Acute Renal Failure: Causes and Prognosis

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There are many causes—more than fifty are given within this present chapter—that can trigger pathophysiological mechanisms leading to acute renal failure (ARF). This syndrome is characterized by a sudden decrease in kidney function, with a consequence of loss of the hemostatic equilibrium of the internal medium. The primary marker is an increase in the concentration of the nitrogenous components of blood. A second marker, oliguria, is seen in 50% to 70% of cases.

In general, the causes of ARF have a dynamic behavior as they change as a function of the economical and medical development of the community. Economic differences justify the different spectrum in the causes of ARF in developed and developing countries. The setting where ARF appears (community versus hospital), or the place where ARF is treated (intensive care units [ICU] versus other hospital areas) also show differences in the causes of ARF.

While functional outcome after ARF is usually good among the surviving patients, mortality rate is high: around 45% in general series and close to 70% in ICU series. Although it is unfortunate that these mortality rates have remained fairly constant over the past decades, it should be noted that today's patients are generally much older and display a generally much more severe condition than was true in the past. These age and severity factors, together with the more aggressive therapeutical possibilities presently available, could account for this apparent paradox.

As is true for any severe clinical condition, a prognostic estimation of ARF is of great utility for both the patients and their families, the medical specialists (for analysis of therapeutical maneuvers and options), and for society in general (demonstrating the monetary costs of treatment). This chapter also contains a brief review of the prognostic tools available for application to ARF.

CHAPTER

8

Causes of Acute Renal Failure

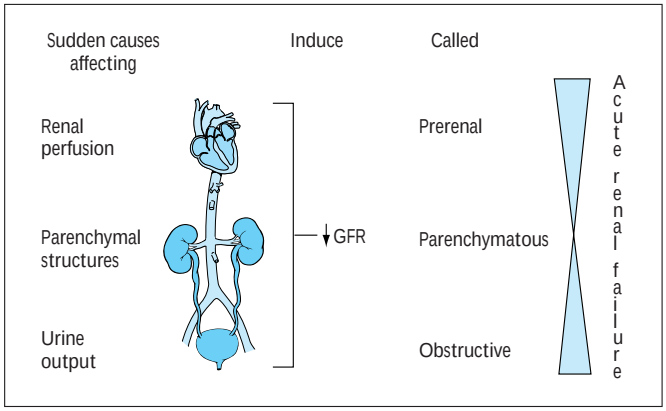

FIGURE 8-1

Characteristics of acute renal failure. Acute renal failure is a syndrome characterized by a sudden decrease of the glomerular filtration rate (GFR) and consequently an increase in blood nitrogen products (blood urea nitrogen and creatinine). It is associated with oliguria in about two thirds of cases. Depending on the localization or the nature of the renal insult, ARF is classified as prerenal, parenchymatous, or obstructive (postrenal).

CAUSES OF PRERENAL ACUTE RENAL FAILURE

- Decreased effective extracellular volume
- Renal losses: hemorrhage, vomiting, diarrhea, burns, diuretics
- Redistribution: hepatopathy, nephrotic syndrome, intestinal obstruction, pancreatitis, peritonitis, malnutrition
- Decreased cardiac output: cardiogenic shock, valvulopathy, myocarditis, myocardial infarction, arrhythmia, congestive heart failure, pulmonary emboli, cardiac tamponade
- Peripheral vasodilation: hypotension, sepsis, hypoxemia, anaphylactic shock, treatment with interleukin L2 or interferons, ovarian hyperstimulation syndrome
- Renal vasoconstriction: prostaglandin synthesis inhibition, α-adrenergics, sepsis, hepatorenal syndrome, hypercalcemia
- Efferent arteriole vasodilation: converting-enzyme inhibitors

FIGURE 8-2

Causes of prerenal acute renal failure (ARF). *Prerenal* ARF, also known as prerenal uremia, supervenes when glomerular filtration rate falls as a consequence of decreased effective renal blood supply. The condition is reversible if the underlying disease is resolved.

CAUSES OF PARENCHYMATOUS ACUTE RENAL FAILURE

- Acute tubular necrosis
  - Hemodynamic: cardiovascular surgery,* sepsis,* prerenal causes*
  - Toxic: antimicrobials,* iodide contrast agents,* anesthesics, immunosuppressive or antineoplastic agents,* Chinese herbs, Opiaceous, Extasis, mercurials, organic solvents, venoms, heavy metals, mannitol, radiation
  - Intratubular deposits: acute uric acid nephropathy, myeloma, severe hypercalcemia, primary oxalosis, sulfadiazine, fluoride anesthesics
  - Organic pigments (endogenous nephrotoxins):
    - Myoglobin rhabdomyolisis: muscle trauma; infections; dermatopolymyositis; metabolic alterations; hyperosmolar coma; diabetic ketoacidosis; severe hypokalemia; hyper- or hyponatremia; hypophosphatemia; severe hypothyroidism; malignant hyperthermia; toxins such as ethylene glycol, carbon monoxide, mercurial chloride, stings; drugs such as fibrates, statins, opioids and amphetamines; hereditary diseases such as muscular dystrophy, metabolopathies, McArdle disease and carnitine deficit
    - Hemoglobinuria: malaria; mechanical destruction of erythrocytes with extracorporeal circulation or metallic prosthesis, transfusion reactions, or other hemolysis; heat stroke; burns; glucose-6-phosphate dehydrogenase; nocturnal paroxystic hemoglobinuria; chemicals such as aniline, quinine, glycerol, benzene, phenol, hydralazine; insect venoms
- Acute tubulointerstitial nephritis (*see* Fig. 8-4)
- Vascular occlusion
  - Principal vessels: bilateral (unilateral in solitary functioning kidney) renal artery thrombosis or embolism, bilateral renal vein thrombosis
  - Small vessels: atheroembolic disease, thrombotic microangiopathy, hemolytic-uremic syndrome or thrombotic thrombocytopenic purpura, postpartum acute renal failure, antiphospholipid syndrome, disseminated intravascular coagulation, scleroderma, malignant arterial hypertension, radiation nephritis, vasculitis
- Acute glomerulonephritis
  - Postinfectious: streptococcal or other pathogen associated with visceral abscess, endocarditis, or shunt
  - Henoch-Schonlein purpura
  - Essential mixed cryoglobulinemia
  - Systemic lupus erythematosus
  - ImmunoglobulinA nephropathy
  - Mesangiocapillary
  - With antiglomerular basement membrane antibodies with lung disease (Goodpasture is syndrome) or without it
  - Idiopathic, rapidly progressive, without immune deposits
- Cortical necrosis, abruptio placentae, septic abortion, disseminated intravascular coagulation

FIGURE 8-3

Causes of parenchymal acute renal failure (ARF). When the sudden decrease in glomerular filtration rate that characterizes ARF is secondary to intrinsic renal damage mainly affecting tubules, interstitium, glomeruli and/or vessels, we are facing a *parenchymatous ARF*. Multiple causes have been described, some of them constituting the most frequent ones are marked with an asterisk.

MOST FREQUENT CAUSES OF ACUTE TUBULOINTERSTITIAL NEPHRITIS

- Antimicrobials
  - Penicillin
  - Ampicillin
  - Rifampicin
  - Sulfonamides
- Analgesics, anti-inflammatories
  - Fenoprofen
  - Ibuprofen
  - Naproxen
  - Amidopyrine
  - Glafenine
- Other drugs
  - Cimetidine
  - Allopurinol
- Immunological
  - Systemic lupus erythematosus
  - Rejection
- Infections (at present quite rare)
- Neoplasia
  - Myeloma
  - Lymphoma
  - Acute leukemia
- Idiopathic
  - Isolated
  - Associated with uveitis

FIGURE 8-4

Most common causes of tubulointerstitial nephritis. During the last years, acute tubulointerstitial nephritis is increasing in importance as a cause of acute renal failure. For decades infections were the most important cause. At present, antimicrobials and other drugs are the most common causes.

CAUSES OF OBSTRUCTIVE ACUTE RENAL FAILURE

- Congenital anomalies
  - Ureterocele
  - Bladder diverticula
  - Posterior urethral valves
  - Neurogenic bladder
- Acquired uropathies
  - Benign prostatic hypertrophy
  - Urolithiasis
  - Papillary necrosis
  - Iatrogenic ureteral ligation
- Malignant diseases
  - Prostate
  - Bladder
  - Urethra
  - Cervix
  - Colon
  - Breast (metastasis)
- Retroperitoneal fibrosis
  - Idiopathic
  - Associated with aortic aneurysm
  - Trauma
  - Iatrogenic
  - Drug-induced
- Gynecologic non-neoplastic
  - Pregnancy-related
  - Uterine prolapse
  - Endometriosis
- Acute uric acid nephropathy
- Drugs
  - ε-Aminocaproic acid
  - Sulfonamides
- Infections
  - Schistosomiasis
  - Tuberculosis
  - Candidiasis
  - Aspergillosis
  - Actinomycosis
- Other
  - Accidental urethral catheter occlusion

FIGURE 8-5

Causes of obstructive acute renal failure. Obstruction at any level of the urinary tract frequently leads to acute renal failure. These are the most frequent causes.

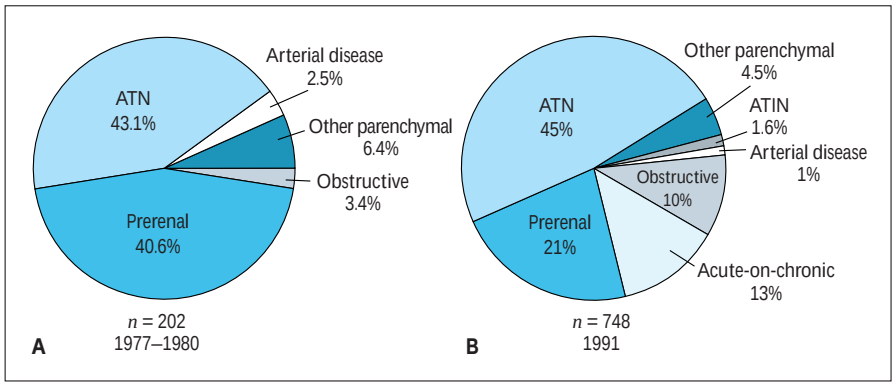

FIGURE 8-6

This figure shows a comparison of the percentages of the different types of acute renal failure (ARF) in a western European country in 1977–1980 and 1991: **A**, distribution in a typical Madrid hospital; **B**, the Madrid ARF Study [1]. There are two main differences: 1) the appearance of a new group in 1991, "acute on chronic ARF," in which only mild forms (serum creatinine concentrations between 1.5 and 3.0 mg/dL) were considered, for methodological reasons; 2) the decrease in prerenal ARF suggests improved medical care. This low rate of prerenal ARF has been observed by other workers in an intensive care setting [2]. The other types of ARF remain unchanged.

FINDINGS OF THE MADRID STUDY

Condition	Incidence (per million persons per year)	95% CI
Acute tubular necrosis	88	79–97
Prerenal acute renal failure	46	40–52
Acute on chronic renal failure	29	24–34
Obstructive acute renal failure	23	19–27
Glomerulonephritis (primary or secondary)	6.3	4.8–8.3
Acute tubulointerstitial nephritis	3.5	1.7–5.3
Vasculitis	3.5	1.7–5.3
Other vascular acute renal failure	2.1	0.8–3.4
Total	209	195–223

FIGURE 8-7

Incidences of different forms of acute renal failure (ARF) in the Madrid ARF Study [1]. Figures express cases per million persons per year with 95% confidence intervals (CI).