Lecture-4

Kidney Function Tests (KFT)/ Biochemical Tests for Renal Function

Kidney plays an important role in the maintenance of water volume, electrolyte and acid-base balance in the body. Kidney serves an important function of excretion of products of metabolism and other harmful substances. Renal/ Kidney function tests are done to assess the functional capacity of kidney (Blood flow to the kidney, glomerular filtration and tubular function). The aim of renal function tests is to detect impairment of renal function as early as possible. The kidney function can be assessed by examination of blood and urine.

The following are commonly used kidney function tests:-

(A) Urine examination: Simple routine examination of urine for Volume, pH, Concentration test / specific gravity test, Osmolality and presence of certain abnormal constituents (Proteins, ketone bodies, blood, glucose etc.).

(B) Blood/serum analysis: Estimation of blood urea nitrogen, serum creatinine, protein and electrolyte.

(C) Glomerular function tests: Clearance test (Urea, inulin, creatinine)

- **Inulin clearance test:** This test is done to find the **glomerular filtration rate (GFR)**. Inulin is filterated by the glomerulus but it is neither secreted nor absorbed by tubules. Inulin is given subcutaneously or by intravenous infusion. The amount of inulin excreted in each minutes is equal to the amount filtered by the glomeruli. Normal rate is 110 to 150 ml per minute.

(D) Tubular function tests: Urine concentration or dilution test, urine acidification test.

Other important renal function tests:

- **Phenol Sulfonaphthalein (PSP) test:** It indicates a general loss of nephron function. A measured amount of phenol Sulfonaphthalein is injected intravenously and then urine is collected at intervals of 40 to 60 minutes. The rate of disappearance of the dye from the plasma can be determined from blood sample taken prior to and then at regular intervals of 30 minutes following its injection. The dye clearance time is prolonged in kidney disease.
- **Methylene blue excretion test:** Methylene blue (2% @0.4 ml/kg) is injected intramuscularly and examined for clearance of dye. In normal condition the excretion of dye reaches its maximum after 1 hour and the clearance is complete within 24 hours. Delay in time indicates kidney dysfunction.

  The choice of kidney function tests starts with routine urine examination, followed by serum creatinine and/or other blood urea estimation and finally the specific tests to measure the tubular and glomerular functions (Clearance tests).

Estimation and clinical significance of creatinine

Creatinine, in a protein-free filtrate, is determined by its reaction with alkaline picrate to form a yellow- red tautomer of creatinine picrate, the Jaffc's reaction. The intensity of the colour is proportional to the optical density which is measured at 520 nm.

Clinical Significance:

- Clinically insignificant at lower values. It is higher in males since it is related to body size.

Increased values:

- Increased serum levels are seen in renal failure and other renal diseases in a manner similar to urea.
- Creatinine, however, does not increase with age, dehydration and catabolic states (eg fever, sepsis, haemorrhage) to the same extent as urea.
- It is also not affected by diet.
- But the Jaffe's reaction for measuring serum creatinine is not as sensitive and reliable as method for urea. It is interfered with by Ketone bodies and glucose and hence false high values may be obtained in diabetes ketoacidosis.
- serum creatinine is not significant. It is associated with muscle wasting diseases.
- The creatinine production depends on the modification of the muscular mass, and it varies little and the levels usually are very stable.

ESTIMATION OF BUN (Blood Urea Nitrogen) (DIACETYL MONOXIME PROCEDURE)

The urea reacts with diacetyl in hot acid solution at nearly 100°C, which is released from diacetyl monoxime by an oxidative condensation reaction, to give a coloured product. Diacetyl monoxime is used because of its greater stability. The absorbance colour developed is measured at 480 nm. The intensity of the colour developed is proportional to the concentration of urea present in the sample.

Clinical significance:

The urea concentration varies with the amount of protein in the diet.

Increase of levels: Increases in urea is significant as a measure of renal function. Increase in blood urea occurs in a number of diseases in addition to those in which the kidneys are primarily involved. The causes can be classified as;

Pre Renal: When there is reduced plasma volume it leads to decreased renal blood flow and hence GFR leading to urea retention. Seen in Reduced plasma volume:-

- Acute intestinal obstruction – Severe and prolonged vomiting.
- Severe diarrhoea.
- Pyloric stenosis with severe vomiting.
- Ulcerative colitis with severe chloride loss.
- Diabetic Ketoacidosis.

- Shocks, severe burns and haemorrhage.
- Salt and water depletion
- Hematemesis
- In crisis of Addison's diseases
- Increased protein catabolism:- Fever, Thyrotoxicosis,Cardiac failure -

Renal Disease: Blood urea is increased in all forms of renal diseases like;
- Acute glomerulonephritis.
- Renal failure
- Malignant hypertension
- Malignant nephrosclerosis
- Hydronephrosis
- Chronic pyelonephritis
- Congenital cystic kidneys

Post renal: Due to obstruction to flow of urine there is retention and so reduction in effective filteration pressure at the glomeruli; when prolonged produces irreversible kidney damage. Causes are:
- Enlargement of prostrate.
- Stones in urinary tract.
- Stricture of the urethra
- Tumors of the bladder affecting urinary flow

Decreased levels: It is rare but may be seen: In some cases of severe liver damage. Physiological condition- Blood urea has been seen to be lower in pregnancy than in normal non pregnant.

REFERENCE VALUES FOR SERUM CHEMISTRY FOR ANIMALS OF DIFFERENT SPECIES

Component	Units	Canine	Feline	Equine	Bovine	Porcine	Ovine
Albumin	g/dl	2.5-3.6	2.3-3.4	2.7-4.2	2.7-4.3	1.9-3.3	2.4-3.9
Bilirubin (total)	mg/dl	0.1-0.3	0.1-0.2	0.5-2.1	0.1-0.3	0.1-0.2	0.1-0.4
Calcium	mg/dl	9.0-10.8	7.4-10.5	10.6-13.0	7.9-10.0	8.0-12.0	10.4-13.0
Cliloride	mEq/L	110-118	116-125	97-104	94-104	100-105	98-115
Cholesterol	mg/dl	108-266	38-186	50-143	87-254	36-54	50-140
Creatinine	mg/dl	0.5-1.4	0.7-1.8	1.0-1.9	0.7-1.1	1.0-2.7	1.2-1.9
Globulin	g/dl	2.4-4.0	2.6-4.5	2.1-3.8	2.5-4.1	5.3-6.4	3.5-5.7
Glucose	mg/dl	77-120	58-120	76-127	37-71	65-95	50-80
Hemoglobin	g/L	130-190	90-150	110-170	80-150	100-180	80-160
Magnesium	mg/dl	1.8-2.4	2.0-2.2	2.2-2.8	1.8-2.3	2.7-3.7	2.2-2.8
Phosphorous (inorganic)	mg/dl	2.4-6.1	2.6-7.9	2.0-4.3	4.6-9.0	5.3-9.6	5.0-7.3
Potassium	ppm	4.2-5.6	4.0-5.3	2.4-5.2	4.0-5.3	4.9-7.1	4.0-6.0
Protein (total)	g/dl	5.4-7.1	5.7-7.9	5.5-7.3	5.9-7.7	7.0-8.9	6.0-7.9
Sodium	ppm	145-153	151-158	136-142	136-144	139-152	136-154
Blood Urea Nitrogen	mg/dl	7-25	18-33	12-26	10-26	8-24	18-31