Chronic Kidney Disease (CKD): Clinical Breakdown

Pathophysiology, GFR Staging Classifications, Primary Etiologies, Complications, and Therapeutic Management

Chronic Kidney Disease (CKD) is defined as abnormalities of kidney structure or function, present for 3 months or longer, with implications for health. It is characterized by the progressive loss of renal function, leading to impaired filtration, electrolyte imbalances, endocrine disruption, and eventual accumulation of uremic toxins.

> **Core Clinical Principle:** CKD is staged based on estimated Glomerular Filtration Rate (eGFR) and persistent albuminuria. Because nephrons undergo hyperfiltration and progressive glomerulosclerosis, early detection and blood pressure control are vital to slowing disease progression.

1. CKD Staging by Glomerular Filtration Rate (eGFR)

Clinical classification categorizes kidney function into stages based on filtration capacity (mL/min/1.73m²).

CKD Stage	Description & eGFR Range	Clinical Status
Stage 1	Normal or high eGFR (90 or higher) + markers of kidney damage	Persistent albuminuria, structural abnormalities
Stage 2	Mildly decreased eGFR (60–89) + markers of kidney damage	Early functional impairment
Stage 3 (a/b)	Moderately to severely decreased eGFR (30–59)	Complications begin to emerge (anemia, bone mineral disorders)
Stage 4	Severely decreased eGFR (15–29)	Preparation for renal replacement therapy
Stage 5	Kidney failure (Less than 15)	Dialysis or kidney transplantation required

2. Primary Etiology & Pathophysiology

Understanding the underlying drivers of renal damage guides targeted nephroprotective therapies.

- **Leading Causes:** Type 2 diabetes mellitus (diabetic nephropathy) and chronic hypertension account for the majority of CKD cases globally, causing progressive microvascular damage and glomerulosclerosis.
- **Secondary Pathologies:** Includes glomerulonephritis, polycystic kidney disease (PKD), chronic tubulointerstitial nephritis, and prolonged urinary tract obstruction.
- **Hyperfiltration Cycle:** As nephrons are destroyed, remaining viable nephrons undergo compensatory hyperfiltration and hypertrophy, eventually sustaining intraglomerular hypertension and accelerating further nephron loss.

3. Systemic Complications & Management Principles

Advanced CKD impacts multiple organ systems, requiring proactive multidisciplinary medical management.

- **Systemic Consequences:** Manifests as secondary hyperparathyroidism (bone mineral disorder), normocytic anemia due to decreased erythropoietin production, metabolic acidosis, fluid overload, and cardiovascular disease.
- **Therapeutic Goals:** Focus on strict blood pressure control (using ACE inhibitors or ARBs for antiproteinuric effects), glycemic optimization, dietary sodium and protein management, avoidance of nephrotoxic drugs (like NSAIDs), and cardiovascular risk reduction.