

# Renal Function Tests

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# Objectives

- Enumerate the functions of kidney
- Discuss the biochemical test which are done to assess the function of kidney
- Discuss the abnormalities in biochemical tests associated with renal impairment

# Kidney Functions

- Excretory
- Homeostatic
- Endocrine
- Metabolic

# Renal Function

- Excretory Functions
  - Formation and excretion of urine
    - Glomerular filtration
    - Tubular reabsorption
    - Tubular secretion
  - Excreting toxic substances in synergy with liver
- Homeostatic function
  - Regulation of blood volume
  - Regulation of blood pH
  - Regulation of serum electrolytes; Na, K, Cl and Ca
  - Reabsorption of essential nutrients

# Renal Function

- Endocrine function
  - Erythropoietin
  - Renin Angiotensin system
  - Vitamin D activation
  - Degradation of hormones like insulin and aldosterone
- Metabolic function
  - Along with liver site for gluconeogenesis

# Renal function tests; Why needed?

- To assess functional capacity of kidneys
- To diagnose renal impairment
- To assess the severity and progression of renal impairment
- To assess the effectiveness of treatment

# Causes of renal disease

- Pre-renal
  - Any condition that results in reduced blood flow to kidneys
    - Severe blood loss
    - Hemolysis
- Renal
  - Damage to renal tissue, glomerular basement membrane or tubules
    - Glomerulonephritis
    - Diabetic or hypertensive nephropathy
    - Tubular damage due to toxic substances
- Post Renal
  - Obstruction to urine outflow
    - Ureteric or urethral stone
    - Prostatic cancer

**This list not exhaustive, these are only few common causes of renal disease**

# Renal function test

- Can be divided into two categories
  - Test for glomerular function
    - Serum Urea
    - Serum Creatinine
    - Clearance tests
  - Tests for tubular function
    - Urine concentration test
    - Dilution test
    - Para amino hippuric acid clearance test
    - Acidification test
  - Urine examination
    - Important for assessing both glomerular and tubular function



# Renal function test

- The following parameters are commonly included in assessing renal function (the normal values/reference range is mentioned)
  - Serum Urea ( 15-45 mg/dl)
  - Serum Creatinine (0.6 – 1.2 mg/dl)
  - Serum Uric acid (males 3.5-7.2 mg/dl, females 2.6-6 mg/dl)
  - Total protein (6.4-8.1 g/dl)
  - Serum albumin (3.2-4.6 g/dl)
  - Serum electrolytes
    - Na (136-146 mEq/L)
    - K (3.5-5.1 mEq/L)
    - Cl (101-109 mEq/L)
    - Phosphate (2.8-4 mg/dl)
    - Calcium (8.8-10.2 mg/dl)

# Renal Function Tests

- Complete hemogram
  - Hemoglobin
  - total RBC
  - RBC indices
    - MCH (Mean corpuscular hemoglobin)
    - MCV (Mean corpuscular volume)
    - PCV (Packed cell volume)
    - MCHC (Mean corpuscular Hemoglobin concentration)
    - RDW (Red cell distribution width)
  - ESR

# Routine urine examination

- Physical appearance
  - Colour
  - pH
  - Specific gravity
- Analytes
  - Protein
  - Glucose
  - Ketones
  - Bilirubin
  - Urobilinogen
  - Leucocyte
  - Nitrite
- Microscopy
  - RBC
  - Pus Cells
  - Epithelial cells
  - Casts
  - Crystals
- 24 hour urine protein
- Albumin/creatinine ration (ACR)

# Clearance test

- Clearance of substance is defined as the volume of plasma that is cleared of that substance in unit time
- Inulin clearance accurately measures GFR as it is neither secreted or absorbed by the renal tubules
- However it is not routinely done in patients.
- In clinical setting estimated GFR (eGFR) is more commonly used; it is calculated from serum creatinine value

# Estimated GFR

- The Cockcroft-Gault formula for estimating creatinine clearance (CrCl) is routinely used as a simple means to provide a reliable approximation of residual renal function in all patients with CKD. The formulas are as follows:
- $\text{CrCl (male)} = \frac{([140 - \text{age}] \times \text{weight in kg})}{(\text{serum creatinine} \times 72)}$
- However this has been extensively modified and there are online calculators of eGFR from serum creatinine and body weight of patients
- The eGFR is used to determine the stage of chronic kidney disease

# Changes in serum analytes in kidney disease

- Serum Urea and creatinine
  - They both are increased in renal disease
  - Urea increases more in glomerular disease as compared to creatinine
  - Urea is a less reliable indicator than creatinine as it is affected by many factors such as;
    - Protein intake
    - Dehydration
    - Muscle breakdown
- Serum Uric acid
  - It may increase in chronic kidney disease but not sufficient to cause gout
  - However raised uric acid is a bad prognostic indicator for chronic renal disease

# Changes in serum analytes in kidney disease

- Total protein and albumin
  - Both serum total protein and albumin is decreased in chronic kidney disease (CKD) due to increased proteinuria
  - Even though proteinuria may also be seen in acute kidney disease but it usually does not alter the total protein and albumin
- Serum electrolytes
  - Sodium is decreased (hyponatremia) and potassium is increased (hyperkalemia) in chronic kidney disease (CKD) as kidney reabsorb sodium in exchange of potassium
  - Chloride and phosphate is increased in CKD
  - Calcium is decreased as vitamin D is deficient

# Changes in hemogram and urine analysis in kidney disease

- RBC count and hemoglobin is decreased in advanced stages of kidney disease due to deficiency of erythropoietin
- Urine examination reveals
  - Proteinuria is seen in both acute and chronic kidney disease as well as kidney infection
  - Proteinuria can be of two types
    - In the initial stages very less amount of albumin escapes into urine; microalbuminuria (30 to 300 mg/day)
    - Frank proteinuria ( when it is greater than 300 mg/day)
    - Best evaluated in 24 hour urine sample
    - In spot urine albumin/ creatinine ratio is used to evaluate proteinuria
  - Presence of RBC may indicate glomerulonephritis , acute nephritis, kidney infection
  - Presence of pus cells, esterase positivity, nitrites may indicate bacterial infection



# Tests for tubular function

- Urine concentration test
  - In CKD kidneys loses the ability to concentrate urine
  - Specific gravity is measured in urine
  - Low fixed specific gravity is indicative of chronic kidney disease
- Dilution test
  - After overnight water deprivation patient is asked to take 1200ml of water in half hour, urine specific gravity is measured in samples collected over next 4 hours. At least one sample should show sp gr of 1.003 or below

# Tests for tubular function

- Para amino hippuric acid clearance test
  - PAH is unique in that it is completely excreted in one passage through kidney as it is both filtered and secreted.
  - Therefore clearance of PAH is a measure of renal plasma flow
- Acidification test
  - In this the ability to acidify urine is tested after administering 0.1g/kg ammonium chloride gelatin coated samples

**Thank you**