Al Muthanna University **College of Pharmacy**

Renal Physiology

By

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Second Stage

Functions of the kidney:

1- Filters blood plasma
- returns useful substances to blood
- eliminates waste

2- Regulation
- osmolarity of body fluids, blood volume.
- acid-base balance
- water and electrolyte balance

3- Endocrine function: secretes
- renin, erythropoietin and calcitriol (activation of vitamin D)

4- Elimination of metabolic end products (urea, creatinine, uric acid … etc.) and foreign materials (drugs)

The urinary system:

1- Kidneys

-Nephron (is the functional unit of kidney responsible for formation of urine)

-Renal arteries (Blood supply)

-Bowman's Capsule (is where glomerular filtration occurs)

2- Ureter

3- Urinary bladder

4- Urethra

Basic Renal Process:

1) Glomerular Filtration: Filtering of blood into tubule forming the primitive urine.
2) Tubular Reabsorption: Absorption of substances needed by body from tubule to blood.
3) Tubular Secretion: Secretion of substances to be eliminated from the body into the tubule from the blood.

Note: all these processes happens in Nephron.

What get filtered in the glomerulus ?

The substances that are secreted into the tubular fluid for removal from the body include:

1) Potassium ions (K+)
2) Hydrogen ions (H+)
3) Ammonium ions (NH4+)
4) Creatinine
5) Urea
6) Some hormones such as insulin.
7) Some drugs (e.g., penicillin)

Whereas proteins, immunoglobulins, ferritin and blood cells not filtered.

A- Biochemical tests of renal function

- Measurement of GFR
- Clearance tests
- Plasma creatinine
- Urea, uric acid and β2-microglobulin

B- Renal tubular function tests

- Osmolality measurements
- Specific proteinurea
- Glycouria
- Aminoaciduria

C- Urinalysis

- Appearance
- Specific gravity and osmolality
- PH
- Glucose
- Protein
- Urinary sediments

General Urine Lab .Form

وزارة الصحة
دائرة صحة المثنى
مستشفى النسائية والأطفال
شعبة المختبرات / وحدة الباراسايت

Patient Name [redacted]

Age Word

Colour : Yellow
App: Turbid
Sugar: —
Ketone bodies: —
ALB:: +
R.B.C : 1 – 2
PUS CELL : 2 – 4 } H.P.F
Epithelial cell : +

Mucus threads : —
Motile bacteria : —
Amorphus urate : ++++
Others

معاون مختبر
examiner's : حسين عبد
Huss /2024 Abd

Urine Analysis Report

Test	Result	
Physical Examination		
Collection	Random	
Volume	Sample	
Colour	Yellow	
Odour	Aromatic	
Aspect	Clear	
Deposit	Nil	
Chemical Examination		
Reaction	Acidic	
Sp .Gravity	1020	
Proteins (Albumin)	Nil	
Glucose	Nil	
Ketone Bodies	Nil	
Urobilinogen	Trace	
Bilirubin	Nil	
Nitrite	Negative	
Microscopic Examination		
Epithelial Cells	Nil	
Red Blood Cells	2-3	/HPF
Pus Cells	3-4	/HPF
Crystals	**"A.Urate+1"**	
Ova & Parasites	Nil	
Casts	Nil	
Bacteruria	Nil	

Why test renal function?

- To identify renal dysfunction
- To diagnosis renal disease
- To monitor disease progress
- To monitor response to treatment
- To assess changes in function that may impact on therapy (e.g. digoxin, chemotherapy)

When should you assess renal function?

- Older age
- Family history of Chronic Kidney disease (CKD)
- Diabetes Mellitus (DM)
- Hypertension (HTN)
- Autoimmune disease
- Systemic infections
- Urinary tract infections (UTI)
- Nephrolithiasis
- Obstruction to the lower urinary tract (bladder, urethra and prostate in male).
- Drug toxicity

Measurement of glomerular filtration rate (GFR)

estimated by measuring the urinary excretion of a substance that is completely filtered from the blood by the glomeruli and it is not secreted, reabsorbed or metabolized by the renal tubules.

Clearance is defined as the (hypothetical) quantity of blood or plasma completely cleared of a substance per unit of time.

$$(4.1)\quad \text{Clearance} = \frac{U \times \dot{V}}{P}\ \text{mL/min}$$

U = urinary creatinine concentration (µmol/L)
$\dot{V}$ = urine flow rate [mL/min or (L/24 h)/1.44]
P = plasma creatinine concentration (µmol/L)

Inulin

The volume of blood from which inulin is cleared or completely removed in one minute is known as the inulin clearance and is equal to the GFR.

Creatinine

- 1 to 2% of muscle creatine spontaneously converts to creatinine daily and released into body fluids at a constant rate.
- Endogenous creatinine produced is proportional to muscle mass, it is a function of total muscle mass
- the production varies with age and sex
- Dietary fluctuations of creatinine intake cause only minor variation in daily creatinine excretion of the same person.
- Small quantity of creatinine is reabsorbed by the tubules and other quantities are actively secreted by the renal tubules
- So creatinine clearance is approximately 7% greater than inulin clearance.
- An estimate of the GFR can be calculated from the creatinine content of a 24-hour urine collection, and the plasma concentration within this period.

Creatinine clearance in adults is normally about of 120 ml/min

Plasma Urea

Urea is the major nitrogen-containing metabolic product of protein catabolism in humans,

- Its elimination in the urine represents the major route for nitrogen excretion.
- More than 90% of urea is excreted through the kidneys, with losses through the GIT and skin
- Urea is filtered freely by the glomeruli
- Plasma urea concentration is often used as **an index of renal glomerular function**
- Urea production is increased by a high protein intake and it is decreased in patients with a low protein intake or in patients with liver disease.
- Many renal diseases with various glomerular, tubular, interstitial or vascular damage can cause an increase in plasma urea concentration.
- The reference interval for serum urea of healthy adults is 5-39 mg/dl. Plasma concentrations also tend to be slightly higher in males than females. High protein diet causes significant increases in plasma urea concentrations and urinary excretion.
- Measurement of plasma creatinine provides a more accurate assessment than urea because there are many factors that affect urea level.

Non renal factors can affect the urea level like:

1. Mild dehydration,
2. High protein diet,
3. Increased protein catabolism, muscle wasting as in starvation,
4. Reabsorption of blood proteins after a GIT haemorrhage,
5. Treatment with cortisol or its synthetic analogous

Clinical Significance

States associated with elevated levels of urea in blood are referred to as uremia or azotemia. Causes of urea plasma elevations:

1. Prerenal: renal hypoperfusion
2. Renal: acute tubular necrosis
3. Postrenal: obstruction of urinary flow

Uric acid

In human, uric acid is the major product of the catabolism of the purine nucleosides (nucleated cells, like meat), adenosine and guanosine and from degradation of endogenous nucleic acids. Overproduction of uric acid may result from increased synthesis of purine precursors.

- In humans, approximately 75% of uric acid excreted is lost in the urine; most of the reminder is secreted into the GIT
- Hyperuricemia is defined by serum or plasma uric acid concentrations higher than 7.0 mg/dl (0.42mmol/L) in men or greater than 6.0 mg/dl (0.36mmol/L) in women

Plasma β2-microglobulin

β2-microglobulin is a small peptide. It is present on the surface of most cells and in low concentrations in the plasma. It is completely filtered by the glomeruli and is reabsorbed and catabolized by proximal tubular cells.

The plasma concentration of β2-microglobulin is a good index of GFR in normal people, being unaffected by diet or muscle mass.

It is increased in certain malignancies and inflammatory diseases. Since it is normally reabsorbed and catabolized in the tubules, measurement of β2-microglobulin excretion provides a sensitive method of assessing tubular integrity.