Kidney Function Tests ,Values And Interpretation

Kidney Function Tests (KFTs) are a panel of biochemical tests used to evaluate renal function, essential in diagnosing and monitoring kidney diseases and conditions that affect renal function.

Overview of Kidney Physiology

The kidneys play critical roles in:

- **Excretion** of nitrogenous waste products (e.g., urea, creatinine, uric acid).
- **Regulation** of extracellular fluid volume, serum osmolality, and electrolyte balance.
- **Endocrine functions** , including production of:
  - **Erythropoietin** (stimulates RBC production),
  - **1,25-dihydroxyvitamin D** (active vitamin D for calcium metabolism),
  - **Renin** (blood pressure regulation via RAAS).

Functional Unit: Nephron

Each nephron comprises:

- **Glomerulus** : Filters plasma based on size and charge; negatively charged basement membrane restricts protein passage.
- **Tubules** : Reabsorb water, electrolytes, nutrients, and secrete additional waste. Responsible for urine concentration.

Categories of Kidney Function Tests

1. **Tests of Glomerular Function**
2. **Tests of Tubular Function**

Panel of Kidney Function Tests

1. Urinalysis

Provides insight into renal pathology:

- **Physical properties** : color, odor, specific gravity, volume.
- **Microscopy** : RBCs, WBCs, casts, crystals.
- **Proteinuria** : Marker of glomerular damage (e.g., nephrotic syndrome).

2. Serum Urea

- Byproduct of protein metabolism (urea cycle in liver).
- **Filtered, reabsorbed, and secreted** by nephrons.

- **Normal:** 20–45 mg/dL
- **Increased:** Renal dysfunction (?GFR <50%), high protein diet, catabolic states.
- **Decreased:** Liver disease, malnutrition.

Limitations : Urea levels are influenced by non-renal factors and rise late in kidney disease.

3. Blood Urea Nitrogen (BUN)

- Reflects nitrogen component of urea.
- **Conversion:** BUN = Urea × 0.47
- **Normal:** 5–26 mg/dL
- **Increased in** :
  - Prerenal causes: Dehydration, CHF, GI bleeding
  - Intrinsic renal disease
  - Postrenal obstruction
- **Decreased in** : SIADH, liver failure, malnutrition

Azotemia = ?BUN and/or ?serum creatinine

4. BUN/Creatinine Ratio

- **Normal:** 10:1 to 20:1
- **Increased:** Prerenal azotemia (e.g., dehydration, GI bleed)
- **Decreased:** Liver disease, low protein intake, rhabdomyolysis

5. Serum Creatinine

- Product of muscle metabolism.
- **Freely filtered** , minimally secreted; not reabsorbed.
- **Normal:**
  - Males: 0.7–1.3 mg/dL
  - Females: 0.6–1.1 mg/dL
- More reliable than BUN for assessing GFR.
- **Increased:** Decreased GFR
- **Decreased:** Low muscle mass, pregnancy
- Affected by medications (e.g., cimetidine, trimethoprim)

Measured by the **Jaffe method** in labs.

6. Creatinine Clearance (CrCl)

Estimates GFR:

- **Formula:** CrCl = (U × V) / P

    - U = urine creatinine (mg/dL)
    - V = urine volume (mL/min)
    - P = plasma creatinine (mg/dL)
- Requires 24-hour urine and concurrent blood sample.
- **Normal:**
    - Males: 100–120 mL/min
    - Females: 95–105 mL/min

7. Urea Clearance

- Less accurate than CrCl due to **tubular reabsorption** of urea.
- **Standard clearance:** ~54 mL/min
- **Max clearance:** ~75 mL/min

8. Electrolytes

- **Sodium, Potassium, Calcium, Phosphate**
- Abnormalities may reflect impaired tubular reabsorption/secretion.

9. Serum Phosphorus

- Normally excreted by kidneys.
- **Increased in** : CKD, hypoparathyroidism
- **Complication** : Calcium-phosphate deposition in soft tissues

10. Calcium

- Altered in CKD due to disrupted **vitamin D metabolism** and secondary hyperparathyroidism.

11. Protein and Albumin

- **Proteinuria** is a sensitive marker for renal disease.
    - **Nephrotic syndrome** : >3–4 g/day
    - **Nephritic syndrome** : 1–2 g/day
    - **Tubulointerstitial disease** : <1 g/day
- Hypoalbuminemia is common in nephrotic syndrome.

12. Dilution and Concentration Tests

Assess tubular function:

- Measure kidney's ability to concentrate/dilute urine via water deprivation or fluid loading tests.

13. Inulin Clearance (Gold Standard GFR Test)

- Inulin is **freely filtered** , not reabsorbed or secreted.

- Rarely used clinically due to cost and complexity.

Clinical Significance

Condition	Serum Creatinine	BUN	BUN/Cr Ratio	GFR
Prerenal AKI	?	??	>20:1	?
Intrinsic AKI	?	?	~10–15:1	??
Postrenal AKI	?	?	>15:1	?

Key Normal Values

Parameter	Normal Range
Serum Urea	20–45 mg/dL
BUN	5–26 mg/dL
Serum Creatinine	0.6–1.3 mg/dL
BUN/Cr Ratio	10–20:1
Creatinine Clearance	95–120 mL/min
GFR	~125 mL/min/1.73m²