

Categorization of Causes of Acute Renal Failure

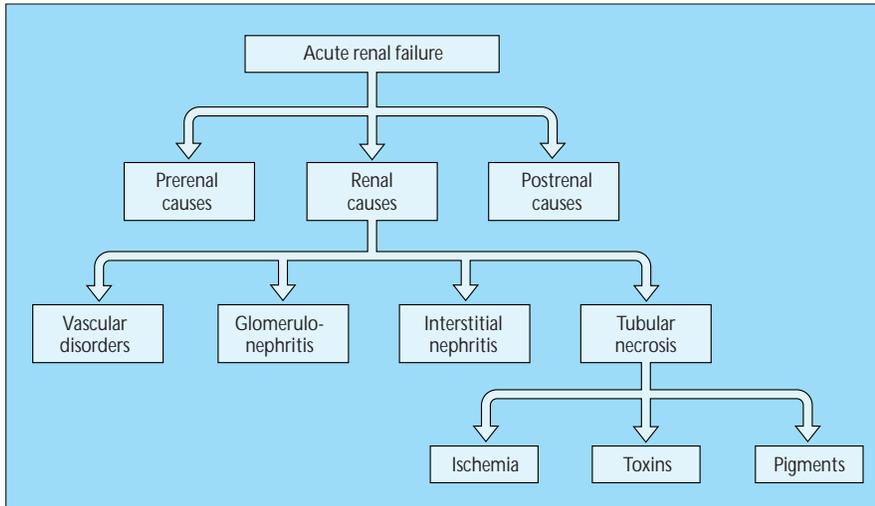


FIGURE 12-7

Acute renal failure (ARF). This figure depicts the most commonly used schema to classify and diagnostically approach the patient with ARF [1, 6, 9]. The most common general cause of ARF (60% to 70% of cases) is prerenal factors. Prerenal causes include those secondary to renal hypoperfusion, which occurs in the setting of extracellular fluid loss (*eg*, with vomiting, nasogastric suctioning, gastrointestinal hemorrhage, diarrhea, burns, heat stroke, diuretics, glucosuria), sequestration of extracellular fluid (*eg*, with pancreatitis,

abdominal surgery, muscle crush injury, early sepsis), or impaired cardiac output. In most prerenal forms of ARF, one or more of the vasomotor mechanisms noted in Figure 12-8 is operative. The diagnostic criteria for prerenal ARF are delineated in Figure 12-9. Once prerenal forms of ARF have been ruled out, postrenal forms (*ie*, obstruction to urine flow) should be considered. Obstruction to urine flow is a less common (5% to 15% of cases) cause of ARF but is nearly always amenable to therapy. The site of obstruction can be intrarenal (*eg*, crystals or proteins obstructing the terminal collecting tubules) or extrarenal (*eg*, blockade of the renal pelvis, ureters, bladder, or urethra). The diagnosis of postrenal forms of ARF is supported by data outlined in Figure 12-10. After pre- and postrenal forms of ARF have been considered, attention should focus on the kidney. When considering renal forms of ARF, it is helpful to think in terms of renal anatomic compartments (vasculature, glomeruli, interstitium, and tubules). Acute disorders involving any of these compartments can lead to ARF.

VASOMOTOR MECHANISMS CONTRIBUTING TO ACUTE RENAL FAILURE

Decreased Renal Perfusion Pressure	Afferent Arteriolar Constriction	Efferent Arteriolar Dilatation
Extracellular fluid volume loss or sequestration	Sepsis	Converting enzyme inhibitors
Impaired cardiac output	Medications (NSAIDs, cyclosporine, contrast medium, amphotericin, alpha-adrenergic agonists)	Angiotensin II receptor antagonists
Antihypertensive medications	Hypercalcemia	
Sepsis	Postoperative state	
	Hepatorenal syndrome	

FIGURE 12-8

Vasomotor mechanisms contributing to acute renal failure (ARF). Most prerenal forms of ARF have operational one or more of the vasomotor mechanisms depicted here [6]. Collectively, these factors lead to diminished glomerular filtration and ARF. NSAIDs—nonsteroidal anti-inflammatory drugs.

DIAGNOSIS OF POSSIBLE PRERENAL CAUSES OF ACUTE RENAL FAILURE

History	Examination	Laboratory/Other
Extracellular fluid loss or sequestration from skin, gastrointestinal and/or renal source (see Fig. 12-15)	Orthostatic hypotension and tachycardia	Normal urinalysis
Orthostatic lightheadedness	Dry mucous membranes	Urinary indices compatible with normal tubular function (see Fig. 12-14)
Thirst	No axillary moisture	Elevated BUN-creatinine ratio
Oliguria	Decreased skin turgor	Improved renal function with correction of the underlying cause
Symptoms of heart failure	Evidence of congestive heart failure	Rarely, chest radiography, cardiac ultrasound, gated blood pool scan, central venous and/or Swan-Ganz wedge pressure recordings
Edema	Presence of edema	

FIGURE 12-9

Diagnosis of possible prerenal causes of acute renal failure (ARF). Prerenal events are the most common factors that lead to contemporary ARF. The historical, physical examination, and laboratory and other investigations involved in identifying a prerenal form of ARF are outlined here [1]. BUN—blood urea nitrogen.

DIAGNOSIS OF POSSIBLE POSTRENAL CAUSES OF ACUTE RENAL FAILURE

History	Examination	Laboratory/Other
Very young or very old age	Distended bladder	Abnormal urinalysis
Nocturia	Enlarged prostate	Elevated BUN-creatinine ratio
Decreased size or force of urine stream	Abnormal pelvic examination	Elevated postvoiding residual volume
Anticholinergic or alpha-adrenergic agonist medications		Abnormal renal ultrasound, CT or MRI findings
Bladder, prostate, pelvic, or intra-abdominal cancer		Improvement after drainage
Fluctuating urine volume		
Oligoanuria		
Suprapubic pain		
Urolithiasis		
Medication known to produce crystalluria (sulfonamides, acyclovir, methotrexate, protease inhibitors)		

FIGURE 12-10

Diagnosis of possible postrenal causes of acute renal failure (ARF). Postrenal causes of ARF are less common (5% to 15% of ARF population) but are nearly always amenable to therapy. This figure depicts the historical, physical examination and tests that can lead to an intrarenal (crystal deposition) or extrarenal (blockade of the collecting system) form of obstructive uropathy [1, 6, 9, 10]. BUN—blood urea nitrogen; CT—computed tomography; MRI—magnetic resonance imaging.

POSTOPERATIVE ACUTE RENAL FAILURE

Frequency	Predisposing Factors	Preventive Strategies
Elective surgery 1%–5%	Comorbidity results in decreased renal reserve	Avoid nephrotoxins
Emergent or vascular surgery 5%–10%	The surgical experience decreases renal function (volume shifts, vasoconstriction)	Minimize hospital-acquired infections (invasive equipment)
	A second insult usually occurs (sepsis, reoperation, nephrotoxin, volume/cardiac issue)	Selective use of volume expansion, vasodilators, inotropes
		Preoperative hemodynamic optimization in selected cases
		Increase tissue oxygenation delivery to supranormal levels in selected cases

FIGURE 12-11

Postoperative acute renal failure (ARF). The postoperative setting of ARF is very common. This figure depicts data on the frequency, predisposing factors, and potential strategies for preventing postoperative ARF [11, 12].

Diagnostic Steps in Evaluating Acute Renal Failure

STEPWISE APPROACH TO DIAGNOSIS OF ACUTE RENAL FAILURE

Step 1	Step 2	Step 3	Step 4
History Record review Physical examination Urinary bladder catheterization (if oligoanuric) Urinalysis (see Fig. 12-15)	Consider urinary diagnostic indices (see Fig. 12-16) Consider need for further evaluation to exclude urinary tract obstruction Consider need for more data to assess intravascular volume or cardiac output status Consider need for additional blood tests Consider need for evaluation of renal vascular status	Consider selected therapeutic trials	Consider renal biopsy Consider empiric therapy for suspected diagnosis

FIGURE 12-12

Stepwise approach to diagnosis of acute renal failure (ARF). The multiple causes, predisposing factors, and clinical settings demand a logical, sequential approach to each case of ARF. This figure presents a four-step approach to assessing ARF patients in an effort to delineate the cause in a timely and cost-effective manner. Step 1 involves a focused history, record review, and examination. The salient features of these analyses are noted in more detail in Figure 12-13. In many cases, a single bladder catheterization is needed to assess the degree of residual volume, which should be less than 30 to 50 mL. Urinalysis is a critical part of the initial evaluation of all patients with ARF. Generally, a relatively normal urinalysis suggests either a prerenal or postrenal cause, whereas a urinalysis containing cells and casts is most compatible with a renal cause. A detailed schema of urinalysis interpretation in the setting of ARF is depicted in Figure 12-15. Usually, after Step 1 the clinician has a reasonably good idea of the likely cause of the ARF. Sometimes, the information noted under Step 2 is needed to ascertain definitively the cause of the ARF. More details of Step 2 are depicted in Figure 12-14. Oftentimes, urinary diagnostic indices (see Fig. 12-16),

are helpful in differentiating between prerenal (intact tubular function) and acute tubular necrosis (impaired tubular function) as the cause of renal failure. Sometimes, further evaluation (usually ultrasonography, less commonly computed tomography or magnetic resonance imaging) is needed to exclude the possibility of bilateral ureteric obstruction (or single ureteric obstruction in patients with a single kidney). Occasionally, additional studies such as central venous pressure or left ventricular filling pressure determinations are needed to better assess whether prerenal factors are contributing to the ARF. When the cause of the ARF continues to be difficult to ascertain and renal vascular disorders (see Fig. 12-17 and 12-18), glomerulonephritis (see Fig. 12-19) or acute interstitial nephritis (see Fig. 12-20) remain possibilities, additional blood analyses and other tests described in Figures 12-18 through 12-20 may be indicated. Sometimes, selected therapeutic trials (*eg*, volume expansion, maneuvers to increase cardiac index, ureteric stent or nephrostomy tube relief of obstruction) are necessary to document the cause of ARF definitively. Empiric therapy (*eg*, corticosteroids for suspected acute allergic interstitial nephritis) is given as both a diagnostic and a therapeutic maneuver in selected cases. Rarely, despite all efforts, the cause of the ARF remains unknown and renal biopsy is necessary to establish a definitive diagnosis.