Lab Activity 32

Urinalanalysis

Portland Community College
BI 233
Physical Characteristics of Urine

- **Color and transparency**
  - Clear, pale to deep yellow (due to urochrome)
  - Concentrated urine has a deeper yellow/amber color
  - A red or red-brown (abnormal) color could be from a food dye, eating fresh beets, a drug, or the presence of either hemoglobin or myoglobin.
  - If the sample contained many red blood cells, it would be cloudy as well as red.
  - **Turbidity or cloudiness** may be caused by excessive cellular material or protein in the urine
Physical Characteristics of Urine

- **Specific gravity** measures density of urine compared to water
- Ranges from 1.001 to 1.035
  - 1.001 is dilute
  - 1.035 is concentrated
- Is dependent on solute concentration
  - $> 1.035$ is either contaminated or contains very high levels of glucose
- Patients who have received radiopaque dyes or dextran can also have high specific gravity
Physical Characteristics of Urine

• Odor
  • Fresh urine is slightly aromatic
  • Standing urine develops an ammonia odor
  • Some drugs and vegetables (asparagus) alter the usual odor
  • Elevated ketones smells fruity or acetone-like
Chemical Composition of Urine

• Urine is 95% water and 5% solutes
• Nitrogenous wastes include urea, uric acid, and creatinine
• Other normal solutes include:
  • Sodium, potassium, phosphate, and sulfate ions
  • Calcium, magnesium, and bicarbonate ions
• Abnormally high concentrations of any urinary constituents may indicate pathology
Urinalysis

“Dipstick" method: chemical reactions cause color changes on ten different pads on the test strip.

1. Leukocytes
2. Nitrite
3. Urobilinogen
4. Protein
5. pH
6. Blood
7. Ketones
8. Bilirubin
9. Glucose
10. Glucose
Dipstick Urinalysis Interpretation

Leukocytes: Indicates infection or inflammation

Normal=negative

- Pyuria: Leukocytes in urine
- Cystitis: Bladder infection
- Pyelonephritis: Kidney infection
Dipstick Urinalysis Interpretation

Nitrite: Might indicate bacterial infection with gram-negative rods (like *E. coli*)

Normal=Negative
Dipstick Urinalysis Interpretation

**pH**: large range 4.5 to 8.0

- The urine pH should be recorded, although it is seldom of diagnostic value.
  - Diet can alter pH
    - Acidic: high protein diet, ketoacidosis
    - Alkaline: vegetarian diet, UTI
  - Phosphates will precipitate in an alkaline urine, and uric acid will precipitate in an acidic urine.
Dipstick Urinalysis Interpretation

**Protein**: Usually proteins are too large to pass through glomerulus (Proteinuria usually represents an abnormality in the glomerular filtration barrier.)

**Normal** = negative
- Trace amounts normal in pregnancy or after eating a lot of protein
- **Albuminuria**: Albumin in urine
Dipstick Urinalysis Interpretation

Glucose: In general the presence of glucose indicates that the filtered load of glucose exceeds the maximal tubular reabsorptive capacity for glucose.

**Normal** = negative

- Glycosuria: Glucose in urine
Dipstick Urinalysis Interpretation

**Ketones:** Intermediate products of fat metabolism

- Urine testing only detects acetoacetic acid, not the other ketones, acetone or beta-hydroxybuteric acid.

- **Normal** = negative or trace amounts
  - **Ketonuria:** ketones in urine
  - (Ketonuria + glucose in urine may indicate diabetes mellitus)
Dipstick Urinalysis Interpretation

Urobilinogen: Produced in the intestine from bilirubin. **Normal**=small amount

- Absence: renal disease or biliary obstruction
- Increased in any condition that causes an increase in production or retention of bilirubin
  - Hepatitis, cirrhosis or biliary disease
Dipstick Urinalysis Interpretation

Bilirubin: indicates the presence of liver disease or biliary obstruction

Normal = negative

- Bilirubinuria: appearance of bilirubin in urine
- Yellow foam when sample is shaken
Dipstick Urinalysis Interpretation

**Blood**: Almost always indicates pathology because RBC are too large to pass through glomerulus.

**Normal** = negative

- **Hematuria**: Blood in urine
- **Possible causes**: Kidney stone, infection, tumor
- **Caution**: Very common finding in women because of menstruation.
Chemical Analysis

- **Sulfates:** Normal constituent of urine
  - The urinary sulfate is mainly derived from sulfur-containing amino acids and is therefore determined by protein intake.
- **Phosphates:** Normal constituent of urine
  - Important for buffering $\text{H}^+$ in the collecting duct
- **Chlorides:** Normal constituent of urine.
  - Major extracellular anion.
  - Its main purpose is to maintain electrical neutrality, mostly as a counter-ion to sodium.
  - It often accompanies sodium losses and excesses.
Chemical Analysis

- **Urea**: The end product of protein breakdown
- **Uric acid**: A metabolite of purine breakdown
- **Creatinine**: Associated with muscle metabolism of creatine phosphate.
Microscopic Examination
Pyuria: WBC in Urine

- Normal:
  - Men: <2 WBCs per high power field
  - Women: <5
- WBC generally indicate the presence of an inflammatory process somewhere along the course of the urinary tract
Microscopic Examination
Hematuria: RBC in Urine

- RBC's may appear normally shaped, swollen by dilute urine or crenated by concentrated urine.
- The presence of dysmorphic (odd shaped) RBC's in urine suggests a glomerular disease such as a glomerulonephritis.
Microscopic Examination
Epithelial Cells

- Too many squamous cells: suggest contamination, poor specimen collection
Microscopic Examination
Epithelial Cells

- Transitional epithelial cells originate from the renal pelvis, ureters, bladder and/or urethra.
- Large sheets of transitional epithelial cells can be seen in bladder cancer.
Microscopic Examination

Bacteria

- Bacteria are common in urine specimens (from contamination)
- Therefore, microbial organisms found in all but the most scrupulously collected urines should be interpreted in view of clinical symptoms.

A = crenated RBC, B = RBC, C = bacteria
Struvite Crystals

- Formation is favored in alkaline urine.

- Urinary tract infection with urease producing bacteria (eg. Proteus vulgaris) can promote struvite crystals by raising urine pH and increasing free ammonia.
Uric Acid Crystals

- High uric acid in blood (by-product of purine digestion/high protein diet)
- Associated with gout (arthritis)
Calcium Oxalate Crystals

- They can occur in urine of any pH.
- Causes: Dietary asparagus and ethylene glycol (antifreeze) intoxication
Microscopic Examination

Casts

• **Casts**: hardened cell fragments formed in the distal convoluted tubules and collecting ducts
• Usually pathological
• Can only be seen with microscopic examination
Hyaline Casts

- Hyaline casts are composed primarily of a mucoprotein (Tamm-Horsfall protein) secreted by tubule cells.

- **Causes**: Low flow rate, high salt concentration, and low pH, all of which favor protein denaturation and precipitation of the Tamm-Horsfall protein.
Red Cell Casts

- Red blood cells may stick together and form red blood cell casts.
- Indicative of glomerulonephritis, with leakage of RBC's from glomeruli, or severe tubular damage.
White Cell Casts

- Usually indicates pyelonephritis (kidney infection)
- Other causes: Interstitial Nephritis (inflammation of the tubules and the spaces between the tubules and the glomeruli.)
The End