Urinalysis is an important screening and diagnostic tool, but health professionals must know how to perform the test and interpret results correctly for it to be beneficial.

Urinalysis: how to interpret results

In this article...

- Steps to follow when carrying out urine testing
- What to look out for
- Common causes of abnormality

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Analysing an individual’s urine can be a useful way of detecting or ruling out some diseases and infections. Urinalysis can be undertaken in many ways, one of which is using a reagent stick. To be effective, the test must be performed properly and the results interpreted correctly. This article gives an overview of the most important aspects of this investigation, highlighting signs to look for and what they may mean.

Urine testing or urinalysis is a valuable tool to screen a patient and diagnose their health status. It provides valuable information about hydration, renal and urinary tracts, liver disease, diabetes mellitus and urinary-tract infections. Urine is formed in the kidneys and, through glomerular filtration, tubular reabsorption and tubular secretion, is how the body gets rid of its natural waste products (Marieb and Hoehn, 2010).

Urinalysis is easy to undertake but results must be interpreted correctly.

Types of analysis

There are different ways of analysing urine and for different reasons, namely:
- 24-hour collection: patient voids into toilet, then all urine is collected for the next 24 hours. As the body chemistry alters constantly, this is used to measure substances, such as steroids, white cells, electrolytes or determine urine osmolarity (Tortora and Derrickson, 2009);
- First-morning specimen: first specimen of morning (or eight hours after recumbent position). Best sample for pregnancy testing;
- Fasting specimen: the second voided specimen after a period of fasting;
- Mid-stream urine (MSU): used to obtain urine for bacterial culture. First and last part of urine stream is voided into the toilet to avoid contaminating the specimen with organisms presenting on the skin;
- Random specimen: for chemical or microscopic examination, a randomly collected specimen suitable for most screening purposes;
- Catheter specimen of urine: collected for bacteriological examination if a patient’s symptoms suggest the presence of a UTI. The sampling technique used for collection is important (Baillie and Arrowsmith, 2005).

This article focuses on random specimen and MSU samples, and analysis using dipstick reagent strips.

Patient assessment/preparation

Urinalysis can potentially identify the presence of life-changing conditions, such as diabetes and renal disease. If abnormalities are detected, the individual may need further investigations, so they should be appropriately counselled to understand the implications before providing a sample. This has to be balanced against harm that could be caused by a missed diagnosis if urinalysis is not done.

Approximately 50ml of urine is required for urinalysis. Adults and children who are continent and can empty their bladder should either provide a random sample or be advised to provide an
MSU sample. They should be mobile and dextrous enough to be able to do this, and be instructed in the technique to prevent contamination from hands or the genital area. Specific cleaning of the genital area seems not to affect contamination rates (Mousseau, 2001), but may be appropriate when personal hygiene is poor or faecal contamination is apparent.

Box 1 outlines the routine observations when undertaking urinalysis. The properties listed should be considered in line with clinical presentation, fluid intake and urine output. Before testing the urine using a reagent dipstick strip, the observations listed should be completed. The following factors can also affect results:

- Use a fresh sample of urine (preferably less than 4 hours old or in line with the reagent strip manufacturer’s instructions to obtain accurate results.
- Bilirubin and urobilinogen are relatively unstable compounds when left in light or at room temperature;
- Exposure of unpreserved urine to room temperature for a period of time can change pH and increase micro-organisms. If it cannot be tested immediately, the sample needs to be stored in line with the reagent strip manufacturer’s instructions or at 2-4°C and then brought to room temperature (15-20°C) before testing;
- Bacterial growth of contaminated organisms may produce positive blood reactions;
- Urine high in alkaline can show false positive results for protein;
- Presence of glucose may reduce pH;
- Presence of urea-splitting organisms may cause urine to become more alkaline (Dougherty and Lister, 2015).

**Standard urine-testing analysis**

Many chemical reagent strips are available and differ between manufacturers. All detect a wide range of substances that can be identified in urine. The tests available include those for substances that are:

- Produced by the body and naturally found in urine;
- Produced by the body and not usually present in the urine;
- Not normally found in the body.

The following test paddles are commonly featured on reagent strips: blood; bilirubin; urobilinogen; nitrite; leucocytes (white blood cells); protein; ketones; glucose; pH (a measure of how acidic or alkaline urine is); and specific gravity (relative density). It is important that the professional undertaking the test understands the manufacturer’s guidance before using the strip. Box 2 outlines the steps that should be followed when performing the urinalysis.

**Significance of findings**

Urine tests are frequently done in various settings, so it is vital that professionals understand how to interpret the common findings displayed on reagent strips and what they mean. This section will discuss each of the paddles identified on the strip.

**Blood**

Urine does not normally contain blood detected by reagent strips. Blood in the urine is known as haematuria and can be subclassified as follows:

- Macroscopic: large volumes of blood in the urine, which takes on a rose or dark colour, especially if left to stand;
- Microscopic: undetectable to the naked eye; reagent strips or a microscope are needed to identify it.

Blood can enter urine via damage to the filtration barrier in the kidneys that normally prevents blood from entering the urine or because of an abnormality to the structures that usually drain urine from the kidneys, store urine (bladder) or transport urine outside (urethra) (Bryant and Catto, 2008). Blood in the urine can be indicative of kidney disease; inflammatory lesions of the urinary tract (infection or cancer); renal damage; or kidney/renal stones.

**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 acts on the bilirubin to transform it into urobiligen. It is usual for urine to contain urobiligen 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.

**Nitrites**

Nitrites are not usually found in urine and are associated with the presence of bacteria.

**Box 1: Routine Observation of Urine**

<table>
<thead>
<tr>
<th>Colour</th>
<th>This usually ranges from pale straw to deep amber, depending on concentration (Steggall, 2007).</th>
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</thead>
<tbody>
<tr>
<td>Dark urine:</td>
<td>may indicate dehydration</td>
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<tr>
<td>Brown/green or strong yellow:</td>
<td>may indicate presence of bilirubin</td>
</tr>
<tr>
<td>Green:</td>
<td>may indicate presence of pseudomonas infection or excretion of cytotoxic drugs, such as mitomycin</td>
</tr>
<tr>
<td>Bright red/red-brown:</td>
<td>may indicate presence of blood (haematuria).</td>
</tr>
<tr>
<td>Menstruation should be ruled out in females:</td>
<td>Certain food or drugs may also influence colour; beetroot can produce a pinkish shade and rifampicin can turn urine orange/red.</td>
</tr>
</tbody>
</table>

**Clarity**

This is usually referred to as clear, slightly cloudy, cloudy or turbid.

Substances that can cause cloudiness but are not harmful include mucus, sperm, prostatic fluid and skin cells. Other substances that make urine cloudy are white/red blood cells, pus or bacteria that need attention. Frothy urine signifies protein in the urine.

**Odour**

Freshly voided urine may have a slight but inoffensive smell.

- Fishy smell/ammonia: may indicate urinary infection
- “Pear drop” or acetone smell: may indicate presence of ketones, as in diabetic ketoacidosis
- Some strongly flavoured foods can also produce an odour, eg asparagus

It can also indicate a blood-clotting disorder or be a side-effect of anticoagulant drugs. Health professionals should also remember that urine can be contaminated with menstrual blood. Goddard et al (2010) highlighted that in most patients investigated for haematuria, no real presence of an underlying cause could be found and the haematuria was put down to a benign cause. However, as serious conditions cannot be identified unless investigated, it is important that haematuria is appropriately investigated unless a sensible reason, such as menstruation, can be identified.

www.nursingtimes.net / Vol 112 Online issue 2 / Nursing Times 08.06.16 2
that can convert nitrate into nitrite. The presence of nitrites can be suggestive of a UTI but clinical presentation of symptoms should also be taken into account. The absence of nitrites, however, does not always rule out the presence of a UTI; DeVillé et al (2004) identified that in approximately 50% of urine samples containing bacteria, the nitrites test was negative.

**Leucocytes (white blood cells)**
In urine, leucocytes are usually associated with a urinary infection but sometimes may indicate a more severe renal problem (Steggall, 2007). When white blood cells are present in the urine, patients are said to have pyuria (pus in the urine). To establish the cause, a clean-catch urine sample should be examined under a microscope, cultured to see what bacteria grows and tested for sensitivity to establish antibiotic treatment. Where no bacterial cells are detected, the patient is said to have sterile pyuria; this can occur in tuberculosis and inflammatory disease of the kidneys (Higgins, 2007).

**Protein**
In a healthy person, urine does not contain a level of protein that is detectable on a urine reagent strip. This is due to the protein molecules being too large to pass through the glomerular filtration barrier. When protein can pass through this barrier, it is known as proteinuria. Proteinuria can be caused by many things, such as damage or disease to the glomerular filtration barrier; hypertension; kidney damage; diabetes mellitus; and pre-eclampsia (Mulryan, 2011). Specific investigations will be required to detect the cause of proteinuria.

**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.

**pH**
This is a measure of acidity or alkalinity in urine. All urine will give a pH reading on analysis and it is usually slightly acidic. A range of 5.0–8.0 is considered normal (Higgins, 2007). Acidic urine may indicate formation of urinary stones, while alkaline urine may indicate a UTI with certain types of bacteria, such as Proteus mirabilis, Klebsiella or Pseudomonas (Higgins, 2007). 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. UTIs and medication can also result in alkaline urine. Results should be interpreted in conjunction with an individual’s specific presentation.

**Specific gravity (SG) (relative density)**
Urine can range from very diluted to very concentrated; its density is measured against pure water at room temperature and pressure. Specific gravity identifies the hydration of an individual – a well-hydrated person will have diluted urine whereas someone who is dehydrated will present with concentrated urine. The normal range of specific gravity is 1.001–1.035.

Diluted urine could occur in an individual who has high fluid intake; diabetes insipidus; hypercalcaemia; endocrine disorders, such as kidney disease; or failed to produce anti-diuretic hormone.

Concentrated urine can be the result of dehydration. When assessing specific gravity, environmental factors such as temperatures should be taken into account. | BOX 2. URINALYSIS USING CHEMICAL REAGENT STRIPS |
<table>
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<tr>
<td>● Explain procedure to patient and gain consent</td>
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<tr>
<td>● Comply with infection-prevention principles: wash hands, use protective equipment</td>
</tr>
<tr>
<td>● Check expiry date on reagent-strip container and make sure it has been stored in line with the manufacturer’s recommendations</td>
</tr>
<tr>
<td>● Advise patient how to collect a fresh sample, preferably a mid-stream sample if possible, as stored urine can give false results</td>
</tr>
<tr>
<td>● Remove reagent dipstick from container, taking care to touch only the plastic handle; replace lid immediately</td>
</tr>
<tr>
<td>● Observe urine for colour and clarity, then fully immerse reagent stick, so all reagent areas are covered. Hold for approximately two seconds. Remove strip from urine and tap on absorbent paper or against inside of urine container to remove excess urine</td>
</tr>
<tr>
<td>● Wait for manufacturer’s recommended time to elapse, holding strip in horizontal position to prevent interaction between adjacent test pads</td>
</tr>
<tr>
<td>● Compare reagent strip against colour reference guide on outside of container (Fig 1)</td>
</tr>
<tr>
<td>● If sample is not being sent to a laboratory for further investigations, dispose of urine, used strip, urine container and gloves, following local policy, and wash hands</td>
</tr>
<tr>
<td>● Document results, and inform doctor and patient; take appropriate action as required</td>
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</tbody>
</table>

**References**

**Conclusion**
Urinalysis using a dipstick reagent strip is an effective screening tool to assess the health status of an individual and detect some diseases and infections. It is important that professionals understand methods for collecting urine, limit the risk of contamination by using reagent strips correctly and accurately interpret results.

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