

Urinalysis Report Interpretation

A Mini-CME Activity

for Underwriting Department, New Business Division, Fortune
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Echo Lecture by:

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Urine – Gross Examination

- **Direct visual observation.**
 - Normal, fresh urine is clear and **pale to dark yellow** or **amber** in color.
 - **Cloudiness** may be caused by excessive **cellular material** or **protein** in the urine or may reflect from **crystallization** or **precipitation of salts** upon standing at room temperature or in the refrigerator.
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Urine – Gross Examination

- **Direct visual observation - 2**

- **Clearing of the specimen after** addition of a small amount of **acid** indicates that **precipitation of salts** is the probable cause of turbidity.
 - A **red or reddish-brown** color could be from a **food dye**, consumption of **beets**, a drug, or the presence of either hemoglobin (from the **breakdown of blood**) or myoglobin (**muscle breakdown**).
 - If the sample contains many red blood cells, it would be **cloudy** as well as **red**.
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Reading The Dipstick

- **The dipstick yields valuable information which is available by direct observation after brief immersion of the urine specimen.**
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Acid/Base (pH)

- **pH**, a reflection of acid/base levels.
 - The initial filtrate of blood plasma is usually acidified by the renal tubules and collecting ducts (microscopic structures in the kidneys of which there are millions) from a pH of **7.4 to about 6** in the final urine → the **urine is acidified**.
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Acid/Base (pH)

- pH ...
 - However, depending on the acid-base status, urinary pH may range from as low as 4.5 to as high as 8.0.
 - One task nature has assigned to the kidneys is to rid the body of acid.
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Specific Gravity

- **Specific gravity** measures urine density which reflects the **ability of the kidney to concentrate or dilute the urine** relative to the plasma from which it is filtered.
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Specific Gravity -2

- Although dipsticks are available that also measure specific gravity in approximations, **most laboratories measure specific gravity with a instrument call a refractometer.**
 - **Specific gravity between 1.002 and 1.035 on a random sample should be considered normal if kidney function is normal.**
 - **Any** measurement below 1.007 to 1.010 indicates hydration **and any** measurement above it indicates relative dehydration
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Specific Gravity

- Urine having a specific gravity **>1.035** is either **contaminated**, contains very **high** levels of **glucose**, or the patient may have recently **received high density radiopaque dyes** intravenously for radiographic studies or **low molecular weight dextran** solutions.
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Protein

- While the dipstick test has a protein measurement, more elaborate tests for urine protein should be performed **since cells suspended in normal urine can produce a false high estimation of protein.**
- Normal total protein excretion does not usually exceed **150 mg/24 hours or 10 mg/100 ml** in any single specimen.

Protein - 2

- > 150 mg/day = proteinuria.
- Proteinuria **>3.5 gm/24 hours** is severe and indicates the **nephrotic syndrome**.
- Dipsticks detect protein by production of color with an indicator dye, Bromphenol blue, which is most sensitive to albumin but detects globulins and Bence-Jones protein poorly.
- Precipitation by heat is a better semi-quantitative method, but overall, it is not a highly sensitive test.

Protein - 3

- The sulfosalicylic acid test is a more sensitive precipitation test. It can detect albumin, globulins, and Bence-Jones protein at low concentrations.

- "Trace" protein is equivalent to 10 mg/100 ml or about 150 mg/24 hours (the upper limit of normal).
 - 1+ → ~ 200-500 mg/24 hours;
 - 2+ → ~0.5-1.5 gm/24 hours;
 - 3+ → ~0.2-5 gm/24 hours, and
 - 4+ → ~7 gm/24 hours or greater.

Glucose

- **Glycosuria (excess sugar in urine) generally means diabetes mellitus.**

Renal Threshold ~ 160-170mg/dl

Ketones

- Ketones (acetone, acetoacetic acid, beta-hydroxybutyric acid) may be present in **diabetic ketosis** or other forms of calorie deprivation (e.g. **starvation**).
 - Ketones are easily detected using either dipsticks or test tablets containing sodium nitroprusside.
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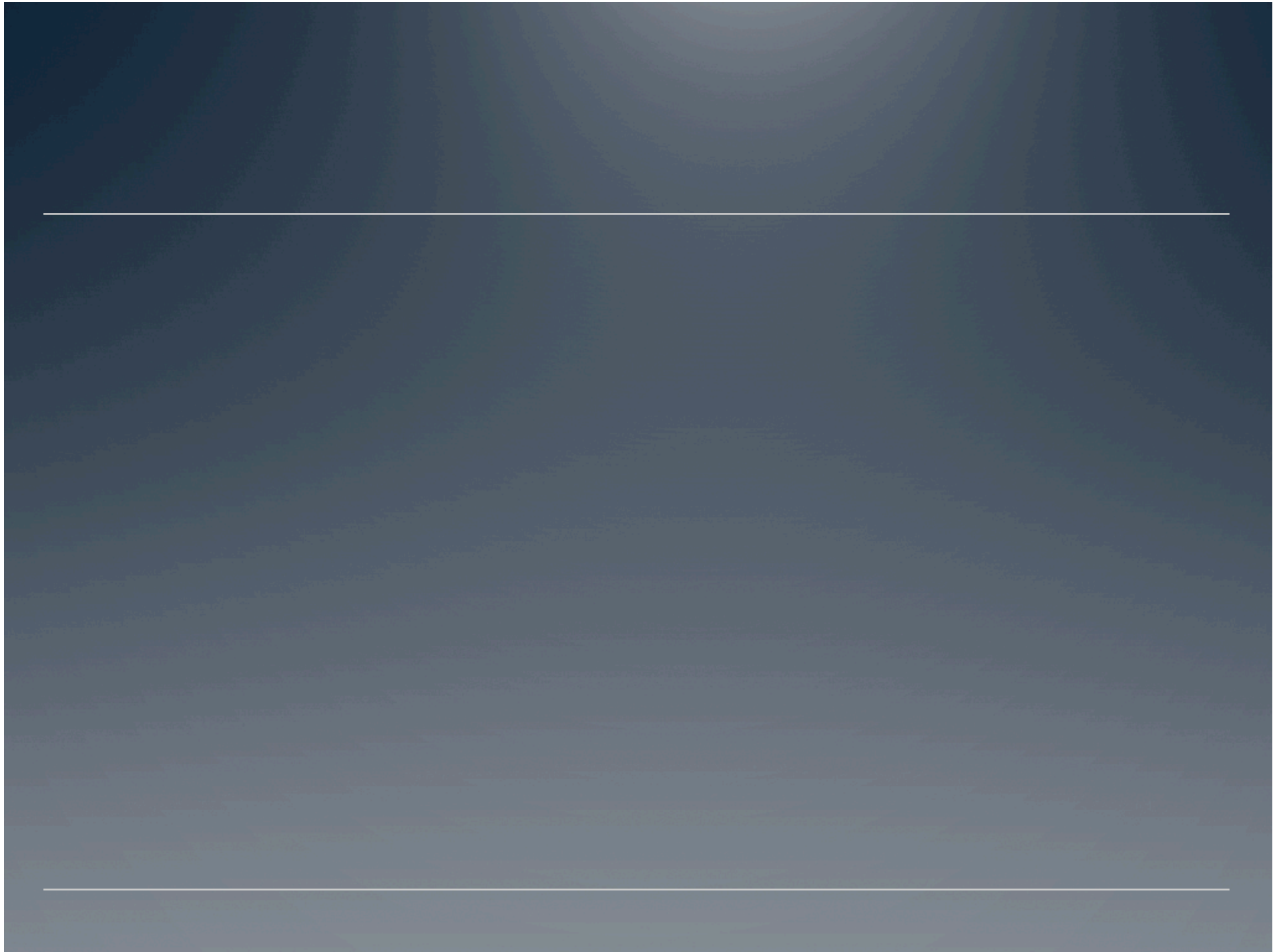
Nitrite

- A positive nitrite test indicates that bacteria may be present in significant numbers.
 - Gram negative rods such as *E. coli* are more likely to give a positive test.
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Leukocyte Esterase

- A (+) leukocyte esterase test < presence of white blood cells either as whole cells or as destroyed cells.
- A negative leukocyte esterase test means that an infection is unlikely. Without additional evidence there is no need for culture.

MICROSCOPIC URINALYSIS



General Considerations

- A sample of well-mixed urine (usually 10-15 ml) is centrifuged in a test tube at relatively low speed (about 2000-3,000 rpm) for 5-10 minutes which produces a concentration of sediment (cellular matter) at the bottom of the tube. The fluid on top is poured off to a volume of 0.2 ml to 0.5 ml left inside the tube. The sediment is re-suspended in the remaining urine by flicking the bottom of the tube several times. A drop of resuspended sediment is poured onto a glass slide and a thin slice of glass (a coverslip) is placed over it. The sediment is first examined under low power to identify crystals, casts, squamous cells, and other large objects.
 - **"Casts" are plugs of material which came from individual tubules. The numbers of casts seen are usually reported as number of each type found per low power field (LPF).**
 - For an example: "5-10 hyaline casts/L casts/LPF."
 - Since the number of elements found in each field may vary considerably from one field to the next, several fields are averaged.
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General Considerations

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 - "Casts"
 - Then, examination is carried out at **high power to identify crystals, cells, and bacteria.**
 - cells are described as the number of each type found **per average high power field (HPF).**
 - For example: "1-5 WBC/HPF."
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RBC

- Hematuria = presence of AbN numbers of red cells in urine. Causes:
 - glomerular damage,
 - tumors which erode the urinary tract anywhere along its length,
 - kidney trauma,
 - urinary tract stones,
 - renal infarcts,
 - acute tubular necrosis,
 - upper and lower urinary tract infections,
 - nephrotoxins,
 - and physical stress (like a contact sport, or long distance running for example).
 - Contamination < from the vagina in menstruating women or < trauma produced by bladder catheterization.
- Theoretically, no red cells should be found, but that is not true because some are present even in healthy individuals.

RBC

- However, if ≥ 1 RBC in every HPF, and if contamination is ruled out, the specimen reflects some abnormality.
 - Some leak excessive numbers of red cells with no identifiable cause = "idiopathic hematuria."
 - RBC's may appear normally shaped, swollen by dilute urine (in fact, only cell ghosts and free hemoglobin may remain), or crenated (deflated and wrinkled up) by concentrated urine.
 - Both swollen, partly **hemolyzed** RBC's and **crenated** RBC's are sometimes difficult to distinguish from WBC's in the urine.
 - In addition, red cell ghosts may simulate yeast.
 - (+) poorly shaped (**dysmorphic**) RBC's in urine ? CONSIDER: **glomerulonephritis**.
 - Dysmorphic RBC's have odd shapes as a consequence of being distorted via passage through the abnormal glomerular drainage structures.
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White Blood Cells

- Pyuria = (+) abnormal numbers of leukocytes (white cells) that may appear with infection in either the upper or lower urinary tract or with acute glomerulonephritis.
- Usually, the WBC's are granulocytes (a type of white cell which includes neutrophils and eosinophils).
- WBCs from the vagina, in the presence of vaginal and cervical infections, or the external urethral meatus (opening) in men and women can contaminate.
- If two or more leukocytes per each high power field appear in non-contaminated urine, the specimen is probably abnormal.

 - Leukocytes have lobed nuclei and granular cytoplasm.

Epithelial Cells

- Renal tubular (the microscopic tubes in the kidneys which lead to the drainage system) epithelial cells which are usually larger than granulocytes (again, a type of white cell which includes neutrophils and eosinophils) contain a large round or oval nucleus and normally appear in the urine in small numbers.
- However, with nephrotic syndrome and in conditions leading to tubular degeneration, the number sloughed into the urine is increased.

Epithelial Cells

- . When lipiduria (literally "fat in the urine") occurs, these cells contain endogenous fats. When filled with numerous fat droplets, such cells are called "oval fat bodies."
- Oval fat bodies exhibit a "Maltese cross" configuration by polarized light microscopy.
- Epithelial cells from the large drainage structures (the renal pelvis, ureter, or bladder) have more regular cell borders, larger nuclei, and smaller overall size than squamous epithelium.
- Renal tubular (from the microscopic tubules in the kidneys) epithelial cells are smaller and rounder than transitional epithelium, and their nuclei occupy more of the total cell volume.
- Squamous epithelial cells from the skin surface or from the outer urethra can appear in urine. They represent possible contamination of the specimen with skin bacteria.

Casts

- Urinary casts are formed only in the distal convoluted tubule (DCT) or the collecting duct (distal nephron).
 - The proximal convoluted tubule (PCT) and loop of Henle do not produce casts.
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Casts 2

- Hyaline casts are composed primarily of a mucoprotein (Tamm-Horsfall protein) secreted by tubule cells.
 - Even with injury causing increased glomerular permeability to plasma proteins with resulting proteinuria, most of the matrix (glue) that cements urinary casts together is Tamm-Horsfall mucoprotein, although albumin and some globulins are also part of it. Low flow rate, high salt concentration, and low pH, all lead to protein denaturation and precipitation, particularly that of the Tamm-Horsfall protein.
 - Protein casts with long, thin tails are formed at the junction of Henle's loop and the distal convoluted tubule and are known as cylindroids.
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Casts

- Hyaline casts can be seen even in healthy patients.
- ~~Red blood cells may stick together and form red blood cell casts.~~
 - Such casts are indicative of glomerulonephritis, with leakage of RBC's from glomeruli, or severe tubular damage.
- White blood cell casts are most typical for acute pyelonephritis, but they may also be present with glomerulonephritis.
 - Their presence indicates inflammation of the kidney, because such casts will not form except in the kidney.
 - *When cellular casts remain in the nephron for some time before they are flushed into the bladder urine, the cells may degenerate to present as a coarsely granular cast, later a finely granular cast, and ultimately, a waxy cast.*

Casts

- Granular and waxy casts are believed to come from renal tubular cell casts.
 - Broad casts come from damaged and dilated tubules → suggests End-stage Chronic Renal Disease.
 - The so-called telescoped urinary sediment is one in which red cells, white cells, oval fat bodies, and all types of casts are found in more or less equal profusion.
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Casts - 2

- The conditions which may lead to a telescoped sediment are:
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(1) malignant hypertension

(2) lupus nephritis,

(3) diabetic glomerulosclerosis, and

(4) rapidly progressive glomerulonephritis.

In end-stage kidney disease of any cause, the urinary sediment often becomes very scant because few remaining nephrons produce dilute urine.

Bacteria

- **Common in urine specimens**
 - because of the **abundant normal microbial flora of the vagina** in the female and the **the external urethral meatus** in both sexes and because of their **ability to rapidly multiply** in urine standing at **room temperature**.
 - Therefore, **microbial organisms found in all but the most scrupulously collected urines should be interpreted and correlated with the condition of the patient..**
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Bacteria

- Diagnosis of bacteriuria in a case of suspected urinary tract infection requires culture.
- Do colony count - to see if significant numbers of bacteria are present.
 - > 100,000/ml of one organism = significant bacteriuria.
 - The presence of multiple organisms reflect contamination.
 - However, the presence of any organism in catheterized or suprapubic tap (needle directly into the bladder) specimens should be considered significant.

Yeast

- **Yeast cells - contaminants or a true yeast infection.**
 - often difficult to distinguish from red cells and amorphous crystals
 - distinguished by their tendency to form buds (this is how they reproduce).
 - Often Candida - which can colonize bladder, urethra, or vagina.
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Crystals

- **Common crystals –**
 - **seen even in healthy patients**
 - **includes calcium oxalate, triple phosphate crystals and amorphous phosphates.**
 - **Rarely crystals of cystine**
 - **(in urine of neonates with congenital cystinuria or severe liver disease),**
 - **tyrosine crystals with congenital tyrosinosis or marked liver impairment, or**
 - **leucine crystals in patients with severe liver disease or with maple syrup urine disease.**
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Miscellaneous Findings

- Unidentifiable objects ("crud")
- Spermatozoa
- Pinworm ova.



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