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# Urine Examination is Like Liquid Kidney Biopsy

- Urinalysis consists of three components: Gross evaluation, dipstick analysis and microscopic examination of the urine sediment.
- Indications.
- In a patient with evidence of kidney disease.
- Someone with albuminuria.
- Acute or chronic reduction in the glomerular filtration rate (GFR).
- In a patient with suspected kidney disease (edema, systemic lupus erythematosus, small-vessel vasculitis, newly identified hypertension).
- Known or suspected kidney stones.
- Urine dipstick showing microscopic hematuria.

## SAMPLE COLLECTION

- The urine specimen must be properly collected.
- The specimen should be collected into a clean dry container.
- Patients should be asked to clean the external genitalia and provide a midstream specimen for analysis.
- The specimen should be examined at room temperature within 2 hours of retrieval. If this is not feasible, the sample should be refrigerated at 2-8°C and then re-warmed to room temperature prior to assessment.

| Gross Assessment | |
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| **Turbid** | Infection, precipitated crystals or chyluria |
| **Yellow** | Lighter when urine is dilute and darker when concentrated. |
| **Red to brown** | **Post centrifuged** red color is in the urine sediment (hematuria) or the supernatant (heme). |
| **White** | Pyuria, phosphate crystals, chyluria |
| **Pink** | Uric acid crystals, due to propofol |
| **Green** | Administration of methylene blue, propofol or amitriptyline |
| **Black** | Hemoglobinuria, myoglobulinuria or ochronosis (alkaptonuria) |
| **Purple** | Bacteriuria in patients with urinary catheters |

| Urine Sediment | |
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| 10 mL centrifuged at 3000 rpm for 5 minutes | Evaluates epithelial cells, casts, crystals |
| Uric acid or amorphous crystals | In acid urine. Acute kidney injury (AKI) with uric acid crystals suggest tumor lysis syndrome |
| Cystine | Cystinuria |
| Calcium oxalate | Any pH. AKI & calcium oxalate crystals: Ethylene glycol ingestion |
| Calcium phosphate | Alkaline pH |
| Magnesium ammonium phosphate crystals (struvite) and calcium carbonate-apatite | Constituents of struvite stones which occurs only when ammonia production is increased and the urine pH is elevated in the setting of a urinary tract infection with a urease-producing organism, such as Proteus or Klebsiella |
| Bacteria or fungi | Infection |
| Red blood cells (RBCs)<br>Transient: Young, following exercise or sexual intercourse, menstruation, underlying malignancy in 50+, cystitis or prostatitis<br>Persistent: Kidney stones, malignancy, and glomerular disease. | Hematuria may be gross or microscopic (two or more RBCs per high-powered field in a spun urine sediment). mL of blood per liter of urine can induce a visible color change. |
| White blood cells (WBCs) | Commonly associated with bacteriuria or sterile pyuria in interstitial nephritis, renal tuberculosis and nephrolithiasis.<br>Urine eosinophils seen in acute interstitial nephritis. |
| Renal tubular epithelial cells | Renal tubular cells are 1.5-3 times larger than white cells and are further distinguished by a round, large, centrally-located nucleus |
| Transitional epithelial cells | Originate anywhere from the renal pelvis to the proximal urethra and are slightly larger than renal tubular epithelial cells. They may have a pear-like or oval appearance |
| Squamous epithelial cells | Are derived from the distal urethra or external genitalia. They are large and irregular in shape with a small central nucleus, and their presence represents contamination by genital secretions |
| Casts | Cylindrical structures formed in the tubular lumen and assume the shape and size of the renal tubule in which they are formed. |
| RBC casts | Glomerular hematuria, proliferative glomerulonephritis |
| WBC casts | Pyelonephritis or noninfectious (interstitial nephritis, proliferative glomerulonephritis) |
| Renal tubular epithelial cell casts | Desquamation of the tubular epithelium, including acute tubular necrosis (ATN), acute interstitial nephritis and proliferative glomerulonephritis |
| Granular casts | ATN |
| Hyaline casts | Small volumes of concentrated urine or with diuretic therapy and are generally nonspecific |
| Lipid droplets | Nephrotic syndrome. Because of the apparent requirement for increased glomerular permeability, lipiduria is almost always diagnostic of some form of glomerular disease |
| Waxy casts | Are nonspecific and may be observed in a variety of acute and chronic kidney diseases. |
| Broad casts | Associated with advanced chronic kidney disease. |

 **IJCP SUTRA 87:** Multiple blood cultures, each containing large volumes of blood, are required to detect bacteremia. *Clin Infect Dis.* 1996;23:40.

| Urine Dipstick | |
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| **Heme** | If a urine dipstick of the red supernatant is positive for heme, the patient has either hemoglobinuria or myoglobinuria. Negative heme test can be seen with ingestion of rifampin or phenytoin, food dyes, beets (beeturia), rhubarb or senna and acute intermittent porphyria. |
| **Leukocyte esterase** | Is a marker for the presence of WBCs? Excessively dilute urine may favor cell lysis and lower the threshold for test positivity. By contrast, a concentrated urine may impede cell lysis and therefore produce a false-negative result. |
| **Nitrite** | **Infection.** Bacteriuria or frank infection may still be present in the absence of nitrite positivity. This would occur with organisms expressing low levels of nitrate reductase (Enterococcus), or when urine dwell time in the bladder is short. |
| **Albumin** | A screen for the presence of such proteins may be performed with the sulfosalicylic acid test.<br>Moderately increased albuminuria in the range of 30-300 mg/day (formerly called "microalbuminuria") cannot be detected with dipstick testing.<br>A patient with severely increased albuminuria that is normally detectable by the dipstick (more than 300 mg/day, formerly called "macro albuminuria") may still have a negative dipstick if the urine is very dilute. |
| **Hydrogen ions** | pH ranges from 4.5 to 8. The appropriate renal response to acidemia is to increase urinary acid excretion, with the urine pH falling below 5.3 and usually below 5. A higher value may indicate the presence of renal tubular acidosis |
| **Specific gravity (SG)** | **SG** varies with the osmolality, rising by app 0.001 for every 35-40 mosmol/kg increase in urine osmolality. Osmolality of 280 mosmol/kg (which is isosmotic to normal plasma) = SG 1.008 or 1.009. |
| **Glucose** | With normal eGFR glycosuria = plasma glucose >180 mg/dL<br>Urine sugar with normal blood sugar: defect of proximal tubule reabsorption in Fanconi syndrome, multiple myeloma, heavy metal exposure and drugs tenofovir, lamivudine, cisplatin, valproic acid and aminoglycosides, sodium-glucose cotransporter 2 inhibitors, etc. |

- **Hematuria with dysmorphic RBCs, RBC casts and proteinuria:** Proliferative glomerular disease, which, in the setting of rapidly declining kidney function, constitutes a nephrologic emergency.
- **Heavy proteinuria with absent or minimal hematuria:** Nonproliferative glomerular diseases including severe diabetic nephropathy or membranous nephropathy, focal segmental glomerulosclerosis, minimal change disease and amyloidosis.
- **Granular or epithelial cell casts and renal tubular epithelial cells:** ATN.
- **Isolated pyuria:** Urinary tract infection (UTI).
- **Normal or near-normal urinalysis:** AKI, ATN, prerenal AKI, urinary tract obstruction, hypercalcemia, cast nephropathy in multiple myeloma, hypertensive emergency, scleroderma, thrombotic microangiopathies, polyarteritis nodosa, tumor lysis syndrome, acute phosphate nephropathy.

In CKD, a normal urinalysis most commonly indicates: persistent states of decreased effective circulating volume, such as in patients with heart failure; urinary tract obstruction; chronic tubulointerstitial diseases; myeloma cast nephropathy and ischemic or hypertensive nephrosclerosis.

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### Formula of 10

Aspirin should be given to all apparently healthy men and women whose 10 years risk of CHD event is 10% or greater.

### Metabolic Syndrome

**Formula of 40:** 40% of adults over age 40 have metabolic syndrome.