Acute Kidney Injury

Definition

- Acute kidney injury (AKI) is a clinical syndrome denoted by an abrupt decline in glomerular filtration rate (GFR) sufficient to decrease the elimination of nitrogenous waste products (urea and creatinine) and other uremic toxins.

Definitions

	RIFLE	AKIN	KDIGO
Serum creatinine level	An increase of >50% developing over <7 days	An increase of ≥0.3 mg/dL or of >50% developing over <48 hr	An increase of ≥0.3 mg/dL developing over <48 hr; or an increase of >50% developing over <7 days
Urine output[a]	<0.5 mL/kg/hr for >6 hr	<0.5 mL/kg/hr for >6 hr	<0.5 mL/kg/hr for >6 hr

EPIDEMIOLOGY

AKI complicates 5–7% of acute care hospital admissions and up to 30% of admissions to the intensive care unit, particularly in the setting of diarrheal illnesses, infectious diseases like malaria and leptospirosis, and natural disasters such as earthquakes.

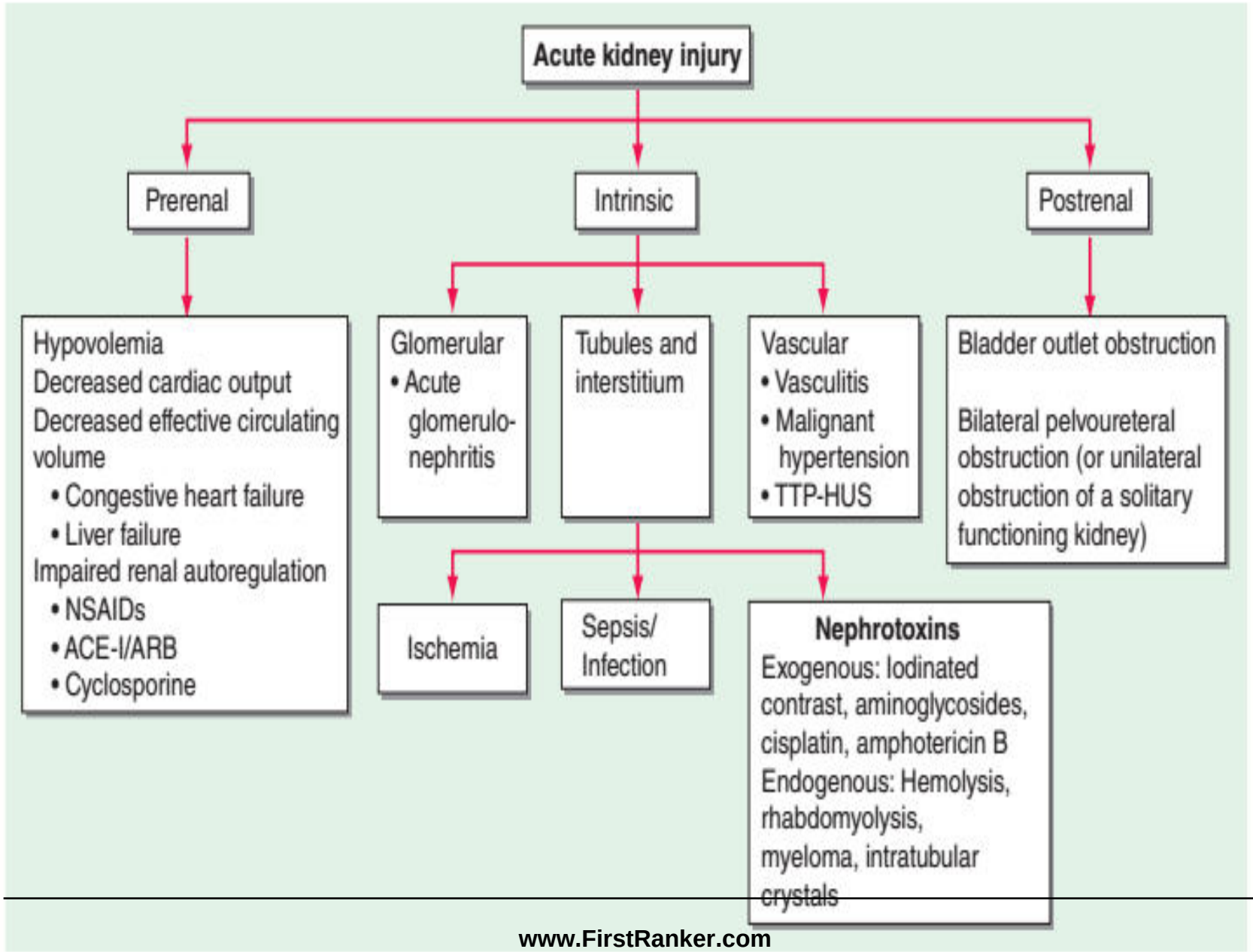
Causes

The causes of AKI are usually divided into three broad patho-physiologic categories:

1. Prerenal AKI—diseases characterized by effective hypoperfusion of the kidneys in which there is no parenchymal damage to the kidney

2. Intrinsic AKI—diseases involving the renal parenchyma

3. Postrenal (obstructive) AKI—diseases associated with acute obstruction of the urinary tract



Patho-physiology

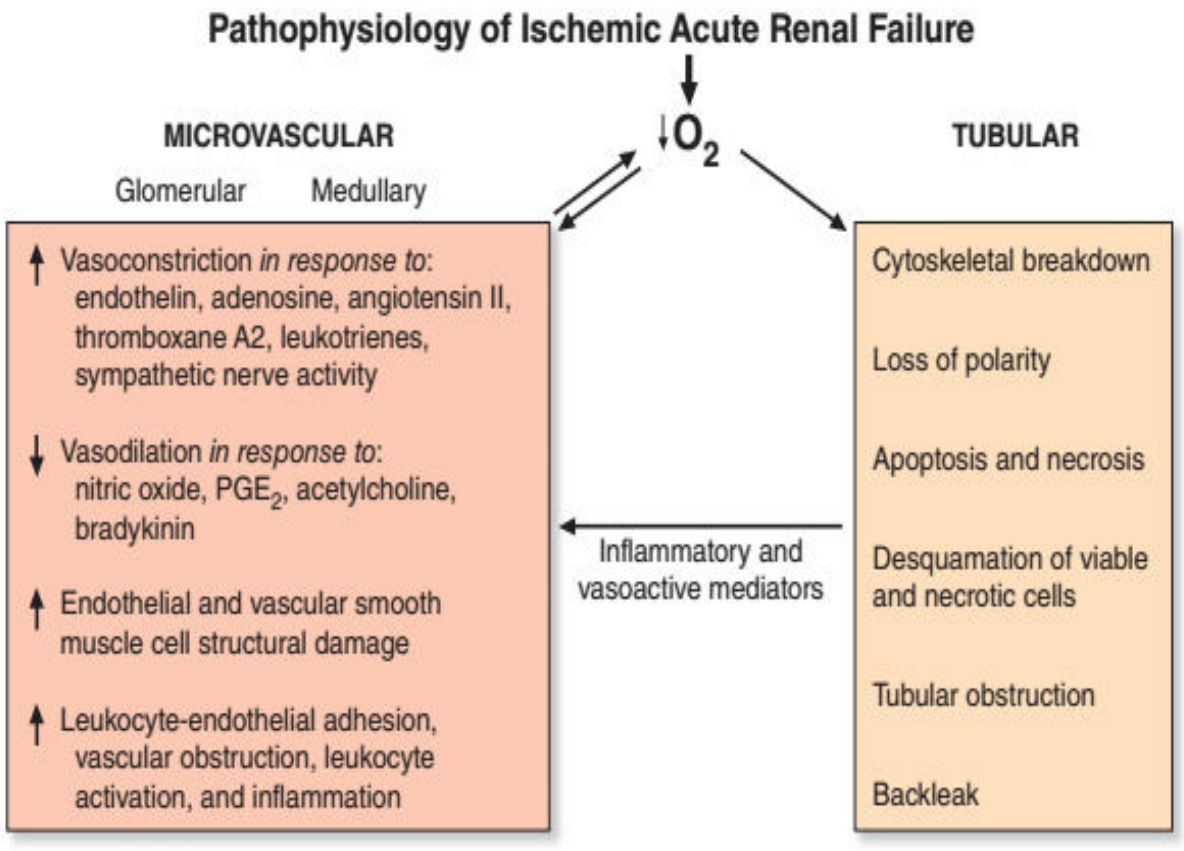


FIGURE 334-4 **Interacting microvascular and tubular events contributing to the pathophysiology of ischemic acute kidney injury.** PGE_2, prostaglandin E_2. *(From JV Bonventre, JM Weinberg: J Am Soc Nephrol 14:2199, 2003.)*

Phases of Ischemic ATN

1. Initiation Phase – GFR declines, lasts for hours- days
2. Extension Phase – continued damage
3. Maintenance Phase – GFR stabilises at nadir of 5-10 ml/min, lasts for 1-2 wks
4. Recovery Phase – gradual return of GFR towards normal, delay in recovery of tubular function.

Diagnosis

Table 31.10 Urine Indices Used in the Differential Diagnosis of Prerenal Acute Kidney Injury and Acute Tubular Necrosis

Diagnostic Index	Prerenal Acute Kidney Injury	Acute Tubular Necrosis
Fractional excretion of sodium (%)	<1*	>2*
U_{Na} (mmol/L)	<20	>40
Urine creatinine/plasma creatinine ratio	>40	<20
Urine urea nitrogen/plasma urea nitrogen ratio	>8	<3
Urine specific gravity	>1.018	≈1.010
Urine osmolality (mOsm/kg H_2O)	>500	≈300
Plasma BUN/creatinine ratio	>20	<10-15
Renal failure index, $U_{Na}/(U_{Cr}/P_{Cr})$	<1	>1
Urine sediment	Hyaline casts	Muddy-brown granular casts

*Fractional excretion of sodium (FE_{Na}) may be >1% in prerenal acute kidney injury associated with diuretic use and/or in the setting of bicarbonaturia or chronic kidney disease; FE_{Na} often <1% in acute tubular necrosis caused by radiocontrast media or rhabdomyolysis.

BUN, Blood urea nitrogen; P_{Cr}, plasma creatinine concentration; U_{Cr}, urine creatinine concentration; U_{Na}, urinary sodium concentration.

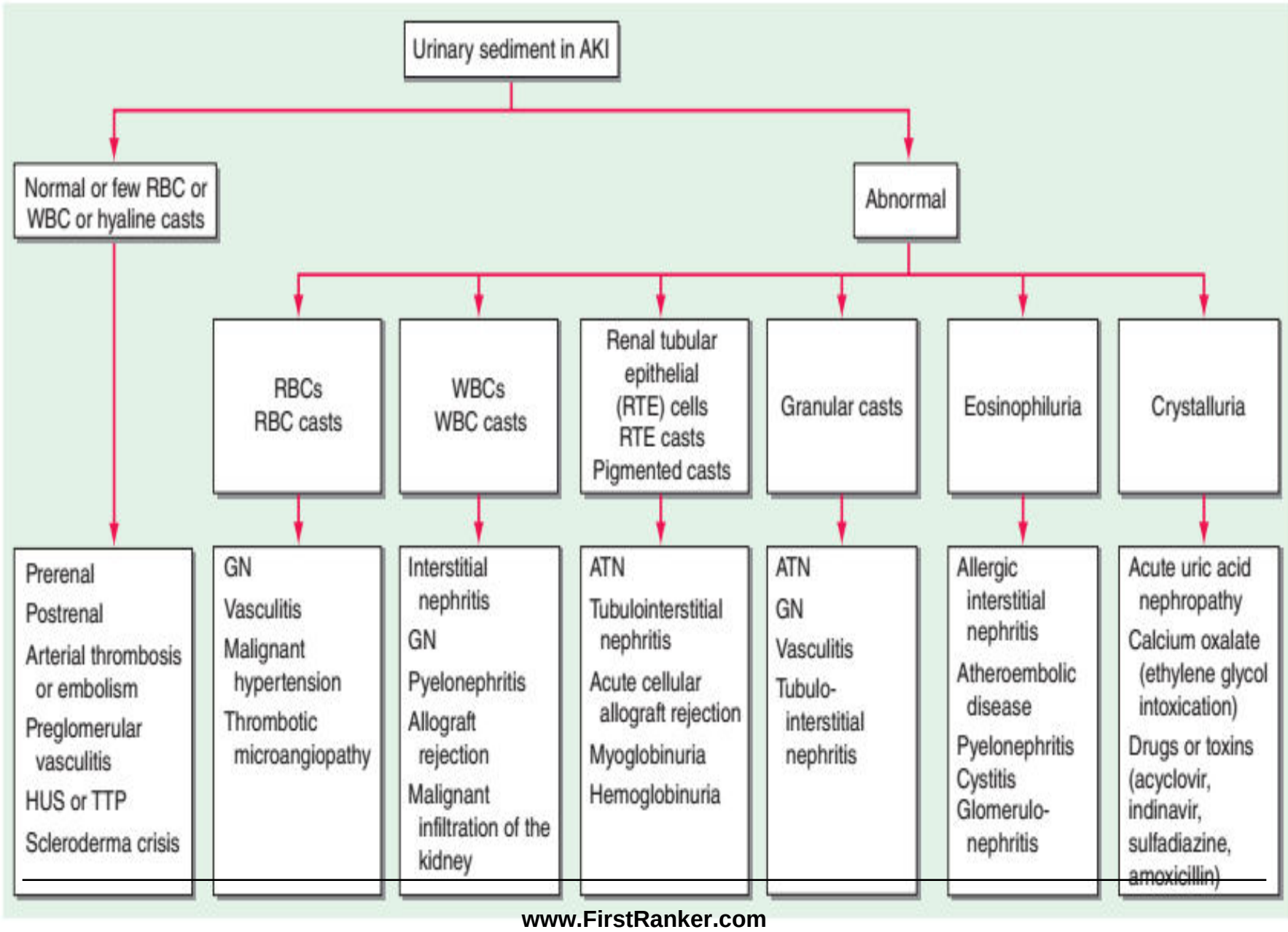


TABLE 334-2 MANAGEMENT OF ACUTE KIDNEY INJURY

General Issues

1. Optimization of systemic and renal hemodynamics through volume resuscitation and judicious use of vasopressors
2. Elimination of nephrotoxic agents (e.g., ACE inhibitors, ARBs, NSAIDs, aminoglycosides) if possible
3. Initiation of renal replacement therapy when indicated

Specific Issues

1. Nephrotoxin-specific
   a. Rhabdomyolysis: aggressive intravenous fluids; consider forced alkaline diuresis
   b. Tumor lysis syndrome: aggressive intravenous fluids and allopurinol or rasburicase
2. Volume overload
   a. Salt and water restriction
   b. Diuretics
   c. Ultrafiltration
3. Hyponatremia
   a. Restriction of enteral free water intake, minimization of hypotonic intravenous solutions including those containing dextrose
   b. Hypertonic saline is rarely necessary in AKI. Vasopressin antagonists are generally not needed.
4. Hyperkalemia
   a. Restriction of dietary potassium intake
   b. Discontinuation of potassium-sparing diuretics, ACE inhibitors, ARBs, NSAIDs
   c. Loop diuretics to promote urinary potassium loss
   d. Potassium binding ion-exchange resin (sodium polystyrene sulfonate)
   e. Insulin (10 units regular) and glucose (50 mL of 50% dextrose) to promote entry of potassium intracellularly
   f. Inhaled beta-agonist therapy to promote entry of potassium intracellularly
   g. Calcium gluconate or calcium chloride (1 g) to stabilize the myocardium

5. Metabolic acidosis
   a. Sodium bicarbonate (if pH <7.2 to keep serum bicarbonate >15 mmol/L)
   b. Administration of other bases, e.g., THAM
   c. Renal replacement therapy
6. Hyperphosphatemia
   a. Restriction of dietary phosphate intake
   b. Phosphate binding agents (calcium acetate, sevelamer hydrochloride, aluminum hydroxide—taken with meals)
7. Hypocalcemia
   a. Calcium carbonate or calcium gluconate if symptomatic
8. Hypermagnesemia
   a. Discontinue Mg^{2+} containing antacids
9. Hyperuricemia
   a. Acute treatment is usually not required except in the setting of tumor lysis syndrome (see above)
10. Nutrition
   a. Sufficient protein and calorie intake (20–30 kcal/kg per day) to avoid negative nitrogen balance. Nutrition should be provided via the enteral route if possible.
11. Drug dosing
   a. Careful attention to dosages and frequency of administration of drugs, adjustment for degree of renal failure
   b. Note that serum creatinine concentration may overestimate renal function in the non–steady state characteristic of patients with AKI