VI. Automation in the Urinalysis Lab

A. Advantages

B. Instruments

1. Principle of reflectance photometry

2. Ames Co. – Clini-Tek

3. Boehringer Mannheim Corp. – Urotron

VII. Kidney Function Tests

A. Introduction - ***review of information***

1. Under normal circumstances, the ultrafiltrate will have a pH of 7.4 and specific gravity of about 1.010

2. Tubules reabsorb useful substances

3. Approximately 1 million functioning units = nephrons

   a. Don't all function simultaneously
   b. 60-75% reserve

4. 2/3 Kidney tissue must be damaged to impair function

* 5. Important flow rates

   a. Renal blood flow = 1200 ml/min
   b. Glomerular filtration rate = 120 ml/min
   c. Urine production = 1 ml/min
   d. Renal plasma flow = 660 ml/min

6. Basic kidney function

   a. Regulation of body water and plasma volume by varying the concentration of the urine
   b. Maintenance of acid-base balance
      1) Secretion and excretion of acids
      2) Excretion of basic substances

3) Hydrogen ion exchange
4) Reabsorption of bicarbonates and alkaline phosphates

c. Control of electrolyte balance

d. Elimination of waste products of metabolism

7. Threshold substances

a. Substances almost completely reabsorbed when concentration in the plasma is within normal range

b. Appear in urine when normal plasma level is exceeded

8. Need for function tests – urinalysis does not reflect extent or localization of damage

9. Basis of function tests – relies on the ability of the kidney to excrete a substance, i.e., nitrogen, salt, water or a dye

B. **Concentration Test (Fishberg)** - measures tubular reabsorption. Used to detect renal disease.

1. Principle – Given 200 ml of fluid and a high protein diet at 6:00 pm (with no other food or liquid until completion of test), a patient with a well functioning kidney will produce up to 300 ml of urine with a specific gravity of 1.026 or higher by 9:00 am the next morning

2. Urine collected at 7, 8 and 9 am

3. Volume and specific gravity of each measured

4. S.G. 1.010 indicates renal impairment

5. Dangerous for patients with ADH deficiency (diabetes insipidus)

6. Edema, sweats, diarrhea and fever interfere

C. **Phenosulfanaphthalein Test (PSP Dye Excretion)** - measures tubular secretion

1. Principle – Test measures the **secretory activity** of the proximal tubule which should excrete 94% of injected dye

2. Excretion of dye affected by tubular impairment and decreased renal flow

3. Procedure
   a. 30 minutes before test, patient drinks two glasses of water
   b. Empty bladder and discard specimen
   c. Inject 1 ml (6 mg) PSP dye
   d. Empty bladder 15, 30, 60 and 120 minutes after dye
   e. Record time, volume and dye concentration of each specimen
      1) Color produced by 10% NaOH
      2) Read spectrophotometrically or with visual standards
      3) Volume should be at least 40 ml per specimen

   f. Normal values
      1) 15 min = 30%
      2) 30 min = 15%
      3) 60 min = 10%

      Total of 55% excretion in first hour

   g. Patient with impaired renal perfusion will excrete less than 20% by the first 15 minutes

   h. Not reliable when liver impaired

D. **Clearance Tests** (Glomerular Filtration Rate Test, GFR test) - used to determine the extent of nephron damage and monitor it. Most common is the creatinine clearance test.

1. Definition: Quantitative expression of rate of excretion of a given substance

2. Calculation:

$$C = \frac{U \times V \times 1.73}{P \times A}$$

C = clearance (ml/min)

U = urinary concentration (mg/dl) of constituent

V = volume of urinary flow (ml/min)

P = plasma concentration of constituent

1.73 = average patient's square meter of body surface

A = patient's actual body size in square meters (taken from nomogram)

3. Types of GFRs

a. **Creatinine clearance** – measure of glomerular filtration rate which depends on the number of nephrons and their function. Creatinine is a waste product of muscle metabolism. Normally found in constant amounts in the blood.

1) 24 hour urine sample needed; also one blood sample

2) Normal = 88-137 ml/min

c) Determines the extent of nephron damage in known cases of renal disease. Can then monitor and medicate.

Example:

b. Other types of Clearance Tests: **Urea, Inulin, PAH (Sodium-p-aminohippurate)**

VIII. Urinary Calculi

A. Composition

1. Crystalloids embedded in a binding substance of mucous and protein

2. Usual constituents

a. Calcium oxalate - 75%
b. Phosphate
c. Magnesium
d. Ammonium
e. Apatite (calcium phosphate and carbonate)
f. Uric acid
g. Cystine

B. Analysis

1. Wet chemical analysis

2. X-ray crystallography (XRD)

3. Infrared spectroscopy (IR)

4. Raman spectroscopy

5. Scanning electron microscopy

6. Computed tomography