

III. **THE ROUTINE URINALYSIS**

A. History – Urinalysis is the oldest lab test still being performed today

1. Cave man noted change in urine properties associated with disease
2. Babylonians and Egyptians noted color, odor, and taste
3. Hippocrates (400 B.C.) added abnormal urine volume
4. Middle ages: four body humors – blood, flem, yellow-bile, and black bile
5. 16-18 Century Piss-Prophets
  
6. 19th Century scientific advancements
  - a. Richard Brite – correlated scared kidneys with clinical picture of edema and urine protein
  - b. Henry Bence-Jones – Bence-Jones protein
  - c. Development of handbooks and invention of microscope
  - d. “Wet” chemistries
  - e. Pre-WWII – simplification of UA procedures
  - f. Thomas Addis – Addis count

B. Importance

1. Diagnosis and management of renal or urinary tract disease
2. Detection of metabolic/systemic diseases not directly related to the kidney

C. Composition - concentrations influenced by diet, physical activity, body metabolism, endocrine function, and even body position.

1. Normal constituents - urea and other organic and inorganic chemicals dissolved in water.
  - a. Organic
    - 1) Uric acid – from purine catabolism
    - 2) Urea – protein and amino acid metabolism, constitutes half of the dissolved solids in urine.
    - 3) Creatinine – muscle metabolism

b. Inorganic

- 1) Anions – (neg charged) Cl, phosphate, sulfate
- 2) Cations – (pos charged) Na, K ammonium

c. Other constituents in small or trace amounts

- 1)  $\text{Ca}^{+2}$
- 2) Oxalate
- 3) Hormones
- 4) Catecholamines
- 5) Enzymes
- 6) Sugars
- 7) Proteins
- 8) Cholesterol and fatty acids
- 9) Vitamins
- 10) Metals

2. Formed elements - usually not part of the original ultrafiltrate. Their presence may indicate a disease process.

- a. RBC
- b. WBC
- c. Epithelial cells (renal, tubular, bladder, squamous)
- d. Hyaline casts (rare to occasional)
- e. Crystals, mucous, bacteria, parasites, yeast

3. Abnormal constituents

- a. A normal constituent in an abnormal amount
- b. A formed element in increased number
- c. A completely abnormal constituent as the result of some physical or metabolic problem

4. **Phenylketonuria** - mousy odor to urine
  - a. Inherited disorder (autosomal recessive) of phenylalanine metabolism causing severe mental retardation
  - b. Diagnosed by finding excess phenylpyruvic acid in serum and urine
  - c. Normally **phenylalanine** metabolized to tyrosine in liver
  - d. Lack of enzyme **phenylalanine hydrolase** causes accumulation of phenylalanine in plasma
  - e. Indications for testing for phenylketonuria
    - 1) Screening of all infants (state law) - PKU - blood test
      - a) Milk contains phenylalanine – after milk ingestion blood levels will increase. (Does not show up in the urine for 2-6 weeks).
      - b) Siblings of known case should be tested
    - 2) Management of disease
      - a) Diet should be monitored to eliminate phenylalanine. As child matures alternate pathways develop.
      - b) Adult mental defectives should be tested to alert relatives to possibility of occurrence
  - f. Tests for phenylketonuria
    - 1) Ferric chloride
    - 2) Phenistix
    - 3) Blood test – PKU Guthrie - bacterial inhibition test
5. **Alcaptonuria**
  - a. Along same line of amino acid metabolism impairment as PKU
  - b. Deficient enzyme – **homogentisic acid oxidase** – used in catabolism of phenylalanine and tyrosine

- c. Homogentisic acid (alkapton) excreted, accumulates in blood, tissues, and urine. May lead to arthritis, liver, cardiac disorders.
- d. No mental retardation
- e. Not usually diagnosed until adult
- f. \* Urine becomes dark brown or black upon standing
- g. Detect spectrophotometrically

### 6. **Maple-Syrup Disease**

- a. Characteristic odor
- b. Elevated levels of **valine, leucine, and isoleucine** in blood and urine
- c. Defective enzyme is branched chain keto acid decarboxylase
- d. Rare disease (autosomal recessive), very early death, some cases have been controlled by early diagnosis and treatment
- e. DNPH test - (2,4 dinitrophenylhydrazine)

### D. Collection of the Urine Specimen

- 1. Containers
  - a. Chemically clean – no contamination, preferably sterile
  - b. Tight-fitting lid
  - c. Clear plastic for routine UA
  - d. Non-routine and 24-hour collection – use brown or dark colored containers to keep light out
  - e. Properly labeled
  - f. Delivered to lab ASAP
- 2. Time
  - a. Random – collected at anytime

- b. First voided or first morning specimen is the recommended specimen for routine UA as it is most likely to reveal abnormalities. It is the most concentrated. Must be fasting for diabetic monitoring.
  - c. 2 glass urine – voiding process is divided into two segments
  - d. Mid-stream or "clean catch" specimen
  - e. Timed – collection of urine over a specified period of time. Examples: 2 hours, 24 hours, etc. Quantitative chemistry tests.
  - f. Catheterized
  - g. Ureteral – requires specialized catheterization to obtain samples from each (right and left) ureters
  - h. Suprapubic aspiration
3. Preservation – unless specimen can be tested within 1 hour, it should be refrigerated (preferred) or chemically preserved
- a. Reasons for preservation
    - 1) Most routinely collected urines are not truly sterile and heavy bacterial growth will occur at room temperature
    - 2) Bacterial growth causes changes in chemical properties
      - a) Increase in pH as bacteria act on urea to form ammonia
      - b) Decrease in glucose, if present, due to bacterial utilization
      - c) False positive protein is possible due to measurement of bacterial protein
      - d) Increased nitrites due to bacterial reduction of nitrates
    - 3) Other changes
      - a) The microscopic examination will reveal the increasing number of bacteria
      - b) Cells and casts will deteriorate in the alkaline urine
      - c) Ketones will disappear from the urine (false negative)

- d) decreased bilirubin from exposure to light
  - e) decreased urobilinogen as it is oxidized to urobilin
  - f) changes in color and turbidity
- b. Methods of preservation (most work by limiting bacteria growth, all have limitations)
- 1) Refrigeration at 4°C (as soon as possible following collection) is the most desirable of preservation methods.
    - a) Refrigeration will increase specific gravity and cause the precipitation of amorphous crystals.
    - b) Dipstick testing of cold urine samples may result in inaccurate results as the speed of the reactions on the dipstick would be reduced (alters the time required for reactions to come to completion).
  - 2) Freezing - destroys formed elements, but preserves bilirubin, urobilinogen, and porphobilinogen
  - 3) Chemical preservatives for routine urinalysis specimens
    - a) Toluene – preserves chemical constituents, prevents bacterial multiplication
    - b) Formalin – kills bacteria; preserves the sediment, but affects chemical tests
    - c) Thymol crystals – interferes with acid precipitation test for protein
    - d) Chloroform – inhibits bacterial growth, but changes the characteristics of the cellular sediment
    - e) Boric acid – may cause crystal precipitation, doesn't inhibit bacteria well
    - f) C & S Transport Kit - increases specific gravity and protein, decreases pH
4. Chemical preservatives for 24 hour urine specimens - National Committee for Clinical Laboratory Standards (NCCLS) provides guidelines.

5. Quality Control - NCCLS recommendations for urine specimen requirements to ensure specimen suitability
  
6. Classification of urine tests
  - a. Screening – detects only presence or absence of a substance
  
  - b. Qualitative (semi-quantitative) – provides a rough estimate of the amount of the substance
  
  - c. Quantitative – accurate determination of the substance being detected