

Lecture Two

Urine examination

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A decorative graphic consisting of several parallel white lines of varying lengths, slanted upwards from left to right, located in the bottom right corner of the slide.

Composition of normal urine (24 hrs) in adults

Sl No	Parameters	Values	Sl No	Parameters	Values
1	Volume	600-2000 ml	10	Urea nitrogen	12-20 gm
2	Specific gravity	1.003-1.030	11	Uric Acid	250-750 mg
3	Osmolality	300-900 mOsm/kg	12	Sodium	40-200 mEq
4	pH	4.6-8.0	13	Potassium	25-125 mEq
5	Glucose	< 0.5 gm	14	Chloride	110-250 mEq
6	Proteins	< 150 mg	15	Calcium (low calcium diet)	50-150 mg
7	Urobilinogen	0.5-4.0 gm	16	Formiminogluta mic acid (FIGlu)	< 3 mg
8	Prophobilinog en	0.2 mg	17	Red cells, epithelial cells and white blood cells	≤ 1-2 per high power field
9	Creatinine	M: 14-26 mg/kg F: 11-20 mg/kg			

Indication of urine analysis

- Suspected renal diseases
 - Glomerulonephritis
 - Nephrotic Syndrome
 - Pyelonephritis
 - Renal failure
- Urine tract infection diagnosis
- Metabolic disorders i.e. Diabetes mellitus
- Differential diagnosis of jaundice
- Detection of Plasma cell dyscrasias
- Diagnosis of pregnancy

Collection of urine: Time of collection (1/3)

Single specimen

- First morning voiding
 - Most concentrated
 - Acidic pH
 - Formed element preserved like casts, cells
- Used for
 - Routine examination
 - Fasting Glucose
 - Protein
 - Nitrite
 - Pregnancy test
 - Microscopic analysis of cellular elements
 - Orthostatic proteinuria
 - Bacteriological analysis



Collection of urine: Time of collection (2/3)

Single specimen



- The Random Specimen
 - Can be collected at any point of time
 - Routine examination
- Post-prandial specimen
 - Collected two hours after a meal in the afternoon
 - Insulin therapy monitoring in Diabetes Mellitus
 - Urobilinogen

Collection of urine: Time of collection (3/3)

24 -hour-specimen

- First urine discarded in morning
- Clean 2 litres bottle with cap- used
- Whole day and night urine collected
- Next day first urine in morning also collected
- Preserved at 4-6°C during collection
- After collection immediate transportation to lab
- Thoroughly mixed and
 - a part of whole sample used for quantitative estimation of
 - Protein
 - Hormones



Collection of urine: Methods of collection

- **Midstream specimen**
 - Used for all types of examination
 - Collected after voiding initial half of urine
- **Clean-catch specimen**
 - Used for bacteriological culture
 - Urethral opening- cleaned with soap and water
 - Collected after voiding initial half of urine
- **Catheter specimen**
 - Used for bacteriological culture
 - For bed ridden and obstructed urinary tract patient
- **Infants**
 - Aspiration done above the symphysis pubis

Changes occur in room temperature after prolonged standing

- Increase in pH- production of ammonia
- Formation of crystal- calcium and phosphate precipitation
- Loss of ketone bodies- volatile
- Decrease of glucose- glycolysis by bacteria and cells
- Oxidation of bilirubin to biliverdin
- Oxidation of urobilinogen to urobilin
- Bacterial proliferation
- Disintegration of cellular elements

Preservation of urine sample

- Test to be done within 2 hrs
- Can be kept at 4-6°C for maximum 8 hrs
- Routine analysis- preservatives avoided
- Preservative used in 24 hrs sample
 - Hydrochloric acid- Adrenaline, Nor-adrenaline, vanillyl mandelic acid, steroids
 - Toluene- measurement of chemicals
 - Boric acid- general preservative
 - Thymol- inhibit bacteria and fungi
 - Formalin- formed elements

Physical examination of urine

Physical examination: appearance

Appearance	Diagnosis	Cause
White and cloudy on standing in alkaline urine	Disappear on addition of a drop of dilute acetic acid	Amorphous phosphates
Pink and cloudy in acid urine	Dissolve on warming	Amorphous urates
Varying grades of turbidity	Microscopy	Pus cells
Uniformly cloudy, do not settle at the bottom following centrifugation	Microscopy, nitrite test	Bacteria

Physical examination: volume

- 24 hrs average urine output- 600 to 2000 ml (adult)
- Polyuria
 - More than 2000 ml per day
 - Occurs in Diabetes Mellitus, Diabetes Insipidus , Chronic renal failure, diuretic therapy.
- Oliguria
 - Less than 400 ml per day
 - Febrile states, acute glomerulonephritis, congestive cardiac failure, dehydration
- Anuria
 - Less than 100 ml per day
 - Acute tubular necrosis, acute glomerulonephritis, complete urinary tract obstruction

Physical examination: colour

Different colours of urine	Found in
colorless	Dilute urine(diabetes mellitus, diabetes insipidus,
red	Haematuria , hemoglobinuria, porphyria, myoglobinuria
Dark brown to black	Alkaptonuria, melanoma
brown	hemoglobinuria
yellow	Concentrated urine
Yellow green or green	biliverdin
Deep yellow with yellow foam	bilirubin
Orange or orange brown	Urobilinogen, porphobilinogen
Milky white	chyluria
Red or orange fluorescence with UV light	porphyria

Physical examination: odour

- Fruity: ketoacidosis, starvation,
- Musty: phenylketonuria
- Fishy: UTI (*Proteus*), tyrosinaemia
- Ammoniacal: UTI (*E. coli*)
- Foul: UTI
- Sulfurous: cystinuria

Physical examination: pH/reaction (1/2)

- Normal range: 4.6-8
- Tested by
 - Litmus paper
 - pH indicator paper
 - pH meter
 - Reagent strip test



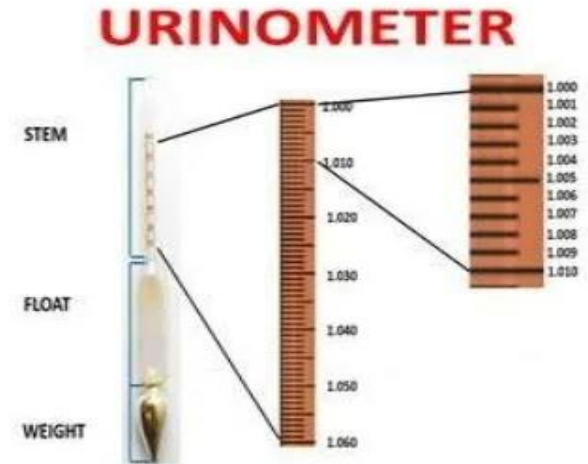
Physical examination: pH/reaction (2/2)

- Acidic urine:
 - Ketosis - diabetes mellitus, starvation, fever
 - UTI by *E. coli*
 - High protein diet

- Alkaline urine:
 - Strict vegetarian
 - UTI by *Proteus* or *Pseudomonas*
 - Sever vomiting
 - CRF

Physical examination: Specific gravity (1/2)

- Depends on the concentration of various solutes in the urine
- Normal range :1.003 to 1.030 at 20°C
- Measured by :
 - Urinometer
 - Refractometer
 - Reagent strip method



Physical examination: Specific gravity (2/2)

- High specific gravity
 - Diabetes mellitus(glycosuria)
 - Nephrotic syndrome (proteinuria)
 - Fever
 - Dehydration
- Low specific gravity
 - Diabetes insipidus
 - Chronic renal failure

Chemical examination of urine

Chemical examination: Protein

Causes of proteinuria (1/3)

- **Normal value:** 150 mg per day
- **Glomerular proteinuria:** due to increased permeability of glomerular capillary wall
 - Selective (only albumin and transferrin bands seen by electrophoresis)
 - Nonselective (pattern same as serum)

Chemical examination: Protein

Causes of proteinuria (2/3)

- **Tubular proteinuria:** Proteinuria caused by renal tubular dysfunction.
- acute and chronic pyelonephritis, heavy metal poisoning, tuberculosis of kidney
- **Overflow proteinuria:** Proteinuria associated with increased production of abnormal low molecular weight proteins,
 - Bence jones protein (plasma cell dyscrasias)
 - Hemoglobin (intravascular haemolysis)
 - Myoglobin (skeletal muscle trauma)
 - Lysozyme (acute myeloid leukemia type M4 or M5)

Chemical examination: Protein

Causes of proteinuria (3/3)

- **Hemodynamic proteinuria:** alteration of blood flow causes increase protein filtration
 - High fever
 - Hypertension
 - Congestive cardiac failure
 - Heavy exercise
- **Post-renal proteinuria:** Inflammation and neoplasia of
 - Renal pelvis
 - Ureter
 - Bladder
 - Prostate
 - Urethra

Causes of glycosuria

- Glycosuria with hyperglycaemia:
 - Diabetes
 - Acromegaly
 - Cushing's disease
 - Hyperthyroidism
 - Drugs like corticosteroids
- Glycosuria without hyperglycaemia:
 - Renal tubular dysfunction

Ketone bodies

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

Causes of ketonuria

- Diabetes
- Non diabetic causes :
 - High fever
 - Starvation
 - Sever vomiting
 - Diarrhoea
- Glycogen storage diseases

Causes of Urobilinogen in urine

- Hemolytic jaundice
- Early hepatitis
- Hepatocellular jaundice

Causes of Haematuria

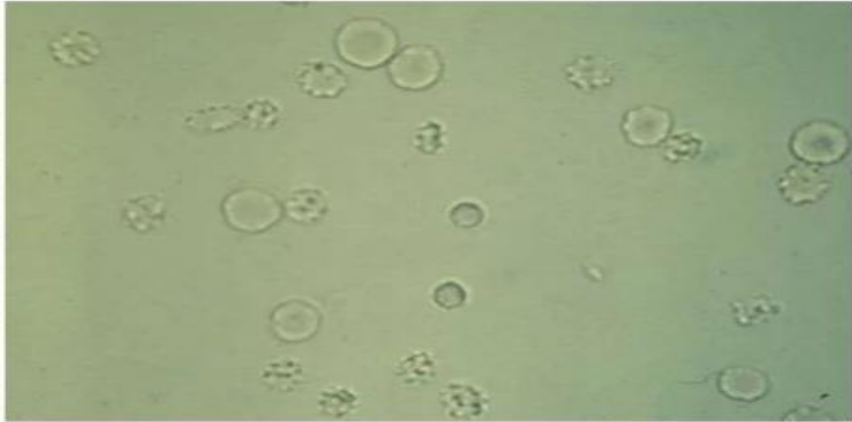
- Disease of urinary tract
 - Glomerular disease :
 - Glomerulonephritis
 - Berger's disease
 - Lupus nephritis
 - Henoch-Schonlein purpura
 - Non glomerular disease: Calculus , tumor, infection, tuberculosis, pyelonephritis, trauma, carcinoma of prostate
- Hematological condition:
 - Coagulation disorders , sickle cell disease

MICROSCOPIC EXAMINATION

Microscopic examination

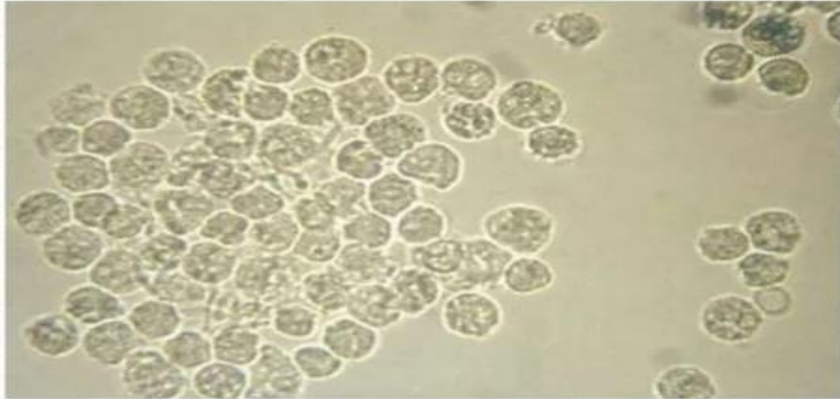
- Qualitative technique
- Urine must be **freshly** voided
- Examined without excessive delay in order to prevent cellular degeneration
- If preservative is required ,then 1 crystal of thymol or 1 drop of formalin (40%)is added to 10 ml of urine
- Well mix sample of urine(10 -15ml)is centrifuged in machine for 5mins at 1500 rpm.
- The top part(supernatant)is discarded. A drop of urine left at the bottom of test tube (sediment)is placed on the glass slide and covered with cover slip it is examined under high power

Red Blood cells



- Normally no RBC found
- Small, smooth, yellowish, anucleate biconcave disks
- 7 μ in diameter- isomorphic
 - Found Fresh urine
- 9-10 μ in diameter- swollen
 - Found in hypotonic urine
- Smaller diameter with spikey surface - crenated
 - hypertonic urine
- Variable in size and shape- dysmorphic
 - Glomerulonephritis

White Blood cells



- Spherical.
- Granular with visible nuclei
- 10-15 μ in size
- distorted, smaller, and have fewer granules-
degenerative WBC
- Infection – seen in clumps

Epithelial cells



- Small, polyhedral, columnar, or oval cells have granular cytoplasm, and an eccentric nucleus is seen.
- Found in acute tubular necrosis, pyelonephritis, viral infection,

Urinary casts

- Cylindrical aggregations of particles
- Form in the distal renal tubules and collecting ducts
- Composed of a precipitation of Tamm- Horsfall protein

Types of urinary casts

- Acellular casts
 - Hyaline casts
 - Granular casts
 - Waxy casts
 - Fatty casts
 - Broad casts
- Cellular casts
 - Red cell casts
 - White cell casts
 - Epithelial cell casts

Hyaline casts



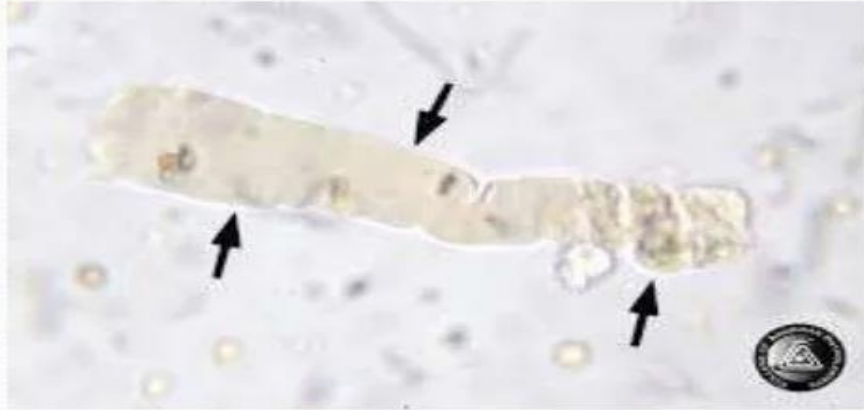
- The most common type of casts.
- They are cylindrical with parallel sides and blunt rounded end, colourless, homogenous, transparent.
- Seen in fever, strenuous exercise, glomerular proteinuria

Granular casts



- They are cylindrical structure with coarse or fine granules
- Seen in acute glomerulonephritis and pyelonephritis

Waxy casts



- They have homogenous smooth glassy appearance ,cracked or serrated margins and irregular broken off ends.
- Seen in end stage renal failure

Fatty casts



- They are cylindrical structures filled with highly refractile fat globules in Tamm Horsfall protein matrix
- Seen in nephrotic syndrome

Crystals in urine

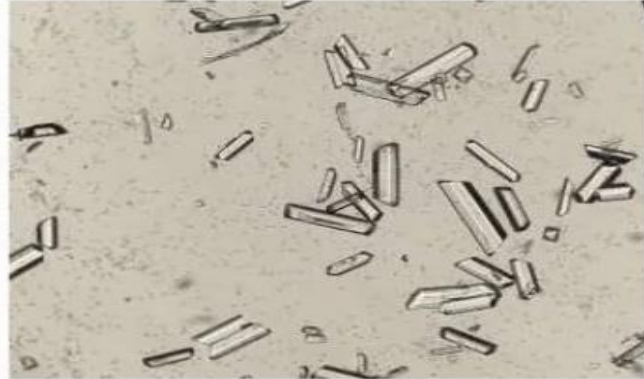
Normal crystals in urine

- Crystals present in acidic urine
 - Uric acid crystals : These are variable in shape and are yellow brown in colour and soluble in alkali and insoluble in acid. Found in Gout and leukemia.
 - Calcium oxalate crystals : These are colourless envelope-shaped .commonly found in diets rich in tomatoes, cabbages. Large number are seen in Ethylene glycol poisoning.
 - Amorphous urates :These are urate salts of potassium, magnesium, or calcium in acid urine
- Crystals present in alkaline urine
 - Calcium carbonate crystals: small colorless, grouped in pair
 - Ammonium phosphate crystals: yellow brown ,cactus like, called as thornapple
 - Phosphates: Triple phosphates: colorless ,3-6 sided prisms with oblique surfaces at the end.
 - Calcium hydrogen phosphate: colorless and variable shape
 - Amorphous phosphate :colorless small granules.

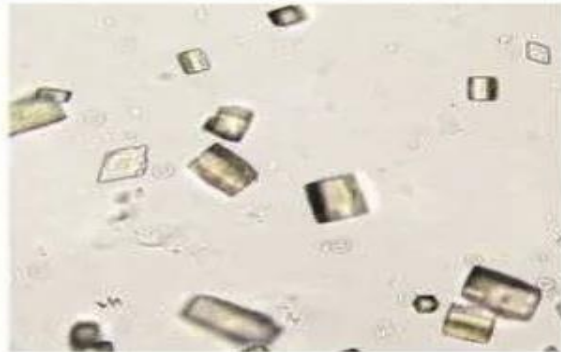
Normal crystals found in urine



Calcium oxalate



Triple phosphate



Uric acid



Calcium carbonate

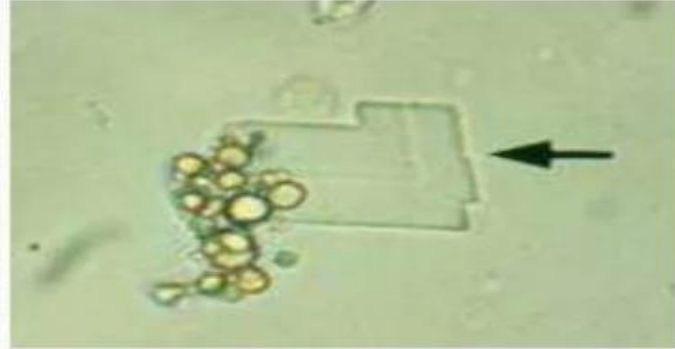
Abnormal crystals in urine

- Cysteine crystals: colorless clear hexagonal, highly refractile plates, soluble in hydrochloric acid. Seen in Cystenuria.
- Cholesterol crystals : colorless refractile, flat rectangular plates with notched corner. Seen in Nephrotic syndrome and hypercholesterolemia.
- Bilirubin crystal: brown and variable shapes. Seen in obstructive liver disease.
- Tyrosine crystals : clusters of fine colorless or yellow needles. Seen in liver disease and Tyrosinemia .
- Leucine crystals: refractile, yellow or brown spheres with radial or concentric striation. Seen in urine along with tyrosine in severe liver disease(cirrhosis)

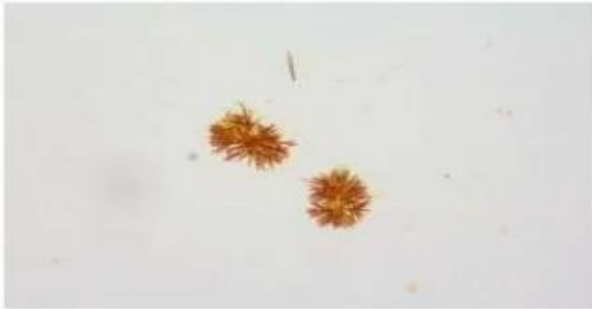
Abnormal crystals found in urine



Cysteine



Cholesterol



Bilirubin



Leucine