Renal Failure, Acute, and Sepsis

Description/Etiology
Acute renal failure (ARF; commonly referred to as acute kidney injury) is a progressive but often reversible deterioration of kidney function that develops during a period of hours to days. The sudden loss of renal function that is characteristic of ARF renders the kidneys unable to excrete waste products and excess fluid. Electrolyte imbalances, metabolic disturbances, and fluid imbalances can result. (For general information about diagnosis and treatment of ARF, see Quick Lesson About ... Renal Failure, Acute: an Overview)

ARF is a frequent and life-threatening complication of sepsis (i.e., a systemic inflammatory response to infection by pathogenic organisms [e.g., bacteria, fungi, protozoa, viruses]), which can cause ARF through a variety of mechanisms. Sepsis causes cardiovascular and pulmonary failure, which can result in systemic hypotension that leads to renal ischemia. Other effects of sepsis include an imbalance of vasodilatory and vasoconstrictive substances, which can cause intrarenal vasoconstriction and an infiltration of inflammatory cells that can damage the kidneys. During pregnancy, septic abortion and puerperal sepsis can cause ARF. Acid-base disorders such as lactic acidosis and respiratory alkalosis may be present in the patient who develops both sepsis and ARF. ARF and sepsis can cause a hypercatabolic state, accelerate protein degradation, and lead to malnutrition. Patients with sepsis who develop ARF have a higher mortality than patients who maintain normal renal function.

Treatment of ARF involves correcting abnormal hemodynamics, eradicating the underlying infection (e.g., with antibiotics or pathogen-specific agents), supporting compromised organ systems, and reducing risk of complications. Vasopressors, transfused blood or blood products, replacement fluids (e.g., crystalloids), and hemofiltration or dialysis may be prescribed to treat patients with ARF.

Facts and Figures
ARF commonly develops in patients with sepsis; sepsis and septic shock account for > 50% of cases of ARF in patients who are admitted to an intensive care unit, and reported mortality is 21–57%. Because pregnant women tend to be younger and have fewer comorbidities than the typical patient with sepsis and ARF, morbidity and mortality rates are lower in this patient population.

Risk Factors
Risk factors for sepsis-induced ARF include critical illness, systemic infection, advanced age, chronic disease, trauma, and use of nephrotoxic medications. Although rare in industrialized countries, pregnancy remains a risk factor for ARF in parts of the world that lack high-quality prenatal care. Septic abortion and puerperal sepsis are leading causes of pregnancy-related ARF.

Signs and Symptoms/Clinical Presentation
There are many possible signs and symptoms of ARF, including anorexia, weakness, vomiting, oliguria, tachycardia, tachypnea, nausea, hyperpnea, lethargy, muscle cramps, edema, fatigue, headache, and rales. Signs of ARF in patients with sepsis include oliguria, increased serum creatinine levels, and decreased glomerular filtration rate (GFR).
Assessment

› Patient History
  • Patient history is particularly important in identifying the cause of ARF (e.g., sepsis, injury, or obstruction)

› Physical Findings of Particular Interest
  • Patient may present with uremic frost (i.e., yellowish skin color)

› Laboratory Tests That May Be Ordered
  • Blood cultures will identify bacteria, if present; gram-negative bacteria are a common cause of sepsis
  • Urinalysis may show hematuria, proteinuria, renal tubular epithelial cells, and tubular or granular casts
  • Urine osmolality may indicate high levels of sodium
  • Serum electrolytes may be abnormal, indicating hyperkalemia and hyponatremia
  • Serum creatinine levels and BUN may be elevated

› Other Diagnostic Tests/Studies
  • CT scan will identify renal obstruction, if present
  • Kidney ultrasound will identify abnormalities, if present
  • EKG will show tall, peaked T waves, widening QRS, and disappearing P waves in patients with hyperkalemia

Treatment Goals

› Promote Emergency Resuscitation and Reduced Risk of Complications
  • Assess respiratory status with pulse oximetry and ABGs and assess for respiratory distress, fluid overload, and pain/other discomfort; administer oxygen and other prescribed medications, including analgesics
  – If resuscitation is necessary, maintain patent airway, support ventilation, provide aggressive fluid support, maintain strict blood glucose control (e.g., at 80–110mg/dl), and provide intensive monitoring
  • Frequently assess all physiologic systems, including monitoring cardiovascular status with invasive hemodynamic monitoring; administer blood products, as prescribed
  • Monitor for hypotension, continuing portals of infection, venous thrombosis, skin breakdown, and healthcare-associated secondary infection; immediately report abnormalities and complications to the treating clinician and treat, as ordered
  – Follow facility infection control protocols for use of strict aseptic technique and universal precautions
  • Monitor laboratory results of blood/body fluid specimen cultures; administer antimicrobials, as ordered, and monitor treatment efficacy and for adverse effects
  • Monitor fluid and electrolyte status with daily weight, intake and output, temperature, and other vital signs
  • Encourage adequate nutrition with dietary regulation of sodium, potassium, protein, and fluid as ordered; provide small, frequent meals or maintain enteral/parenteral feedings, if prescribed

› Promote Relief of Pain and Other Presenting Signs and Symptoms
  • Frequently assess for pain, nausea, and other discomfort; administer analgesics, antiemetics, sedatives, and other prescribed medications, as ordered
  – Provide local heat and gentle back massage to promote muscle relaxation and reduce pain, as ordered
  • Provide good oral and skin hygiene and reposition frequently to reduce discomfort using pillows or other supportive devices for stabilization. Elevate the head of the bed for easier breathing, if appropriate, and minimize thirst by providing ice chips
  • Provide a calm and quiet environment and encourage frequent family visitation

› Promote Emotional Well-Being and Educate
  • Assess anxiety level and coping ability of both patient and family; provide emotional support, educate, and encourage discussion of ARF and sepsis, potential complications, risks and benefits of all treatment, and individualized prognosis
  • Provide frequent updates to the patient and family about how the patient’s changing physiologic status leads to changes in the treatment regimen; educate about the rationale for all treatment strategies to reduce anxiety
  • Request referral, if appropriate, to a mental health clinician and/or clergyperson for counseling on strategies for coping with a life-threatening condition

Food for Thought

› Increased plasma neutrophil gelatinase-associated lipocalin, which is a protein that is produced by the kidneys after ischemic or nephrotoxic injury, may be a useful biomarker for identifying patients with suspected sepsis who are at high risk of ARF (Shapiro et al., 2010)
Findings from a research study indicated that urinary L-type fatty acid-binding protein (L-FABP) can be a useful biomarker for sepsis associated with acute renal injury (Doi et al., 2010).

The Acute Dialysis Quality Initiative Group developed a classification system for ARF in critical care patients that is called RIFLE, which defines the three grades of increasing severity of ARF: risk, injury, and failure and the two outcome variables of loss and end-stage kidney disease. The RIFLE classification system has been successfully used in clinical studies but requires additional research, and investigators suggest that it should include the patient’s preexisting kidney function (Van Biesen et al., 2006).

I.V. infusion of alkaline phosphatase has shown promise as a novel treatment for improving renal function in patients with sepsis-induced ARF (Pickkers et al., 2012).

**Red Flags**

- Oxygenation and perfusion are important if septic shock occurs; intubation and mechanical ventilation may be necessary to treat hypoxia.
- Delayed initiation of appropriate antimicrobial therapy for sepsis is associated with increased risk for ARF.

**What Do I Need to Tell the Patient/Patient’s Family?**

- Educate that ARF resulting from sepsis is a severe but treatable condition that requires intervention based on the causative pathogenic organism, intensive patient monitoring in a critical care unit, and extensive supportive care for all organ systems.
- Emphasize the importance of continued medical surveillance after discharge from acute care and seeking immediate medical attention for new or worsening signs and symptoms.

**Note**

Recent review of the literature has found no updated research evidence on this topic since previous publication on December 19, 2014.

**References**