and concentration technologies, offers a promising alternative to traditional detection of cervical cancer screening. Urine has emerged as an alternative specimen, as demonstrated by urine lipoarabinomannan (LAM) testing. All the parameters in normal urinalysis if found in abnormally high or low, it is an advisory for further tests in the concerned issue. This article will focus urine's potential as a non-invasive biomarker for various diseases as a cost-effective diagnostic tool.

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Introduction

Our normal human urine is a liquid waste that our kidneys make to remove excess fluids and waste materials from our body. Urine mostly consists of water and waste materials as well as salt and electrolytes. Other constituents include urea, chloride, creatinine and inorganic and organic compounds. Normal human urine is pale yellow in colour and has mild odour. Usually, our kidneys produce 1000-1500mL of urine in 24 hours with a pH value ranging from 4.5 to 8.0 (acidic and alkaline). Acidity (pH) is a measure of the amount of acid in the urine. Urine is a highly sensitive and non-invasive biomarker and has the potential to provide valuable information about a wide range of diseases. Self-urine examination can be used to identify various health abnormalities, including renal, metabolic, and infectious diseases [1,2]. The solute components present in urine include urea, chloride (Cl⁻) sulphate (SO₄²⁻), sodium (Na⁺), ammonia/ammonium (NH₃/NH₄⁺), potassium (K⁺), phosphate (PO₄³⁻), magnesium (Mg²⁺), calcium (Ca²⁺) and creatinine. The human urine comprises of various amino acids, including alanine, aspartate, asparagine, arginine, cysteine, cystine, glutamate, glutamine, histidine, lysine, glycine, isoleucine, phenylalanine, leucine, proline, methionine, valine, serine, tyrosine, threonine, and tryptophan respectively. Urinalysis has proven to be a valuable tool in monitoring and diagnosing various neurological disorders also. Many biomarkers such as beta amyloid, alpha-synuclein, and myelin basic protein (MBP) have been detected in the urine of individuals with Alzheimer's disease, Parkinson's disease, and multiple sclerosis, respectively. These biomarkers serve as important indicators for these diseases' diagnosis and progression tracking [3,4].

The pH value of human urine is very significant. A pH that is above normal may be a sign of kidney stones, urinary infections, kidney problems, or other disorders. Protein is an important building block in the body. Everyone has protein in their blood. But it should only be

present in our blood, not our urine. Our kidneys play a role in this process. Healthy kidneys remove waste products and extra water from our blood, but leave behind the things our body needs, like protein. When kidneys are injured, protein leaks into our urine. Having protein in our urine suggests that our kidney's filtering units are damaged by kidney disease. Glucose is usually a sign of diabetes. White blood cells known as pus cells also are signs of infection. Bilirubin is a waste product from the breakdown of old red blood cells. They are normally removed from the blood by the liver. The presence of protein, glucose, pus cells, bilirubin and red blood cells in the urine may be a sign of infections or critical diseases in liver, kidney, prostatitis and urinary tract infections (UTI) respectively [5-7]. Finding blood in the urine requires further testing. It does not mean always that we have a serious medical problem. In addition to the dipstick test, urine may also be evaluated with a visual examination. The urine will be looked at for colour and clearness. Blood may make urine look red or the colour of tea or cola. An infection may make urine look cloudy. Foamy urine can be a sign of kidney problems. Urinalysis also done using microscopic examination. A small amount of urine will be looked at under a microscope to check for things that do not belong in normal urine that cannot be seen with the naked eye, including red blood cells, white blood cells (pus cells), bacteria (germs), or crystals (which are formed from chemicals in the urine and may eventually get bigger and become kidney stones). In a nutshell, urinalysis holds promise as a non-invasive method for detecting and monitoring neurological disorders also, with identifying specific biomarkers providing valuable insights into the diagnosis and progression of these conditions [8-10].

Discussion:

We can self-examine our urine by following few abnormal characteristics which we usually neglect or focus carefully. These characteristics are flow of urine, colour, odour, sedimentation, formation of foam in urine, presence of sugar and sudden pain or irritation during passing urine etc. Human urine is a highly effective and non-invasive, yet rich source of information

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for diagnosing and monitoring numerous chronic diseases. Because urine is a filtrate of the blood, it contains thousands of metabolites, proteins, and cells that can be a signal for long-term health issues. If we follow and monitor irregular flow of urine compared to usual flow as well as amount of urine excreted and feeling uncontrollable pressure to pee in each 2-3 hours for more than a month, we should see a urologist without further delay. The symptoms indicate beginning of prostate gland enlargement, known as "*Benign Prostate Hyperplasia*" (BPH), development of kidney stone, urinary tract infections (UTI). UTI usually happens due to bacterial infections (*E. coli* bacteria) and its probabilities are maximum whenever we use public wash rooms and poor-quality unfiltered drinking water. Women are most affected in this issue and it is advisable to keep "*Ethanol spray*" with them for apply in the toilet before they use. If we see change in colour of our urine for a period of two to three weeks with change in odour and feeling irritation, our urinary bladder may be infected and could result development of RBC (Red Blood Cells) in the urine. Also, possibilities of UTI cannot be overruled. Finding sedimentation and foamy urine for a period of three to four weeks of time could be due to discharge of "*Albumin*" (Protein) which could be the development of "*Nephritis*". Under these circumstances, we must see our urologist and consult without delay. To check, presence of sugar as sediments in urine, we may monitor our urine by keeping our toilet unflashy for at least one hour and see the results. Usually, ants start gathering at the sedimented areas of urine. If we start feeling light to moderate pain during passing of urine for a period of two weeks while no other abnormality is seen (colour, odour etc), it could be the development of kidney stone or symptoms of kidney diseases.



Figure 1: Samples of infected and normal urine.



Figure 2: Urinalysis in laboratory.

If we observe these symptoms, our first duty is to perform "Urine for RE" (routine examination) in a reputed laboratory. If the results are within the usual reference values, we don't need to worry. We may keep hydrating ourselves so as to normalise the irritation, and slight colour change found in urine. If irregularities or abnormal results are observed, there could be many diseases that can be identified with some more advanced tests like USG, KFT (Kidney Function Test) and PET (Positron Emission Transmission)-CT scan according to the advices of a urologist. Some diseases which are diagnosed preliminarily by the urine RE test are: *chronic kidney disease* (CKD). RE-Urine testing (especially 24-hour collection) is crucial for detecting protein leakage

(proteinuria) and elevated creatinine levels, which are early markers of kidney damage. The presence of glucose or ketones can signal uncontrolled diabetes or prediabetes. Specific urinary metabolites if found in RE test (trimethylamine-*N*-oxide) and proteins (albumin, angiostatin), it could be the biomarkers for high blood pressure and heart disease risk. RE-Urine tests can detect markers for bladder, kidney, and prostate cancer, often before symptoms appear. The presence of blood (more than 10 cells of RBC) in urine could be early signs of prostatitis, tumours in urinary bladder and prostate cancer. In this case, we need to repeat the same test twice in a month and report to our urologist for further investigations. In this context, this is to be noted that in case of women, the presence of RBC (up to 5-6 cells) are normal due to their menstruation. Modern research studies are going on to detect early symptoms of diseases like Alzheimer's (beta-amyloid) and Parkinson's (alpha-synuclein) in RE of urine. Chronic, low-level inflammations associated with diseases like arthritis or chronic obstructive pulmonary disease (COPD) can be detected in RE-Urine through the presence of markers such as desmosine and cytokines in the urine.

We can presume or identify potential diseases based on changes in the colour, smell, and rate of flow of our urine, as these are often early warning signs of health conditions. While changes can sometimes be caused by diet or medications, persistent changes often indicate issues with the kidneys, liver, or metabolic system. While passing urine in our daily life just watch few things which will certainly help us to self-identify initiation of diseases. Clear to pale yellow colour of urine usually indicates proper hydration while dark yellow/amber colour indicates dehydration, causing the kidneys to concentrate urine. Red or pink colour may indicate blood in the urine (known as haematuria), which can be signal of urinary tract infections (UTIs), kidney stones, prostatitis or bladder/kidney cancers. Dark brown/tea-coloured urine suggests liver disease (hepatitis, cirrhosis) or severe muscle breakdown (rhabdomyolysis). Orange colour may indicate liver dysfunction or bile duct issues. Green or blue colour (which is very rare) can indicate a bacterial infection (*Pseudomonas*) or metabolic disorders. Like colour, the smell of the urine also very much informative. Strong ammonia smell indicates dehydration or a UTI. Sweet or fruity odour can be a sign of diabetes or a metabolic disorder. Foul or unpleasant odour indicates presence of pus cells in urine or UTI, or in rare cases, specific genetic metabolic disorders. Another very important point to be noted is "*Rate of flow and volume*" of urine. Slow stream and difficulty in urinating may suggest an enlarged prostate (BPH) in men, or an obstruction in the urethra. Weak stream and dribbling in urine can indicate bladder outlet obstruction. Frequent urination (2 hourly) indicates a potential sign of diabetes, UTI, or an overactive bladder. Sometimes we have temporary changes in colour of urine. This is primarily caused by intake of certain foods in our diet or dietary supplements (beet root) or vitamins. In a very recent development, it has been learnt that scientists at the University of Texas at Arlington, Chan-Zuckerberg Bio hub, and Stanford University, studying the RNA (a type of genetic material) and other substances within urine sample can show changes in cell types, revealing early signs of cancer and other diseases [11].

When to see a doctor?

If changes in colour or smell persist for more than a few weeks, or if they are accompanied by pain, burning, fever, or swelling in hands/feet, we should consult a doctor for a urinalysis. Before visiting a doctor, self-analysis is also very crucial. We should consult the test values with the standard reference values of all the parameters and constituents of urine that includes values of salutes, amino acids, Hb% and pus cells specifically. Any abnormalities should be immediately reported to the medical professional without delay in order to save our life because we all know kidney diseases are silent killers. Unlike blood tests, urine collection is painless and easy, making it ideal for regular monitoring. RE-Urine testing serves as a cornerstone of preventive medicine, helping to manage chronic conditions and prevent them from becoming more critical.

Conclusion:

Urine holds great promise as a non-invasive biomarker for a wide range of human diseases. Its abundance, ease of collection, and stability make it an ideal specimen for biomarker analysis. Moreover, urine composition provides valuable insights into the body's metabolic state, making it a rich source of diagnostic and prognostic information. Numerous studies have demonstrated that urine contains diverse biomolecules, including proteins, peptides, lipids, nucleic acids, and metabolites, which can serve as biomarkers for conditions like cancer, diabetes, cardiovascular diseases, and kidney diseases. Various analytical techniques, such as mass spectrometry, nuclear magnetic resonance, and immunoassays, can detect these biomolecules. Additionally, urine-based biomarkers offer several

advantages over conventional blood-based biomarkers. Urine samples can be collected non-invasively and are less influenced by factors like circadian rhythm, stress, and meal consumption. Furthermore, urine samples can be stored for extended periods without significant degradation, making them invaluable for longitudinal studies. In conclusion, urine represents a promising biological fluid that can serve as a non-invasive biomarker for various human diseases. The development of urine-based biomarkers has the potential to revolutionize disease diagnosis, prognosis, and personalized medicine. Further research is warranted to discover novel biomarkers and validate their clinical utility across different diseases.

Data Record & Availability:

Corresponding author has all the case study laboratory urine RE-results and observations are based on these markers. These data can be available from the authors on request.

Conflict of Interest:

Both the authors declare that there is no conflict of interest

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