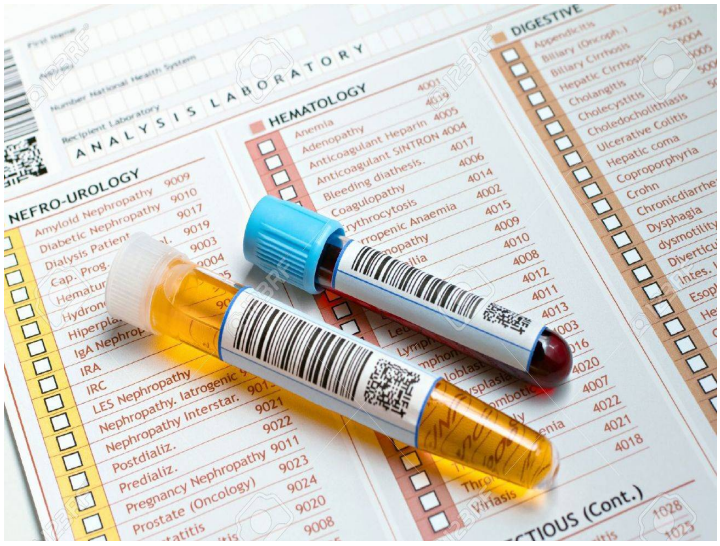
How to interpret your urine sample results



Chronic UTI Info Factsheet Series

Once you have submitted your urine sample for analysis, it will be sent off to the local laboratory or hospital laboratory if you are an in-patient/outpatient. The standard length of time for a laboratory culture analysis is around 18-24 hours and the sample may not immediately be sent to the laboratory but rely on a once daily collection from the GP surgery.

How your urine is analysed in the laboratory:

1. Appearance
2. Analysis by dipstick
3. Urine microscopy
4. Incubation on a petri dish for bacterial/yeast growth
5. Final report produced for GP and patient

1. Appearance

When it arrives, your sample will be analysed by its appearance (colour, cloudiness, smell), another dipstick check carried out and finally, macroscopic analysis.

Normal urine is usually a light yellow in colour and clear without any cloudiness. Any change in this can show:

- ✓ a possible infection (cloudy urine),
- ✓ dehydration (dark urine colour)
- ✓ red blood in the urine, also referred to as hemaeturia (for women this can be due to menstrual blood)
- ✓ liver disease (urine can look the colour of tea)
- ✓ breakdown of muscle (orange or tea coloured urine).

Certain medications, foods and vitamins (Vitamin D) can also change the colour. Very foamy urine may represent large amounts of protein in the urine (proteinuria).

2. Dipstick Analysis

Another dipstick is applied to the urine (as your GP will have done in the surgery) to check for signs of infection or inflammation (white and/or red blood cells, protein and nitrates) including the pH of the urine. Additionally, the dipstick reagent pads test for the presence of Bilirubin, Urobilinogen, Ketones and Glucose.

Urine pH

This is usually lower being slightly acidic. This is due to the normal daily acid production in the body to maintain an acid-base balance in the body. Therefore, any abnormalities in the acid-base balance in the body has a direct effect on urinary pH levels.

These levels are particularly useful in the evaluation of stones, crystals or infection. For example, in a patient with a kidney stone, the urinary pH level is helpful when trying to distinguish between different types of stone.

People with a UTI due to Proteus and Klebsiella typically have alkaline urine whereas bacteria such as e-coli are usually found in a more acidic environment. This pH will also be noted on the report. However, pH is also affected by diet; a high protein intake can give rise to acidic urine, whereas a high intake of dairy products or vegetables can give rise to alkaline urine.

Bilirubin and urobilinogen

Bilirubin is a chemical produced when red blood cells are broken down. It is transported in the blood to the liver, where it is processed and excreted into the gut as a constituent of bile. In the gut, bacteria act on the bilirubin to transform it into urobilinogen. It is usual for urine to contain urobilinogen but not bilirubin. Bilirubin in the urine may be an indicator of a breakdown of red blood cells. It may not be effectively removed by the liver, which may suggest liver disease or a problem with drainage of bile into the gut, such as gall stones.

Ketones

These are chemicals that are formed during the abnormal breakdown of fat and are not normal constituents of urine. Breakdown of fat may result from prolonged vomiting, fasting or starvation; individuals on a diet or who present with diarrhoea and vomiting may have a positive result. Ketones can also be present in the urine of people with poorly controlled diabetes.

This can make the blood more acidic and is known as diabetic ketoacidosis; it should be reviewed urgently by a doctor. Some medications, such as captopril, may also produce a false positive result (Steggall, 2007).

Glucose

Glucose in the urine (glycosuria) can occur in pregnancy or patients taking corticosteroids. It may also be indicative of diabetes mellitus but is not a normal constituent of urine. Although glycosuria is an indication of endocrine abnormality, it is not diagnostic and further investigation, such as fasting blood tests, may be required.

Protein

Protein in the urine may be a sign of kidney disease. 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.

Small amounts of albumin may be found in the urine when kidney dysfunction begins to develop. If it is felt necessary the laboratory may request that a further more detailed Urine Albumin test be carried out by the GP or hospital. 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.

Nitrates

Urine will contain a certain amount of nitrate sometimes down to foodstuffs but, in a normal urine sample, this type of nitrite will be indicated as 'absent' or 'not present' on a dipstick. But, in certain instances, nitrates can be indicated as being 'present' or "+". The commonest occurrence of positive nitrites in urine is in the presence of bacteria which convert the non-ionic nitrate into nitrite. Organisms where nitrates would be shown as positive on dipstick include certain species of E.coli, Klebsiella, Proteus or Pseudomonas. These are classified as gram negative bacteria (more can be found in this document regarding the identification of gram positive and gram negative bacteria during incubation on a petri dish).

3. Microscopic Examination

Once this dipstick check has been carried out, a microscopic examination is the next step using urine sediment. The urine sample is centrifuged (spun) to concentrate the substances in it at the bottom of a tube. The fluid at the top of the tube is then disposed of and the drops of fluid remaining are examined under a microscope and the following will be noted on your urine sample report:

Red Blood Cells (RBCs)

Normally, a few RBCs are present in urine. Inflammation, injury, or disease in the kidneys or elsewhere in the urinary tract, for example in the bladder or urethra, can cause RBCs to leak out of the blood vessels into the urine. However, RBCs can also be a contaminant due to blood from haemorrhoids or menstruation.

White Blood Cells (WBCs or Leukocytes)

The number of WBCs in urine is normally low. When the number is high, it indicates an infection or inflammation somewhere in the urinary tract due to the immune system response.

The agreed total number of leukocytes to be present in a millilitre of urine to establish the baseline for infection remains unchanged since the work of C Dukes in 1928. He proposed a threshold of <10 wbc/per millilitre of urine as the upper limit of normal white blood cell excretion in the urine. Above that limit and the sample may be positive for infection.

Epithelial Cells

Epithelial cells can be either Squamous, originating from the vagina, urethra or genital skin, Urothelial, that is cells from the bladder and finally Renal Tubular originating from the kidneys. When analysing the sample, significant epithelial cells may lead to further analysis to identify their type.

Squamous epithelial cells originate from the urethra or vagina and are commonly found in urine samples due to transfer whilst providing the sample – these are often reported as a contaminate in the sample without specific analysis of the actual type of epithelial cell.

However, it's the presence of urothelial epithelial cells that would indicate a urinary tract infection. Or, if many renal epithelial cells are discovered in urinalysis, then it could indicate a viral infection or problem with the kidneys.

4. *Bacterial Incubation*

If the microscopic examination shows signs of infection then a sample of the urine sediment will be placed on a Petri dish and left to incubate over 18 -24 hours. Bacteria can reproduce very quickly given the right conditions, such as warmth, moisture and suitable nutrients.

To ensure the cultures are not contaminated by other microorganisms, the following sterile conditions are needed;

- ✓ the Petri dishes, nutrient agar jelly inside these dishes and other culture media must be sterilised.
- ✓ The inoculating loops used to transfer microorganisms to the petri dish must be sterilised (usually by passing the metal loop through a Bunsen burner flame)
- ✓ and finally, the lid of the Petri dish is sealed with sticky tape to stop microorganisms from the air getting in and contaminating the culture.

Bacteria will produce colonies differing in appearance as they grow, some colonies may be coloured, some colonies are circular in shape, and others are irregular. Different bacterial strains produce these characteristics. The sample from the petri dish is then "gram stained" to identify the actual strain of bacteria. This means a crystal violet colour stain is applied to the sample and placed under a microscope. All bacteria are described as either gram negative or gram positive. Gram positive bacteria remain purple. Gram negative bacteria are stained pink.

Gram Negative bacterial strains include:

- ✓ Escherichia coli
- ✓ Klebsiella pneumoniae
- ✓ Proteus Mirabilis
- ✓ Pseudomonas species
- ✓ Morganella Morganii
- ✓ Citrobacter species

Gram positive strains include:

- ✓ Enterococcus faecalis
- ✓ Enterococcus faecium (E. faecium)
- ✓ Staphylococcus aureus
- ✓ Staph saprophyticus

Under the microscope, the appearance of bacteria is observed. The lab can then finally determine

- ✓ Are they Gram positive or negative?
- ✓ What are the physical characteristics?
- ✓ Are the cells individual or are they in chains, pairs etc.?
- ✓ How many are there and how large are the cells?

The final part of the process is to then count the total colony numbers of the single bacteria identified.

These are known as colony forming units usually abbreviated as CFU. For a positive diagnosis to be made of an infection, the agreed standard is currently $>10^5$ /ml in a millilitre of urine.

Up to 10,000 colonies of bacteria/ml are considered normal. Greater than 100,000 colonies/ml represents a positive urinary tract or kidney infection. For counts between 10,000 and 100,000, the culture is indeterminate and results will show low growth or mixed growth.

If sufficient bacteria are grown and the single pure strain identified such as e coli or enterococcus, antibiotics will be tested against the bacteria to check their effectiveness in stopping the infection. This is known as susceptibility and resistance and the results will be noted on the lab report to help your GP prescribe the correct antibiotic.

Yeast can also be present in urine. If yeast is found in urine, then the laboratory may recommend tests for a yeast (fungal) infection on vaginal secretions or may culture on a petri dish to identify the yeast and whether it could be causing UTI or other disease symptoms.

Casts

Casts are particles that are formed from protein secreted by kidney cells. Under the microscope, they often look like a sausage shape because of the way they form and in healthy people they appear nearly clear. This type of cast is called a "hyaline" cast.

When an infection is present in the kidney, other things such as RBCs or WBCs can become trapped in the protein as the cast is formed. When this happens, the cast is identified by the substances inside it, for example as a red blood cell cast or white blood cell cast.

Different types of casts are associated with different kidney diseases and the type of casts found in the urine may give clues as to which is affecting the kidney.

Normally, healthy people may have a few casts. After strenuous exercise, more casts may be detected. Cellular casts, such as RBC and WBC casts, indicate a kidney disorder.

Crystals

Urine contains many dissolved substances (solutes) - waste chemicals that your body needs to eliminate after filtration through the kidneys.

These can form crystals and they may group together to form kidney "stones". These stones can become lodged in the kidney itself or in the ureters – tubes that pass the urine from kidney to the bladder – causing extreme pain. Medications, drugs, and x-ray dye can also crystallize in urine.

Additionally, bacteria that cause a UTI can increase the pH value of urine. This can make the urine alkaline. When a person has a change in their pH values this can promote the formation of crystals.

Once the laboratory analysis has been finished the report is sent to your GP. If the report is positive for bacterial infection, your GP or the receptionist will contact you and ask you either to visit the surgery or a prescription for the identified antibiotic to treat the UTI will be available for you to collect. If the report details the possibility of kidney stones, you may be referred by the GP for further tests and treatment particularly if the stone is causing considerable pain. If the sample is negative, then if symptoms persist, you may request a retest from your GP.

A sample report is detailed on the next page.

5. MICROBIOLOGY REPORT

MICROBIOLOGY REPORT

USG/Dipstick:

Specific Gravity	1.010
pH	6.5
Protein	Trace
Glucose	None
Ketones	None
Bilirubin	None
Urobilinogen	None
Haemoglobin	None

MICROSCOPY:

White Blood Cells	<10/cmm
Red Blood Cells	Not seen
Bacteria	Not seen
Epithelial Cells	++
Crystals	Not seen
Casts	Not seen

MICROBIOLOGY REPORT

Organisms isolated

	>3 x 10^5/L	*Escherichia coli*
Antimicrobial		
Trimethoprim		R
Cefuroxime		R
Amoxycillin/Clavulanic acid		R
Cephalexin		R
Nitrofurantoin		S
Ciprofloxacin		R
Doxycycline		S
Gentamicin		S