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.
8.2 Acute Renal Failure

Causes of Acute Renal Failure

**CAUSES OF PARENCHYMATOUS ACUTE RENAL FAILURE**

- Acute tubular necrosis
- Hemodynamic: cardiovascular surgery, sepsis, prerenal causes
- Toxic: antimicrobials, iodide contrast agents, anesthetics, immunosuppressive or antineoplastic agents, Chinese herbs, Opiatoxus, Extasix, mercurials, organic solvents, venoms, heavy metals, mannitol, radiation
- Intratubular deposits: acute uric acid nephropathy, myeloma, severe hypercalcemia, primary oxalosis, sulfadiazine, fluoride anesthetics
- Organic pigments (endogenous nephropathies): Myoglobin rhabdomyolysis, muscle trauma; infections; dermatomyositis; metabolic alterations; hypersensitive coma; diabetics, diabetic ketoacidosis, severe hypokalemia; hyper- or hyponatremia; hypophosphatemia; severe hypothyroidism; renal vasoconstriction: prostaglandin synthesis inhibition, /H9251 adrenergics, sepsis, hepatorenal syndrome, hypercalcemia
- Efferent arteriole vasodilation: converting-enzyme inhibitors

**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).

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**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.

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**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.
Acute Renal Failure: Causes and Prognosis

MOST FREQUENT CAUSES OF ACUTE TUBULOINTERSTITIAL NEPHRITIS

<table>
<thead>
<tr>
<th>Antimicrobials</th>
<th>Analgesics, anti-inflammatories</th>
<th>Other drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>Fenoprofen</td>
<td>Cimetidine</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>Ibuprofen</td>
<td>Allopurinol</td>
</tr>
<tr>
<td>Rifampicin</td>
<td>Naproxen</td>
<td></td>
</tr>
<tr>
<td>Sulfonamides</td>
<td>Glafenine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other drugs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Immunological
- Systemic lupus erythematosus
- Rejection
- Infections (at present rare)
- Neoplasia
- Myeloma
- Lymphoma
- Acute leukemia
- Idiopathic
- Isolated
- Associated with uveitis

CAUSES OF OBSTRICTIVE ACUTE RENAL FAILURE

- Congenital anomalies
  - Ureteroceles
  - 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)
- Renal parenchymal
  - Retroperitoneal fibrosis
  - Idiopathic
  - Associated with aortic aneurysm
  - Trauma
  - Iatrogenic
  - Drug-induced
  - Gynecologic non-neoplastic
  - Pregnancy-related
  - Ureteral prolapse
  - Endometriosis
- Other vascular acute renal failure
  - Acute anuric nephropathy
  - Drugs
  - e-Aminocaproic acid
  - Sulfonamides
- Infections
  - Schistosomiasis
  - Tuberculosis
  - Candidiasis
  - Aspergillosis
  - Actinomycosis
- Other
  - Accidental urethral catheter occlusion

FINDINGS OF THE MADRID STUDY

<table>
<thead>
<tr>
<th>Condition</th>
<th>Incidence (per million persons per year)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute tubular necrosis</td>
<td>88</td>
<td>79–97</td>
</tr>
<tr>
<td>Prerenal acute renal failure</td>
<td>46</td>
<td>40–52</td>
</tr>
<tr>
<td>Acute on chronic renal failure</td>
<td>29</td>
<td>24–34</td>
</tr>
<tr>
<td>Obstructive acute renal failure</td>
<td>23</td>
<td>19–27</td>
</tr>
<tr>
<td>Glomerulonephritis (primary or secondary)</td>
<td>6.3</td>
<td>4.6–8.3</td>
</tr>
<tr>
<td>Acute tubulointerstitial nephritis</td>
<td>35</td>
<td>1.7–5.3</td>
</tr>
<tr>
<td>Vasculitis</td>
<td>35</td>
<td>1.7–5.3</td>
</tr>
<tr>
<td>Other vascular acute renal failure</td>
<td>2.1</td>
<td>0.8–3.4</td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>195–223</td>
</tr>
</tbody>
</table>

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.

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 percent- ages 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.

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).