

Urine analysis

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- Urine is formed by the kidneys, is a product of ultrafiltration of plasma by the renal glomeruli.

Collection of urine

- Early morning sample-qualitative
- Random sample- routine
- 24hrs sample- quantitative
- Midstream sample-UTI
- Supra- pubic aspiration

Urine examination

- Physical examination
- Macroscopic examination
- Microscopic examination
- Chemical examination
- Culture
- Cytology

Physical examination

- Volume
- Color
- Reaction or urinary pH
- Specific gravity

Urinary volume

- Normal = 600-1550ml
- ***Polyuria***- >2000ml
- ***Oliguria***-<400ml
- ***Anuria***-complete cessation of urine(<200ml)
- ***Nocturia***-excretion of urine by a adult of >500ml with a specific gravity of <1.018 at night (characteristic of chronic glomerulonephritis)

Causes of polyuria

- Diabetes mellitus
- Diabetes insipidus
- Polycystic kidney
- Chronic renal failure
- Diuretics
- IVF- Intravenous saline/glucose

oliguria

- Dehydration-vomiting, diarrhea, excessive sweating
- Renal ischemia
- Acute tubular necrosis
- Obstruction to the urinary tract
- AKI



URINE COLOR CHART



Color & appearance

- Normal- clear & pale yellow
- Colorless- dilution, diabetes mellitus, diabetes insipidus, diuretics
- Milky- urinary tract infection
- Orange- fever, excessive sweating
- Red- beetroot ingestion, hematuria- pigments
- Brown/ black- alkaptunuria, melanin

Urinary pH/ reaction

- Reaction reflects ability of kidney to maintain normal hydrogen ion concentration in plasma & ECF
- Normal= 4.6-8

Acidic urine

- Ketosis- DKA, starvation, fever
- Systemic acidosis
- UTI- E.coli

Alkaline urine

- Strict vegetarian
- Systemic alkalosis
- UTI- Proteus
- Alkalization therapy

Specific gravity

- Depends on the concentration of various solutes in the urine.
- Measured by-urinometer
 - refractometer
 - dipsticks

High specific gravity(hyperosthenuria)

- Normal-1.016-1.022
- Causes- All causes of oliguria, Glycosuria

Low specific gravity(hyposthenuria)

- All causes of polyuria except glycosuria

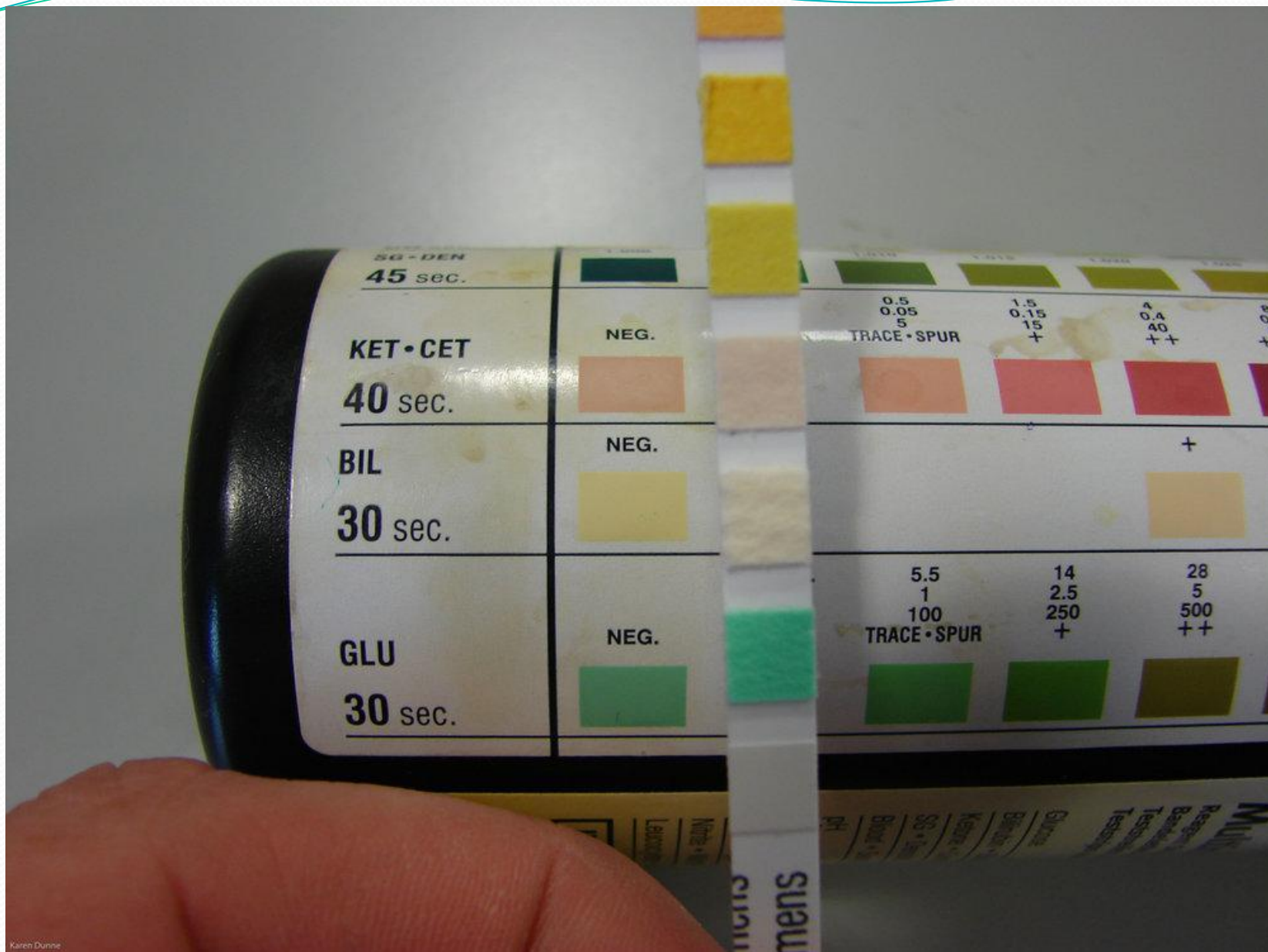
- *Fixed specific gravity (isosthenuria)=1.010*

Seen in chronic renal disease when kidney has lost the ability to concentrate or dilute

Macroscopic examination

Urine dipsticks

- Urine dipstick is a narrow plastic strip which has several squares of different colors attached to it.
- Each small square represents a component of the test used to interpret urinalysis.



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- The squares on the dipstick represent the following components in the urine:
 - specific gravity (concentration of urine),
 - acidity of the urine (pH),
 - protein in the urine (mainly albumin),
 - glucose (sugar),
 - ketones
 - blood
 - bilirubin and
 - urobilinogen



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- The main advantage of dipsticks is that they are
 - 1. convenient,
 - 2. easy to interpret,
 - 3. and cost-effective

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- The main disadvantage is that the
 - 1. Information may not be very accurate as the test is time-sensitive.
 - 2. It also provides limited information about the urine as it is qualitative test and not a quantitative test (for example, it does not give a precise measure of the quantity of abnormality).

Chemical examination

- Proteins
- Sugars
- Ketone bodies
- Bilirubin
- Bile salts
- Urobilinogen
- Blood

Tests for proteins

- Test – HEAT & ACETIC ACID TEST
- Sulphosalicylic acid test
- Dipsticks

- Normal urinary protein – 150mg of tubular protein- non-albumin
- Normal urinary albumin- 20mg/day

Proteinurea

- Renal

Glomerulonephritis

Nephrotic syndrome

Renal tumor or infection

Functional- Severe muscular exertion - Orthostatic proteinuria Pregnancy

- Pre-Renal Fever, Renal hypoxia, Hypertension

- Post-Renal

Cystitis

Urethritis or prostatitis

vaginal secretions

Causes of proteinuria

- Prerenal causes-Heavy exercise,Fever,hypertension, multiple myeloma, eclampsia
- Renal –acute & chronic glomerulonephritis, Renal tubular dysfunction, Polycystic kidney, nephrotic syndrome
- Post renal- acute & chronic cystitis, tuberculosis cystitis

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- Selective proteinuria
 - Nonselective proteinuria

Types

- Glomerular proteinuria
- Tubular proteinuria
- Overflow proteinuria

Ranges of albuminuria

- Significant albuminuria = microalbuminuria
30-300mg/d
- Very significant albuminuria – 300mg-3gms/d (macroalbuminuria or frank albuminuria)
- nephrotic range albuminuria > 3gms /d

Significance of microalbuminuria

- microalbuminuria cannot be detected by dipstick.
- Is an indicator of subclinical cardiovascular disease and prognostic marker for DMN.

Nephrotic syndrome

more The nephrotic syndrome is defined by albuminuria
than 3 -3.5 g/day with
,hypoalbuminemia
,edema
.lipiduria, hyperlipidemia
but few cells or casts
.It Could be primary or secondary

Nephritic syndrome

,The nephritic syndrome is characterized by hematuria

,RBC casts

,proteinuria

,hypertension

edema, and

.deteriorating renal function

Patients may note dark, smoky, or cola-colored urine

Bence Jones proteins

- These are light chain globulins seen in multiple myeloma, macroglobulinemias, lymphoma.

Test for sugar

- ***Glycosuria with hyperglycemia***- diabetes, acromegaly, Cushing's disease, hyperthyroidism, drugs like corticosteroids.
- ***Glycosuria without hyperglycemia***- renal tubular dysfunction

Ketone bodies

- 3 types
 - Acetone
 - Acetoacetic acid
 - β -hydroxy butyric acid
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- They are products of fat metabolism

Causes of ketonuria

- Diabetes
- Non-diabetic causes- high fever, starvation, severe vomiting/diarrhea.

Causes of hematuria

- **Pre renal**- bleeding diathesis, hemoglobinopathies, malignant hypertension.
- **Renal**- trauma, calculi, acute & chronic glomerulonephritis, renal TB, renal tumors
- **Post renal** – severe UTI, calculi, trauma, tumors of urinary tract

Microscopic examination

- Contents of normal urine is few epithelial cells, occasional RBC's, few crystals.

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- WBC- pyurea
 - Normal 2-3 p=/hpf
 - Seen in
 - UTI
 - Granulomatous diseases, TB
 - Drugs
 - Malignancy

Hematuria

- Presence of RBCs in the urine
- N R- 2-3/Hpf
- More than 5/hpf



RBC

- **Pre renal**- bleeding diathesis, hemoglobinopathies, malignant hypertension.
- **Renal**- trauma, calculi, acute & chronic glomerulonephritis, renal TB, renal tumors
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BY ORIGIN

- Glomerular
- Non-Glomerular.

Pain

- Painless/painfull

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- DD – by clinical picture
 - presence of dysmorphic RBCs
 - Other types
 - Painful and painless
 - By timing
 - Initial
 - Diffuse
 - Terminal

Crystals in urine

- **Crystals in acidic urine**
- Uric acid
- Calcium oxalate
- Cystine
- **Crystals in alkaline urine**
- Ammonium magnesium phosphates(triple phosphate crystals)
- Calcium carbonate

casts

- Are microscopic clusters of urinary particles, such as cells, fat bodies, or microorganisms, wrapped in a protein matrix and found in the urine.
- They form via precipitation of Tamm-Horsfall protein.
- Acellular and cellular casts.
- Urinary casts originates form in the distal nephron.
- Some types indicate renal disease.

Types of casts

● Acellular casts

Hyaline casts

Granular casts

Waxy casts

Fatty casts

Pigment casts

Crystal casts

● Cellular casts

Red cell casts

White cell casts

Epithelial cell cast

Hyaline casts

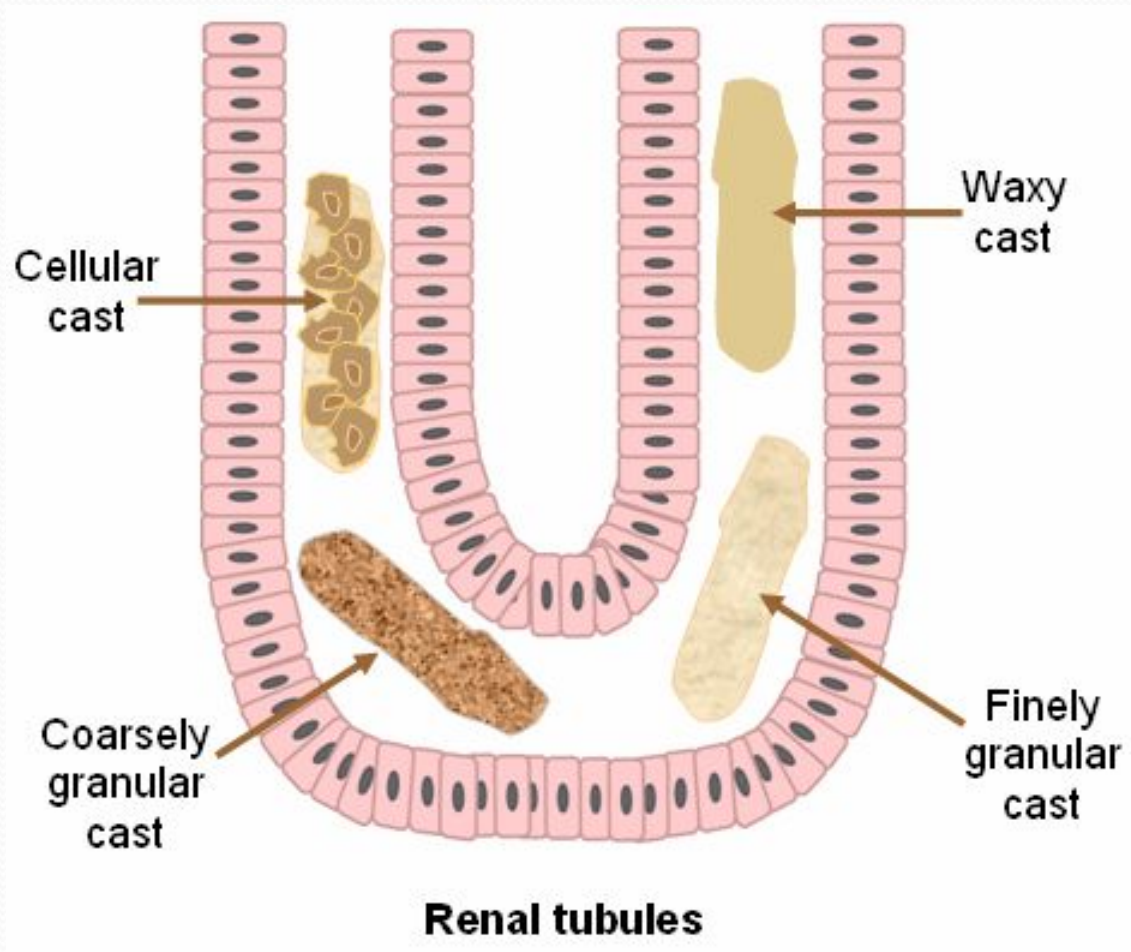
- The most common type of cast, hyaline casts are solidified Tamm-Horsfall protein secreted from the tubular epithelial cells
- Seen in fever, strenuous exercise, damage to the glomerular capillary

Granular casts

- Granular casts can result either from the breakdown of cellular casts or the inclusion of aggregates of plasma proteins (e.g., albumin) or immunoglobulin light chains
- indicative of chronic renal disease

Waxy casts

- waxy casts suggest **severe, longstanding kidney disease** such as renal failure(end stage renal disease).



Fatty casts

- Formed by the breakdown of lipid-rich epithelial cells, these are hyaline casts with fat globule inclusions

They can be present in various disorders, including

- nephrotic syndrome,
- diabetic or lupus nephropathy,
- Acute tubular necrosis

Pigment casts

- Formed by the adhesion of metabolic breakdown products or drug pigments
- Pigments include those produced endogenously, such as
 - hemoglobin in hemolytic anemia
 - myoglobin in rhabdomyolysis.

Red cell casts

- The presence of red blood cells within the cast is always pathologic, and is strongly indicative of *glomerular damage*.
- They are usually associated with nephritic syndromes.

White blood cell casts

- Indicative of inflammation or infection,
- pyelonephritis
- acute allergic interstitial nephritis,
- nephrotic syndrome, or
- post-streptococcal acute glomerulonephritis

Epithelial casts

- This cast is formed by inclusion or adhesion of desquamated epithelial cells of the tubule lining.

These can be seen in

- acute tubular necrosis and
- toxic ingestion, such as from mercury, diethylen glycol, or salicylate.



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Urine substances to be checked	Normal values	Collection timings	Significance
Physical characteristics			
•pH	1.4.7 to 7.7 2.Average = acidic 6.0	1.A random and fresh sample	1.Urine pH never reaches 9 2.In the case of pH 9, test the fresh sample
•Color	•Variable, pale-yellow to dark amber	•A random sample	Red color urine, check for hemoglobin
•Odor	•Faint aromatic	•A random sample	Urine from a diabetic patient has a fruity (acetone) odor.
•Volume	1.Normal range = 1200 to 2000 mL 2.Average = 1400 mL 3.Extreme range = 600 to 3600 mL	1.A random sample 2.24 hours urine sample	1.Polyuria increased urine output 2.Polyuria with normal BUN and creatinine. 3.Oliguria <200 mL in adult
•Specific gravity	1.1.008 to 1.030 2.Average = 1.018 3.1.012 to 1.025 4.Concentrated urine = 1.025 to 1.030+ 5.Dilute urine = 1.001 to 1.010 6.Infant <2 years = 1.001 to 1.018	1.A Random sample 2.24 hours urine sample	•Specific gravity is the measurement of the kidneys' ability to concentrate urine.

Chemical characteristics

•Glucose	1.Quantitative = nil 2.1 to 15 mg (60 to 830 μmol/L) 3.<0.5 g/day (<2.8 mmol/day)	1.A random sample 2.24 hours urine sample 3.24 hours urine sample	1.Urine glucose >1000mg/dL (>55 mmol/L) 2.Test blood glucose 3.Inform the physician
•Ketones	•Negative	•A random sample	1.Ketonuria indicates diabetic crises 2.It may be seen in starvation
•Albumin	1.Adult male = 10 to 140 mg/L (1 to 14 mg/dL) 2.Adult female = 30 to 100 mg/L (3 to 10 mg/dL) 3.Child <10 years = 10 to 100 mg/L (1 to 10 mg/dL)	1.24 hours urine sample 2.24 hours urine sample 3.24 hours urine sample	1.Adult = Proteinuria >2000 mg/24 hours. 2.Child = $\geq$40 mg/24 hours 3.indicate glomerular disease
•Microalbumin	1.<30 mg/day 2.<20 mg/L	1.24 hours urine sample 2.10 hours of urine collection	
•Protein	1.Qualitative =nil 2.Quantitative = 0 to 0.1 g/24 hours	•24 hours urine sample	•Indicate renal disease

Bicarbonate•	Nil•		HCO ₃ are estimated in• acid-base balance
Chloride (as NaCl)•	.Values varies with salt intake to 20 g (85 to 340 meq) 5 Average = 10 g (170 meq) Adult = 140 to 250 meq/24 hours (140 to 250 mmol/day)	24 hours urine sample	It is part of the acid-base .balance
Creatinine•	Male = 14 to 26 mg/kg/body weight/day (124 to 230 µmol/kg/day) Female = 11 to 20 mg/kg/body weight/day (97 to 177 µmol/kg/day)	24 hours urine sample	
Creatine•	Male = 0 to 50 mg.1 Female = 0 to 150 mg.2 Children = 5.4 to 13.7 mg/kg/body weight.3	24 hours urine sample	

•Bilirubin	1.Negative 2.May find 0 to 0.02 mg;dL (0 to 0.34 μmol/L)	A random sample (Check within one hour)	1.Urine bilirubin is negative in hemolytic disease. 2.It appears in the urine before other S/S of liver disease
•Urobilinogen	1.Random sample = <1 mg/dL 2.2 hours sample = <1 mg/2 hours 3.24 hours sample = 0.5 to 4.0 mg/day	1.A random sample 2.Collect 2 hours of a urine sample 3.Collect 24 hours urine sample	1.It rapidly decomposed at room temperature 2.Also, when exposed to light

•Ammonia	•10 to 105 meq	•24 hours urine sample	•It is part of the acid-base balance
•Hemoglobin	•Negative	•A random sample	•It indicates extensive burns or crushing injuries
•Myoglobin	Negative	A random sample	
•Nitrite	•Negative	•A random sample (Fasting sample is better)	•A negative test does not rule out bacteria in the urine
•Leukocyte esterase	•Negative	•A random sample	•The positive test needs a urine culture
•HCG	1.Pregnant = positive 2.Nonpregnant = Negative	•A random urine sample	•It is advised in pregnancy and follow-up of tumors

Microscopic characteristics			
•RBCs	1. 0 to 3 RBCs/HPF 2. 0/Low power field	A random sample	The persistent presence of RBCs in the urine needs thorough investigations
•RBC cast	0/HPF	A random sample	Indicates hemorrhage in the nephron
•WBCs	1. 0 to 4/HPF 2. Female = slightly more	A random sample	Urine culture should be done when increased WBCs are found
•WBC cast	Negative	random sample	Seen in renal inflammatory diseases
•Epithelial cells	1. Renal tubular cells = 0 to 3/HPF 2. Squamous cells = Commonly seen	A random sample	

