Acute Kidney Injury (AKI) : Causes, Symptoms and Treatment

Acute kidney injury previously known as acute renal failure is an abrupt reduction in glomerular filtration rate characterized by an increase of blood urea nitrogen (BUN) and serum creatinine with or without a decrease in urine output.

It may result from :

- Decrease ineffective circulation.
- Renal cell injury.
- Arterial or venous obstruction.
- Obstruction to urine flow.

Effects of Acute kidney injury

1. The kidneys are unable to perform their major functions of:-
2. Fluid and electrolyte balance
3. Blood pressure control
4. Regulation of acid-base balance
5. Hormonal control
6. Excretion of toxic products of metabolism

What are the Causes of Acute Kidney Injury?

To function properly, the kidney requires:

1. Normal blood flow;
2. Functioning glomeruli and tubules to separate and process an ultrafiltrate containing waste products from the blood; and
3. Drainage and elimination of formed urine from the body.

The sudden interruption of any of these processes will lead to Acute kidney injury.

Disorders causing AKI are classified on the basis of their primary site of interference with these processes into three large groups.

- Pre-renal causes,
- Intrinsic causes and
- Post renal (obstructive) causes

Conditions that interfere with blood delivery to the kidney are called **Prerenal**, and are most commonly functional (and potentially reversible) in nature (for example ECF volume contraction, congestive heart failure) but on occasion may be structural (e.g., renal artery stenosis).

Diseases that cause intrinsic injury to the kidney proper (glomeruli, tubules, interstitium, small blood vessels) are grouped under **Renal causes or (intrinsic causes)** (e.g., acute glomerulonephritis, acute tubular necrosis, acute interstitial nephritis or small vessel vasculitis).

Acute Tubular Necrosis is a distinctive clinicopathological syndrome in which the tubules are the primary site of injury. The terms ARF and ATN should not be used interchangeably.

Finally, conditions that interfere with normal drainage and elimination of formed urine are classified as **Postrenal** (e.g., prostatic outlet obstruction, bilateral ureteral obstruction).

Pre-renal acute kidney injury (also commonly referred to as “pre-renal azotemia”) and acute tubular necrosis (ATN) are the most common causes of acute kidney injury in hospitalized patients.

Pre-renal Causes

Some combination of hypovolemia, hypotension and diminished renal perfusion is the most common cause of AKI in hospitalized patients. Therefore identification of pre-renal (functional) AKI is important because it the decreased perfusion is reversed promptly, kidney function improves.

Pre-renal ARF may evolve from

1. Blood loss,
2. Sodium depletion (due to diarrhea, excessive diuresis or congenital or acquired salt-wasting renal or adrenal disorders),
3. Burns.
4. Redistribution of plasma volume to a so-called “third space loses ” (e.g., ascites in patients with hemorrhagic pancreatitis or hepatic cirrhosis), or
5. Reductions in effective arterial blood volume with consequent renal hypoperfusion (as in congestive heart failure, hepatic cirrhosis or nephrotic syndrome).
6. Dehydration from other causes.
7. Gastrointestinal losses
8. In other situations, especially when for one reason or another renal perfusion is tenuous or already compromised, drugs that affect afferent and/or efferent arteriolar resistance (e.g., NSAIDs, ACE inhibitors) can precipitate pre-renal azotemia.

The kidneys are intrinsically normal, with the restoration of renal perfusion the renal function becomes normal. The diminished intravascular volume leads to a fall in cardiac output decreasing GFR. If reversed within a certain time no renal damage.

Pathophysiology of Pre-renal Azotemia

The kidney is able to maintain a relatively constant glomerular filtration rate (GFR) and to a lesser extent renal blood flow (RBF) despite modest reductions in mean arterial pressure. This process, termed renal autoregulation, derives largely from hormonally-mediated adjustments in afferent and efferent arteriolar resistance. By increasing Reff/Raff angiotensin-II and prostaglandin-E maintain PGC and GFR at the expense of RBF.

As a result, filtration fraction (GFR/RBF) and post-glomerular capillary oncotic pressure increase, which facilitates sodium and water reabsorption from the adjacent proximal tubule.

Angiotensin-II also directly increases proximal tubular sodium reabsorption and stimulating aldosterone synthesis and release increases sodium reabsorption in more distal tubular segments as well.

At the same time, volume-related antidiuretic hormone release leads to enhanced water and urea reabsorption in the collecting duct. Urine formed under these conditions is of reduced volume, highly concentrated, and contains scant amounts of sodium.

These characteristics are the basis of tests for distinguishing pre-renal azotemia from acute tubular necrosis. Renal autoregulation breaks down as mean arterial pressure falls below about 80 mm Hg, at which point further adjustments in intra-renal hemodynamics are unable to maintain GFR and RBF in the face of a progressive reduction in renal perfusion pressure.

Causes of intrinsic failure

- **Acute tubular necrosis ATN –** may evolve from pre-renal failure
- **Drug nephrotoxicity** may be due to acute tubular necrosis.
    - These nephrotoxic drugs are
    - Aminoglycosides, amphotericin B
    - IV radiocontrast peak rise of Cr 3-5 days latter
    - NSAIDs, acetaminophen, cisplatin,
- **Acute cortical necrosis**

Ischemic/hypoxic insults more common in the neonates may have hematuria(gross or microscopic), HTN, thrombocytopenia, Oliguria, and azotemia

- **Endogenous toxins**
- **Glomerulonephritis**

-Poststreptococcal
-Lupus erythematosus
-Membranoproliferative
-Idiopathic rapidly progressing GN

- **Vascular Causes**

-Hemolytic uremic syndrome (azotemia, thrombocytopenia, anaemia-MAHA) commonest cause of AKI in toddlers. Follows E.coli gastroenteritis.
-Renal vein thrombosis esp in neonates

- **Interstitial Nephritis**

-This can be caused by drugs such as Penicillins, Rifampicin, NSAIDs, sulfonamides and present as Rash, fever, eosinophilia, +/-eosinophiluria)

- **Tumors**

-Renal parenchymal infiltration
-Uric acid nephropathy especially. Acute lymphoblastic leukemia, B-cell lymphomas)

Post-renal Causes

Post renal kidney injury arises from obstruction of the urinary tract

- Intra-renal Obstruction
  - Acute uric acid nephropathy
  - Drugs (e.g., acyclovir)
- Extra-renal Obstruction
  - Renal pelvis or ureter (e.g., stones, clots, tumors, papillary necrosis, retroperitoneal fibrosis)
  - Bladder (e.g., Benign prostate hypertrophy, neuropathic bladder, Neurogenic bladder)
  - Urethra (e.g., urethral stricture)
- Bilateral ureteral obstruction

The nature of the obstructing lesion, the site of the obstruction, the rapidity of onset, and the magnitude of the obstruction are all important determinants of the presentation of postrenal ARF. Since postrenal ARF is often reversible, it is essential that the clinician quickly recognize and correct the cause of obstruction.

In addition to a careful history and physical examination and examination of the urinary sediment, renal ultrasound and spiral computed tomography are the diagnostic tools most helpful in detecting obstruction.

Because of 'compensatory' increases in GFR in the contralateral non-obstructed kidney, unilateral ureteral obstruction does not usually result in a rise in the serum creatinine concentration.

Signs and symptoms

Signs and symptoms of the precipitating illness

- Diarrhea, vomiting, bleeding.
- Upper respiratory tract infections
- Systemic lupus erythematosus
- skin rash, joint pains, fever
- Drug ingestion (previous 44 days)
- RVT in neonates
- Recent urinary tract infection- obstructive uropathy
- Pain +/-hematuria

Signs and symptoms related to renal failure

- Patients are usually oliguric (urine volume < 500 mL daily).

- Pallor
- Edema
- Hypertension
- Clinical features of advancing URAEMIA include anorexia, nausea, and vomiting followed by drowsiness, apathy, confusion, muscle twitching,