

3 glass technique	For detection of prostatic infection 1. 1 st portion of voided urine 2. Middle portion of voided urine: Serves as control for kidney and bladder infection -If (+), result for #3 is considered invalid 3. Urine after prostatic massage Compare WBC and Bacteria of specimen 1 and 3 Prostatic infection: $1 < 3$ (10x)
Pediatric specimen	Wee bag
Drug Specimen Collection	<u>Chain of custody</u> : step by step documentation of handling and testing of legal specimen Required amount: 30-45 mL Temperature (urine): 32.5-35.7°C (w/in 4 mins) Blueing agent → Toilet bowl (to prevent adulteration)
Types of Urine Specimen	
Occasional/Single/Random	Routine Qualitative UA
24 hr	1 st voided urine → discarded w/ preservative Ex. 8AM → 8AM
12 hr	Ex. 8AM → 8PM Addis count: measure of formed elements in the urine using hemacytometer
Afternoon (2PM-4PM)	Urobilinogen (alkaline tide)
4 hr	Nitrite determination (1 st morning/4 hr) $\text{NO}_3 \rightarrow \text{NO}_2 = (+)$ UTI
1 st morning	Pregnancy test (hCG) Ideal specimen for routine UA Most concentrated and most acidic = preservation of cells and casts
Fasting/2 nd morning	Glucose determination 2 nd voided urine after a period of fasting
Changes in Unpreserved Urine	
Decreased	
Clarity	Bacterial multiplication Precipitation of AU/AP
Glucose	Glycolysis
Ketones	Volatilization
Bilirubin	Photooxidation
Urobilinogen	Oxidized to urobilin
RBC/WBC	Disintegrate in alkaline urine
Increased	
pH	Urea --- (Urease) ---> NH_3
Bacteria	Multiplication
Odor	Urea --- (Urease) ---> NH_3
Nitrite	Bacterial multiplication
Differentiate contamination from true infection	Contamination: ↑ Bacteria True infection: ↑ Bacteria and WBCs
Preservation	
Refrigeration	2-8°C ↑ SG (hydrometer/urinometer) Precipitate AU/AP
Formalin	Addis count
Boric acid	Urine culture

Red/Purple/Burgundy red/ purplish red/Portwine	Porphyria (Lead poisoning: normal color)
Brown/black	Methemoglobin (acid urine) Homogentisic acid: Alkaptonuria -Urine darkens after a period of standing -(-) Homogentisic acid oxidase
Urine Color Changes w/ Commonly Used Drugs	
Cola-colored	Levodopa (Tx: Parkinsonism) Red → Brown (alkaline)
Yellow	Mepacrine/Atabrine (Tx: Malaria, Giardiasis)
Red to brown	Metronidazole/Flagyl (Tx: Trichomoniasis, Amoebiasis, Giardiasis) Methyldopa/Aldomet (Antihypertensive)
Orange-red (acid)	Phenazopyridine/pyridium (Tx: UTI)
Bright orange-red (acid)	Rifampin (Tx: TB) = all body fluids are red
Bright yellow	Riboflavin (Multivitamins)
Nubecula	Faint cloud in urine after a period of standing WBCs, epithelial cells and mucus
Bilifuscin (Dipyrrole)	Hemoglobin Köln = unstable Red-brown urine
Clarity/Transparency/Turbidity	
Clear	Transparent, no visible particulates
Hazy	Few particulates, print easily seen through urine
Cloudy	Many particulates, print blurred through urine
Turbid	Print cannot be seen through urine
Milky	May precipitate or clear
Bacteria	Uniform turbidity, NOT cleared by acclification or filtration
Chyluria	Lymph fluid in urine Parasitis
Squamous epithelial cells	↑ females
Radiographic contrast media	↑ SG by refractometer (>1.040) Rgt strip: not affected by RCM
Vaginal cream	Tx: <i>Candida</i> Pseudochyluria
Laboratory Correlations in Urine Turbidity	
Acidic urine	AU RCM
Alkaline urine	AP Carbonates
Soluble w/ heat	AU Uric acid
Soluble w/ dilute acetic acid	RBCs AP Carbonates
Insoluble in dilute acetic acid	WBCs Yeasts Spermatozoa Bacteria
Soluble in ether	Lipids Lymph fluid Chyle

Specific Gravity	
SG	Density of solution compared w/ density of similar volume of distilled H ₂ O at a similar temperature NV = 1.003-1.035 (random) SG <1.003 = not a urine except DI
Refractometer (TS meter)	Based on refractive index: $RI = \frac{\text{light velocity in air}}{\text{light velocity in soln}}$ Compensated to temperature (15-38°C) Corrections: a. 1g/dL glucose: (-0.004) b. 1g/dL protein: (-0.003) <u>Calibrations:</u> a. Distilled H ₂ O = 1.000 b. 5% NaCl = 1.022 ± 0.001 c. 9% Sucrose = 1.034 ± 0.001
Urinometer	Requires temperature correction a. ↑ 3°C calibration temperature (20°C) = (+0.001) b. ↓ 3°C calibration temperature (20°C) = (-0.001) Requires correction for glucose and protein (Rf/U)
Rf < U by 0.002	Refractometer reading is lower than the urinometer reading by 0.002
Urinometer calibration	K ₂ SO ₄ solution: 1L H ₂ O + 20.29g K ₂ SO ₄ SG = 1.015
Isosthenuria	SG = 1.010 (Glomerular filtrate)
Hyposthenuria	SG < 1.010
Hypersthenuria	SG > 1.010
Urine Odor	
Aromatic/Odorless	Normal
Ammoniacal	Urea → (Urease) → NH ₃ Ex. UTI (<i>Proteus</i> : ↑ urease)
Fruity, sweet	DM (Ketones)
<u>Rotten fish/Galunggong</u>	<u>Trimethylaminuria</u>
Sweaty feet	Isovaleric acidemia
Mousy	Phenylketonuria
Cabbage	Methionine malabsorption
Caramelized sugar, curry	MSUD
Bleach	Contamination
Sulfur	Cystine disorder

Chemical Examination of Urine	
Specific Gravity	
Principle (Rgt Strip)	pKa dissociation constant ↑ concentration = ↑ H ⁺ Indicator: Bromthymol blue = (↓) Blue → Green → Yellow (↑)
Other info.	Not affected by glucose, protein and RCM
Harmonic Oscillation Densitometry	Frequency of soundwave entering a solution will change in proportion to the density (SG) of the solution -Yellow IRIS (Automated): International Remote Imaging System
pH	
Normal	Random = 4.5-8.0 1 st morning = 5.0-6.0 pH 9.0 = Unpreserved urine

	ID: yellow-brown granules of hemosiderin in cells and casts
Sediment Constituents	
RBCs	NV = 0-2 or 0-3/hpf Hypertonic: crenated, shrink Hypotonic: Ghost cells, swell, hemolyzed Dysmorphic: glomerular membrane damage, w/ projections, fragmented Sources of error: -Yeasts -Oil droplets -Air bubbles -CaOx crystals 🎵 Remedy: add 2% acetic acid -RBCs: lysed -Other cells: intact
WBCs	NV = 0-5 or 0-8/hpf Glitter cells (Hypotonic urine) -Granules swell -Brownian movement <u>>1% eosinophils: significant</u> -↑ Drug-induced allergic reaction -↑ Inflammation of renal interstitium
Addis count	Quantitative measure of formed elements of urine using hemacytometer Specimen: 12 hr urine Preservative: Formalin NV: a. RBCs: 0-500,000/12 hr urine b. WBCs: 0-1,800,000/12 hr urine c. Hyaline Casts: 0-2000/hr urine
Squamous epithelial cells	Largest cells in the urine sediment From linings of vagina, female urethra and lower male urethra 🎵 Variation: Clue cells: -EC w/c are studded w/ bacteria (bacterial vaginosis) -Whiff/Sniff test: vaginal discharge + 10% KOH → Fishy amine-like odor -Culture: <i>G. vaginalis</i> = HBT medium
Transitional epithelial cells (Urothelial cells)	Spherical, polyhedral, or caudate w/ <u>centrally located nucleus</u> Derived from the linings of the renal pelvis, ureter, urinary bladder, male urethra (upper portion) Not clinically significant in small numbers
Renal tubular epithelial cells	Rectangular, polyhedral, cuboidal or columnar w/ an <u>eccentric nucleus</u>, possibly bilirubin stained or hemosiderin laden From nephron: -PCT: rectangular, columnar/convoluted -DCT: round/oval >2 RTE/hpf: tubular injury
Oval fat body	Lipid containing RTE cells Lipiduria (Ex. nephrotic syndrome) Cholesterol: Maltese cross
Bubble cells	RTE cells w/ nonlipid containing vacuoles Acute tubular necrosis
Yeast	<i>C. albicans</i> (DM, vaginal moniliasis)
<i>T. vaginalis</i>	Flagellate w/ jerky motility

	Hartnup disease: "Blue diaper syndrome" Obermayer's test: $\text{FeCl}_3 \rightarrow (+)$ Violet w/ chloroform
Argentaffinoma	Carcinoid tumor involving argentaffin cells $\uparrow$ 5-HIAA: metabolite of serotonin $\text{FeCl}_3 \rightarrow (+)$ Blue-green (PKU) Nitrosonaphthol $\rightarrow (+)$ Violet w/ HNO_3 Be sure patient should avoid banana, pineapple, tomatoes (serotonin-rich)
Cystine Disorders	
Cystinuria (Renal type)	Defect in renal tubular transport of: -Cystine (least soluble $\rightarrow$ urine) -Ornithine -Lysine -Arginine
Cystinosis	Inborn error of metabolism Cystine deposits in many areas of the body Cyanide-nitroprusside $\rightarrow (+)$ Red-purple
Homocystinuria	Defect in the metabolism of homocystine Silver nitroprusside $\rightarrow (+)$ Red-purple
Brand's modification of Legal's nitroprusside	Rxn: Cyanide-nitroprusside $\rightarrow (+)$ Red-purple
Mucopolysaccharide Disorders	
MPS	Dermatan SO_4 Keratan SO_4 Heparan SO_4
Clinical significance	Alder-Reilly syndrome Hurler syndrome = MPS $\rightarrow$ cornea of the eye Hunter syndrome = Sex-linked recessive Sanfilippo syndrome = Mental retardation only
CTAB	(+) White turbidity
Urine Disorders	
Lesch-Nyhan disease	$\uparrow$ Urinary uric acid crystals
Porphyrias	
D-ALA	Glycine + Succinyl CoA $\rightarrow$ (ALA synthetase) $\rightarrow$ D-ALA
Porphobilinogen	D-ALA $\rightarrow$ (ALA synthetase) $\rightarrow$ Porphobilinogen <u>Lead poisoning</u> : inhibits ALA synthase
Uroporphyrinogen	Porphobilinogen $\rightarrow$ (Uroporphyrinogen synthase/ Uroporphyrinogen cosynthase) $\rightarrow$ Uroporphyrinogen <u>Acute intermittent porphyria</u> : (-) Uroporphyrinogen synthase <u>Congenital erythropoietic porphyria</u> : (-) Uroporphyrinogen cosynthase
Coproporphyrinogen	Uroporphyrinogen $\rightarrow$ (Uroporphyrinogen decarboxylase) $\rightarrow$ Coproporphyrinogen <u>Porphyria cutanea tarda</u> : (-) Uroporphyrinogen decarboxylase
Protoporphyrinogen	Coproporphyrinogen $\rightarrow$ (Coproporphyrinogen oxidase) $\rightarrow$ Protoporphyrinogen <u>Hereditary coproporphyria</u> : (-) Coproporphyrinogen oxidase
Protoporphyrin IX	Protoporphyrinogen $\rightarrow$ (Protoporphyrinogen oxidase) $\rightarrow$ Protoporphyrin IX <u>Variegate porphyria</u> : (-) Protoporphyrinogen oxidase
Heme	Protoporphyrin IX + Fe^{2+} $\rightarrow$ (Ferrochelatase) $\rightarrow$ Heme <u>Lead poisoning</u> : inhibits Ferrochelatase
Porphyrias	Vampire disease Disorders of porphyrin metabolism

	Access to procedure manuals Competency of personnel performing the tests			
Microscopic Quantitations				
	EC (lpf)	Crystals (hpf)	Bacteria (hpf)	Mucous threads
None	0	0	0	-
Rare	0-5	0-2	0-10	0-1
Few	5-20	2-5	10-50	1-3
Moderate	20-100	5-20	50-200	3-10
Many	>100	>20	>200	>10
Casts (lpf)	None = 0 Numerical ranges = 0-2/2-5/5-10/>10			
RBCs (hpf)	None = 0 Numerical ranges = 0-2/2-5/5-10/10-25/25-50/50-100/>100			
WBCs (hpf)	None = 0 Numerical ranges = 0-2/2-5/5-10/10-25/25-50/50-100/>100			
Quality Assurance Errors				
Preanalytical	Patient misidentification Wrong test ordered Incorrect urine specimen type collected Insufficient urine volume Delayed transport of urine to the laboratory Incorrect storage or preservation of urine			
Analytical	Sample misidentification Erroneous instrument calibration Reagent deterioration Poor testing technique Instrument malfunction Interfering substances present Misinterpretation of quality control data			
Postanalytical	Patient misidentification Poor handwriting Transcription error Poor quality of instrument printer Failure to send report Failure to call critical values Inability to identify interfering substances			
TQM	Based on a team concept involving personnel at all levels working together to achieve a final outcome of customer satisfaction through implementation			
CQI	Improving patient outcomes by providing continual quality care in a constantly changing health-care environment			
PDCA	Plan-Do-Check-Act			
PDSA	Plan-Do-Study-Act			

	(+) Pink = HbF (-) Yellow brown = Maternal Hgb
Diarrhea	Acute: <4 weeks Chronic: >4 weeks
Secretory diarrhea	↑ solute secreted by the intestine Endotoxins
Osmotic diarrhea	↑ amounts of osmotically active solutes in the lumen (maldigestion) ↑ CHO in stool
Intestinal hypermotility	Secretory and osmotic diarrhea Laxatives Emotions/stress Cardiovascular drugs
Fecal enzymes	1. Trypsin = X-ray paper = Trypsin deficiency (CF): inability to digest gelatin on the X-ray paper 2. Chymotrypsin 3. Elastase I = pancreas specificity
Fecal CHO	<u>Stool pH = 7.0-8.0</u> pH 5.5 = CHO disorders (lactose intolerance) Clinitest: >0.5 g/dL = CHO intolerance Follow up tests: a. D-xylose: malabsorption b. Lactose intolerance test: maldigestion
Fecal Leukocytes	Primarily neutrophils ↑ Neutrophils: -Salmonella -Shigella -Campylobacter -Yersinia -EIEC (-) Fecal leukocytes: -Parasites -Viruses -S. aureus -Vibrio spp
Methylene blue	For wet preparation Faster procedure than Wright's and GS (for dry smears) but may be more difficult to interpret
Lactoferrin Latex agglutination test	Sensitive in refrigerated and frozen specimens
↑ amounts of striated fibers	Biliary obstruction Gastrocolic fistulas
Fecal fats	NV = 1-6 g/day
Qualitative Fecal fat test	Sudan III = most routinely used Sudan IV Oil red O
Split fat stain	Free fatty acids and fatty acids from hydrolysis of soaps and neutral fats NV = 100 droplets (<4 µm) Slightly increased = 100 droplets (1-8 µm) Increased = 100 droplets (6-75 µm)
Quantitative Fecal fat test	Confirmative test for steatorrhea 3 day specimen