Clinical urine tests

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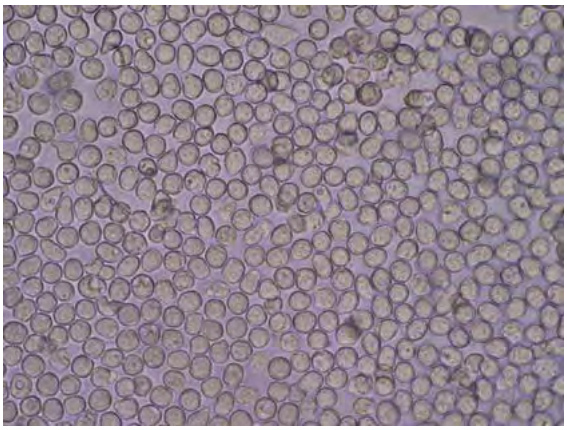
Clinical urine tests are various tests of urine for diagnostic purposes. The most common is a **urinalysis** (**UA**), one of the most common methods of medical diagnosis.[1] The word is a portmanteau of the words *urine* and *analysis*.[2] Other tests are **urine culture** (a microbiological culture 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.

Urinalysis

Intervention



White blood cells seen under a microscope from a urine sample.

MeSH	D016482
Other codes	LOINC Codes for Urinalysis panels (http://search.loinc.org/search.zul?query=Urinalysis+panel+ur+-CHEM+-DRUG)
MedlinePlus	003579

Contents

Target parameters

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.[3]

In addition to the substances mentioned in tables below, 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.[4]
- 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.[5]

Smell

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.[6]

Ions and trace metals

Target	Lower limit	Upper limit	Unit	Comments	LOINC Codes
Nitrite	n/a	0 / negative[7]		The presence of nitrites in urine, termed nitrituria, indicates the presence of coliform bacteria.	5802-4 (https://search.loinc.org/search.zul?query=5802-4)
Sodium (Na) – per day	150[8]	300[8]	mmol / 24 h	A urinalysis is frequently ordered during the workup of acute renal failure. Full kidney function can be detected through the simple dipstick method.	2956-1 (https://search.loinc.org/search.zul?query=2956-1)
Potassium (K) – per day	40[8]	90[8]	mmol / 24 h	Urine K may be ordered in the workup of hypokalemia. In case of gastrointestinal loss of K, the urine K will be low. In case of renal loss of K, the urine K levels will be high. Decreased levels of urine K are also seen in hypoaldosteronism and adrenal insufficiency.	2829-0 (https://search.loinc.org/search.zul?query=2829-0)
Urinary calcium (Ca) – per day	15[9]	20[9]	mmol / 24 h	An abnormally high level is called hypercalciuria and an abnormally low rate is called hypocalciuria.	14637-3 (https://search.loinc.org/search.zul?query=14637-3)
	100[9]	250[9]	mg / 24 hours		6874-2 (https://search.loinc.org/search.zul?query=6874-2)
Phosphate (P) – per day	n/a[8]	38[8]	mmol / 24 h	Phosphaturia is the hyperexcretion of phosphate in the urine. This condition is divided into primary and secondary types. Primary hypophosphaturia is characterized by direct excess excretion of phosphate by the kidneys, as from primary renal dysfunction, and also the direct action of many classes of diuretics on the kidneys. Additionally, secondary causes, including both types of hyperparathyroidism, cause hyperexcretion of phosphate in the urine.	14881-7 (https://search.loinc.org/search.zul?query=14881-7)

A sodium-related parameter is fractional sodium excretion, which is the percentage of the sodium filtered by the kidney which is excreted in the urine. It is a useful parameter in acute renal failure and oliguria, with a value below 1% indicating a prerenal disease and a value above 3%[10] indicating acute tubular necrosis or other kidney damage.

Proteins and enzymes

Target	Lower limit	Upper limit	Unit	Comments
Protein	0	trace amounts[7] / 20	mg/dl	Proteins may be measured with the Albustix test. Since proteins are very large molecules (macromolecules), they are not normally present in measurable amounts in the glomerular filtrate or in the urine. The detection of protein in urine, called proteinuria, may indicate the permeability of the glomerulus is increased. This may be caused by renal infections or by other diseases that have secondarily affected the kidneys, such as hypertension, diabetes mellitus, jaundice, or hyperthyroidism.
Human chorionic gonadotropin (hCG)	–	50[11]	U/l	This hormone appears in the urine of pregnant women.And also in case of testicular cancer in male. Home pregnancy tests commonly detect this substance.

Blood cells

Target	Lower limit	Upper limit	Unit	Comments
Red blood cells (RBCs) / erythrocytes	0[7][12]	2[7] – 3[12]	per High Power Field (HPF)	May be present as intact RBCs, which indicate bleeding. Even trace amount of blood is enough to give the entire urine sample a red/pink hue, and it is difficult to judge the amount of bleeding from a gross examination. Hematuria may be due to a generalized bleeding diathesis or a urinary tract-specific problem (trauma, stone, infection, malignancy, etc.) or artefact of catheterization in case the sample is taken from a collection bag, in which case a fresh urine sample should be sent for a repeat test. If the RBCs are of renal or glomerular origin (due to glomerulonephritis), the RBCs incur mechanical damage during the glomerular passage, and then osmotic damage along the tubules, so get dysmorphic features. The dysmorphic RBCs in urine which are most characteristic of glomerular origin are called "G1 cells", which are doughnut-shaped rings with protruding round blebs sometimes looking like Mickey Mouse's head (with ears). Painless hematuria of nonglomerular origin may be a sign of urinary tract malignancy, which may warrant a more thorough cytological investigation.
RBC casts	n/a	0 / negative[7]		
White blood cells (WBCs) / leukocytes / (pus cells)	0[7]	2[7] / negative[7]		
	–	10	per µl or mm^3	"Significant pyuria" at greater than or equal to 10 leucocytes per microlitre (µl) or cubic millimeter (mm^3)
"Blood" / (actually hemoglobin)	n/a	0 / negative[7]	dip-stick qualitative scale of 0 to 4+	Hemoglobinuria is suggestive of *in vivo* hemolysis, but must be distinguished from hematuria. In case of hemoglobinuria, a urine dipstick shows presence of blood, but no RBCs are seen on microscopic examination. If hematuria is followed by artefactual *ex vivo* or *in vitro* hemolysis in the collected urine, then the dipstick test also will be positive for hemoglobin and will be difficult to interpret. The urine color may also be red due to excretion of reddish pigments or drugs.

Other molecules

Target	Lower limit	Upper limit	Unit	Comments
Glucose	n/a	0 / negative[7]		Glucose can be measured with Benedict's test. Although glucose is easily filtered in the glomerulus, it is not present in the urine because all of the glucose filtered is normally reabsorbed from the renal tubules back into the blood. Presence of glucose in the urine is called glucosuria.
Ketone bodies	n/a	0 / negative[7]		With carbohydrate deprivation, such as starvation or high-protein diets, the body relies increasingly on the metabolism of fats for energy. This pattern is also seen in people with diabetes mellitus, when a lack of the hormone insulin prevents the body cells from using the large amounts of glucose available in the blood. This happens because insulin is necessary for the transport of glucose from the blood into the body cells. The metabolism of fat proceeds in a series of steps. First, triglycerides are hydrolyzed to fatty acids and glycerol. Second, the fatty acids are hydrolyzed into smaller intermediate compounds (acetoacetic acid, betahydroxybutyric acid, and acetone). Thirdly, the intermediate products are used in aerobic cellular respiration. When the production of the intermediate products of fatty acid metabolism (collectively known as ketone bodies) exceeds the ability of the body to metabolize these compounds, they accumulate in the blood and some end up in the urine (ketonuria).
Bilirubin	n/a	0 / negative[7]		The fixed phagocytic cells of the spleen and bone marrow destroy old red blood cells and convert the heme groups of hemoglobin to the pigment bilirubin. The bilirubin is secreted into the blood and carried to the liver, where it is bonded to (conjugated with) glucuronic acid, a derivative of glucose. Some of the conjugated bilirubin is secreted into the blood and the rest is excreted in the bile as bile pigment that passes into the small intestine. The blood normally contains a small amount of free and conjugated bilirubin. An abnormally high level of blood bilirubin may result from an increased rate of red blood cell destruction, liver damage (as in hepatitis and cirrhosis), and obstruction of the common bile duct as with gallstones. An increase in blood bilirubin results in jaundice, a condition characterized by a brownish-yellow pigmentation of the skin and of the sclera of the eyes.
Urobilinogen	0.2[7]	1.0 [7]	Ehrlich units or mg/dL	

Creatinine	4.8[8]	19[8]	mmol / 24 h	
Urea	12	20	g / 24 h	
Uric acid	250	750	mg / 24 h	
Free catecholamines, dopamine – per day	90 [13]	420 [13]	µg / 24 hours	
Free cortisol	28[14] or 30[15]	280[14] or 490[15]	nmol/24 h	Values below threshold indicate Addison's disease, while values above indicate Cushing's syndrome. A value smaller than 200 nmol/24 h (72 µg/24 h[16]) strongly indicates absence of Cushing's syndrome.[15]
	10[17] or 11[16]	100[17] or 176[16]	µg/24 h	
Phenylalanine		30.0	mg/L[18]	In neonatal screening, a value above the upper limit defines phenylketonuria.[18]

Other urine parameters

Test		Lower limit	Upper limit	Unit	Comments
Urine specific gravity		1.003 [1][7]	1.030[1][7]	no unit	This test detects the ion concentration of urine. Small amounts of protein or ketoacidosis tend to elevate the urine's specific gravity (SG). This value is measured using a urinometer and indicates hydration or dehydration. If the SG is under 1.010, the patient is hydrated; an SG value above 1.020 indicates dehydration.
Osmolality		400[8]	n/a[8]	mOsm/kg	Urine osmolality testing can be used in conjunction with Plasma osmolality tests to confirm diagnosis of SIADH[19]
pH		5[7]	7[7]	(unitless)	
Bacterial cultures	by urination	–	100,000	colony forming units per millilitre (CFU/mL)	Bacteriuria can be confirmed if a single bacterial species is isolated in a concentration greater than 100,000 CFU/ml of urine in clean-catch midstream urine specimens (one for men, two consecutive specimens with the same bacterium for women).
	by bladder catheterisation	–	100		For urine collected via bladder catheterisation, the threshold is 100 CFU/ml of a single species.

Drugs

Urine may be tested to determine whether an individual has engaged in recreational drug use. In this case, the urinalysis would be designed to detect whatever marker indicates drug use.

History

Helen Murray Free and her husband, Alfred Free, pioneered dry reagent urinalysis, resulting in the 1956 development of Clinistix (also known as Clinistrip), the first dip-and-read test for glucose in urine for patients with diabetes.[20] This breakthrough led to additional dip-and-read tests for proteins and other substances.[21] The invention was named a National Historic Chemical Landmark by the American Chemical Society in May 2010. [22]

Methods

When doctors order a urinalysis, they will request either a routine urinalysis or a routine and microscopy (R&M) urinalysis, with the difference being a routine urinalysis does not include microscopy or culture.

Urine test strip

A urine test strip can quantify:

- Leukocytes – with presence in urine known as leukocyturia
- Nitrite – with presence in urine known as nitrituria
- Protein – with presence in urine known as proteinuria, albuminuria, or microalbuminuria
- Blood – with presence in urine known as hematuria
- specific gravity

Microscopic examination

The numbers and types of cells and/or material such as urinary casts can yield a great detail of information and may suggest a specific diagnosis.

A urine sample is about to be examined under a phase-contrast microscope using a Neubauer counting chamber. The urine is under the cover slide, in the upper segment formed by the H-shaped grooves.

- Hematuria – associated with kidney stones, infections, tumors and other conditions
- Pyuria – associated with urinary infections
- Eosinophiluria – associated with allergic interstitial nephritis, atheroembolic disease
- Red blood cell casts – associated with glomerulonephritis, vasculitis, or malignant hypertension
- White blood cell casts – associated with acute interstitial nephritis, exudative glomerulonephritis, or severe pyelonephritis
- (Heme) granular casts – associated with acute tubular necrosis
- Crystalluria – associated with acute urate nephropathy (or acute uric acid nephropathy, AUAN)
- Calcium oxalatin – associated with ethylene glycol
- Waxy casts – associated with chronic renal disease

Other methods

- Urine culture – a microbiological culture of urine samples, detecting bacteriuria, is indicated when a urinary tract infection is suspected.
- Ictotest – this test is used to detect the destruction of old red blood cells in the urine.
- Hemoglobin test – this tests for hemolysis in the blood vessels, a rupture in the capillaries of the glomerulus, or hemorrhage in the urinary system, which cause hemoglobin to appear in the urine.

See also

- Blood test
- Uroscopy, the ancient form of this analysis
- Medical technologist
- Urinary casts
- Proteinuria
- Urine test strip
- Urine collection device
- Pregnancy test, measures hCG levels in urine

- Blood lead level

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External links

- Lab Tests Online: Urinalysis (http://www.labtestsonline.org/understanding/analytes/urinalysis/glance.html)
- Different Types of Urinalysis (http://www.redurine.com/medical_tests/urine_test.html)
- Instructions How to Use with Reader and Without By Color Comparison (http://www.meditests.com

Wikimedia Commons has media related to ***Urinalysis***.

/urinalysis.html)
- Conoximent de las Orines, an early book about analyzing urine for medical purposes. Estimated date 1466. (http://digital2.library.ucla.edu/viewItem.do?ark=21198/zz0002267k)

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