Lec no: 2 Urine examination Pathological analysis

Urinary system

Urinary system consists of pair of kidneys and urinary tracts which includes (two ureters, urinary bladder and urethra). Each kidney contains 1.3 million urinary units called nephrons. Each nephron consist of glomerulus and urinary ducts (Bowman's capsule, proximal convoluted tubule, Henley loop, distal convoluted tubule and collecting duct).

Nephrons responsible of urine formation through three sequence process:

1-Glomerular filtration, the Glomerular filtration rate(GFR) reach 180 liter /day. 2-Reabsorption 3-Secretion

Urination: is a voluntary process depends on person's choice to the suitable time and place to empty the urinary bladder from storage urine, without pain.

Disturbances in urination include:

1-Painful urination, frequency and urgency because of microbial UTI.
2-Impairment of urine flow, incomplete emptying because of urinary bladder obstruction.

3-Urinary retention, a sign of benign prostate enlargement (hypertrophy due to disfunction of bladder muscles or sphincter muscles.

Urinary tract infection (UTI):

Etiology(causes)

The most common cause of urinary tract infections (i.e., urethritis, cystitis, and pyelonephritis) is *E coli. Staphylococcus saprophyticus* is the second most common cause of these infections in females In complicated cases of urinary tract infections such as those resulting from anatomic obstructions or from catheterization, the most common causes are *E coli, Klebsiella pneumoniae, Proteus mirabilis, Enterococcus*, and *Pseudomonas aeruginosa*

Manifestations:

Urethritis: is an infection of the urethra that causes pain and discomfort during voiding (**dysuria**).

Cystitis: is an infection of the urinary bladder. Signs and symptoms of cystitis include urgency and frequency of urination, voiding small volumes of urine.

Kidney stones can serve as a location in which bacteria can escape antibiotics and cause recurrent urinary tract infections. *Proteus* can cause stones to form when it produces an enzyme called urease, which can catalyze the breakdown of urea to ammonia and carbon dioxide. The ammonia that results from this reaction will increase the pH of urine and cause formation of kidney stones.

Epidemiology

Most cases of urinary tract infection occur in women (female to male ratio is 30:1). The incidence of urinary tract infections increases with age.

■ Postmenopausal women have higher rates of infection because of bladder or uterine prolapse; loss of estrogen, which causes a change in the vaginal flora; loss of lactobacilli in the vaginal flora, which results in periurethral colonization with gram-negative aerobes (e.g., *E coli*); and higher of concomitant medical illness (e.g.,diabetes mellitus).

■ Males experience a rapid increase in the incidence of urinary tract infections sometime in the fifth decade of life due to obstruction of the urethra following development of benign prostatic hypertrophy.

■Urinary tract infections are usually endogenous; infection follows contamination of the distal end of the urethra with bacteria from the patient's own fecal organisms.

Kidney Function Test (URINE ANALYSIS)

Physical examination:

1-Urine volume: This is dependent normally up on fluid intake, environmental condition, diet and activity of the human .

Value above or below the **normal value (1.5 L/Day)** can be considered as pathological disorder but it should be combined with clinical and laboratory examination.

A-above normal (polyuria) urine volume (2.5-3L/Day) large quantities intake of liquids, diuretics, alcohol, in sufficient of urinary ducts in reabsorption of water and urine concentrated as in diabetes mellitus.

B-under normal (Oligourea) urine volume (< 400 ml/Day)

C- Anuria, urine volume (< 50 ml/Day), due to: hot weather, sweating, low water intake, or due to disease in kidney or urinary ducts.

2-Color: Can be observed in a test tube or in a urinometer tube. **Yellow to amber (Normal);** the color comes primarily from the presence of urobilin. Urobilin is a final waste product resulting from the breakdown of heme from hemoglobin during the destruction of aging blood cells. **Colorless to pale yellow**; dilute urine with low specific gravity and polyuria. **Dark yellow or yellow brown**; concentrated urine with a high specific gravity and small quantity.

Yellow brown or greenish yellow; yellow green foam when urine is shaken Urobilinoids – chromagon derived from heme green biliverdin yellow-brown-billirubin-and urobilin.

Cloudy; hematuria (clearer after centrifugation).

Blue; medication contain methylene blue or food with blue dyes.

3-Transparency (clarity):

Clear – freshly voided urine is clear.

Cloudy – not necessarily pathological as many samples may become cloudy.

Epithelial cells – present in large numbers.

Blood – red to brown color and smoky.

Leukocytes – may produce milky, ropy appearance if large number. **Bacteria** – produce a uniform turbidity if in large number; the turbidity doesn't settle out and cannot be removed by filtration.

4-Mucus:

5-Crystals: a salt compounds organized in geometrical shapes and looks like crystals, important in stones formation (cysteine crystals and oxalate crystals).

Amorphous urate – white or pink cloud **in acid urine**

Amorphous phosphate – white cloud **in alkaline urine**

6-Specific gravity (SG): determined by refractometer and indicator paper stripes. Normal value in Man **1.010 – 1.030**(Average normal = 1.025). depending on SG the urine will be diluted (SG< 1.002) or concentrated (SG>1.065) depend on the solvents in urine.SG used to determine the kidney efficiency keeping water balance in urine.

7-Odour: Normal odor – aromatic or acetone

Abnormal odor – aromatic odor of ketone bodies (sweet fruit odor) as in starvation and diabetes. In UTI the odor of urine is bad smell.

8-Foam:

Shake the sample and observe:

• If the amount of foam produced is in excess and slow to disappear – proteinuria

• If the color of the foam great – yellow or brown – bile pigments • If the color of the foam red to brown – hemoglobinuria

Microscopic Examination of Urine Sample

Important structure to be include casts, erythrocytes, leukocytes, epithelial cells, budding yeasts, protozoa and bacteria.

Casts: Cylindrical bodies performed in distal collecting tubules from RBCs or WBCs or fatty compounds or waxes. Dignosis of cast type aid in diagnosis of the disease. **Types of casts:**

Hyaline casts, density granulated casts, finely granulated casts, red cell casts (hematuria), and white cell casts (inflammation), wax casts, fat casts, and epithelial casts.

Budding yeasts: Candida albicans, found in diabetes patients urine because of the low PH and the presence of sugar necessary for the growth.

Protozoa: like Trichomonas vaginalis that infect the vagina in women and urethra in men and cause trichomoniasis.

Chemical Examination of Urine:

-PH of urine

The normal hydrogen ion (pH) concentration, in the urine (5-8) depends on the type of diet. Vegetable diet, citrus fruits (also bacterial infections) produce **alkaline urine**, while high protein diet (also blood acidosis where PH<7.35, some microbial infections, ketones elevation due to diabetes or aspirin intake) produce **acidic urine**. PH measured by paper strip or pH meter.
-Proteins of urine: a little quantity, of protein are found normally in urine (150 mg/day)any access in protein called proteinuria which is an indication for many diseases like kidney diseases , fever and pregnancy.
Types of protein in urine:

1-**Albumine**: is the first protein appearing in urine due to its low molecular weight and size (albuminuria), this protein appears in Diabetes and hypertenation.

2- Immunoglobulins: appear in urine due to inflammations and microbial infections

3-Hemoglobine: found in urine due to blood hemolysis.

-Glucose in urine:

No glucose is present in the urine normally which passes glomerular filter, because it is completely absorbed in the tubules. It present when the blood

glucose level elevated to(180mg/ml) which is called **renal threshold**, when blood glucose elevated the glucose present in urine as in diabetes.

Acetone (Ketone body) (ketones):

The ketone bodies include acetone, acetoacetic acid (diacetic acid) and betahydroxybutric acid. A state in which these substances are present in increased amount in the blood and urine is called ketosis. Acetoacetic acid and beta hydroxyl butric acid from which acetone is derived is normal **intermediate product of fat metabolism**. When greater amounts of fatty acids are utilized with the production of more acetoacetic acid and beta-hydroxybutric acid can be oxidized by the tissues. These bodies accumulate in the blood and are excreted in the urine (**ketonuria).** This bodies present in urine in starvation or low blood glucose levels.

Urine Culture:

Asymptomatic infection can be diagnosed by culture.

1-**Acute UTI** is more frequently seen in females of all ages; these patients are usually treated on an outpatient basis and are rarely admitted to hospital.
2-**Chronic UTI** in both males and females of all ages is usually associated with an underlying disease (e.g. pyelonephritis, prostatic disease, or congenital anomaly of the genitourinary tract) and these patients are most often hospitalized.

Since urine itself is a good culture medium, all specimens should be processed by the laboratory within **2 hours** of collection, or be kept refrigerated at **4C** until delivery to the laboratory and processed no longer than 18 hours after collection. The examination procedure includes the following steps:

1. Examination of a Gram-stained smear. (for the presence or absence of bacteria, polymorph nuclear leukocytes, and squamous epithelial cells).

2. A screening test for significant bacteriuria. The absence of leukocytes and bacteria in a Gram-stained smear of a clean catch urine sample prepared as

described above is good evidence that the **urine is not infected.** A urine specimen that is "negative" on careful examination of the Gram-stained smear does not need to be cultured.

3. A definitive culture for urine specimens found to be positive in the screening test, and for all specimens obtained by cystoscopy, suprapubic bladder puncture (SBP), or catheterization.

4. Susceptibility tests are generally more importanton cultures obtained from patients who are hospitalized or have a history of recurring UTI.