

Sepsis and Septic Shock

Description/Etiology

Sepsis is a potentially fatal host response to infection that occurs in association with systemic inflammatory response syndrome (SIRS). SIRS is a severe inflammatory reaction that is diagnosed when two or more of the following criteria are present: temperature $> 100.4^{\circ}\text{F}/38^{\circ}\text{C}$ or $< 96.8^{\circ}\text{F}/36^{\circ}\text{C}$; heart rate $> 90/\text{min}$; respiratory rate $> 20/\text{min}$ or $\text{PaCO}_2 < 32 \text{ mm Hg}$; and WBC count $> 12,000/\text{mm}^3$, $< 4,000 \text{ mm}^3$, or the presence of $> 10\%$ immature forms. SIRS can occur with or without an infection, but sepsis can only be diagnosed when SIRS occurs in a person with a suspected or confirmed infection. Severe sepsis (i.e., sepsis with multiple-organ dysfunction) can lead to septic shock (i.e., severe sepsis with persistent hypotension despite adequate fluid resuscitation) and death.

The bloodstream, the skin, and the respiratory, gastrointestinal, and genitourinary tracts are common sites of infection associated with sepsis. Most infections associated with sepsis are bacterial in origin. Gram-positive bacteria that cause sepsis include *Staphylococci*, *Enterococci*, and *Streptococci*. Gram-negative bacteria that may cause sepsis include *Escherichia coli*, *Pseudomonas* spp., *Klebsiella* spp., *Proteus* spp., and *Pseudomonas* spp. Infections associated with sepsis can also be fungal, viral, rickettsial, or parasitic in origin. Although the pathophysiology of the continuum from infection to sepsis to septic shock is not completely understood, it is thought to involve an imbalance between pro- and anti-inflammatory mediators that result in tissue damage. Subsequent activation of inflammatory and coagulation pathways occurs and contributes to maldistribution of blood flow and significant immunosuppression. Clinical signs and symptoms of sepsis vary depending on the cause of infection and can mimic other conditions, which can make sepsis difficult to diagnose. Laboratory and diagnostic tests are performed to assess for other causes and to determine the cause of infection.

ICD-9

495.91, 785.52

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Treatment involves fluid resuscitation, intensive antimicrobial therapy aimed at the suspected source of infection, vasopressors to increase mean arterial pressure (MAP), transfusion of blood products for bleeding complications, and intensive patient monitoring. Improved survival for patients who have been diagnosed with septic shock has been demonstrated when early goal-directed therapy (e.g., maintaining adequate urine output, MAP at $\geq 65 \text{ mm Hg}$, and central venous pressure [CVP] at 8–12 mm Hg) is provided. Collaboration of a multidisciplinary team of clinician specialists in infectious disease, critical care, and/or surgery may be necessary. In severe cases, dialysis and/or surgery (e.g., surgical resection of an infectious site or to resolve renal disease) may be indicated. Prognosis depends on the pathogenic cause, site, and severity; the promptness and effectiveness of treatment; the host's immune response; and whether or not organ dysfunction or septic shock has occurred.

Facts and Figures

More than 18 million cases of severe sepsis occur each year, resulting in 1,400 deaths worldwide. In the United States, sepsis affects 0.3% individuals in the general population. Severe sepsis accounts for 2% of hospital admissions, with ~ 50% of these patients requiring treatment in the intensive care unit (ICU); in fact, severe sepsis accounts for 10% of all ICU admissions. An estimated 750,000 new cases of severe sepsis occur in hospitalized patients in the U.S. annually. The incidence of severe sepsis and septic shock is increasing in the

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U.S., likely due to the growing number of older adults and high-risk patients in the general population, the increasing use of invasive procedures in healthcare settings, the growing number of antibiotic resistant microorganisms, and the increased use of chemotherapy and immunosuppressant drugs. The incidence of sepsis increases with age. About 60% of cases of severe sepsis develop in patients who are older than 65 years of age. The incidence of severe sepsis in hospitalized patients is 0.2:1,000 in children and 26.2:1,000 in adults who are > 85 years of age. Even with aggressive treatment, mortality rates for patients with severe sepsis and/or septic shock are 20–50%. Sepsis may account for more than one-third of in-hospital deaths in the U.S. The incidence and mortality in septic shock is higher in men than in women. Annual hospital costs for treatment of sepsis in the U.S. are estimated at \$14 billion.

Risk Factors

Risk factors for sepsis and death from septic shock include genetic factors, catheterization, presence of an intravascular or prosthetic device, certain surgeries, urinary tract infection, appendicitis, diverticulitis, Crohn's disease, cholecystitis, renal disease, prostatitis, meningitis, and complicated obstetric delivery. Children, older adults, and individuals who are immunocompromised are at increased risk for both sepsis and progression to septic shock. Additional risk factors for progression to septic shock include prolonged time between onset of manifestations and initiation of treatment for sepsis, misdiagnosis of infection, microbial drug resistance and persistent infection, including supra- and nosocomial infections, and use of ineffective antibiotics (e.g., when microbial is not susceptible to the antibiotic).

Signs and Symptoms/Clinical Presentation

- › Sepsis: Fever or hypothermia, hyperventilation, tachycardia, chills, shaking, warm skin, skin rashes, lethargy, confusion, coma, hyperglycemia, muscle weakness, bleeding diathesis (i.e., predisposition to bleeding/hemorrhage), increased cardiac output, and signs and symptoms that reflect the primary site of infection (e.g., diarrhea, abdominal pain, and abdominal distention in cases of gastrointestinal infection; severe headache, neck stiffness, and cervical/submandibular lymphadenopathy in cases of head and neck infection)
- › Severe sepsis/septic shock: Liver dysfunction (e.g., jaundice), hypotension, cool skin, pancreatitis, renal failure, decreased cardiac output, adrenal dysfunction, acute respiratory distress syndrome, multiple-organ dysfunction syndrome, encephalopathy, neuropathy, and disseminated intravascular coagulation (DIC)

Assessment

› **Physical Findings of Particular Interest**

- In adults with septic shock, systolic blood pressure (BP) can be < 90 mm Hg or reduced ≥ 40 mm Hg from baseline; MAP can be < 70. Systolic BP in children may be < 2 standard deviations below normal for age

› **Laboratory Tests That May Be Ordered**

- Blood cultures may be positive for bacteria, and Gram stain can identify the type of bacteria; daily testing may be indicated
- CBC may reveal \downarrow or \uparrow WBCs, a low platelet count, and/or anemia
- BUN, serum creatinine, myoglobin, osmolality, bilirubin, and lactate may be \uparrow ; serum albumin may be \downarrow ; and liver enzymes may be \uparrow
- UA may show \uparrow urine creatinine and urine culture may be positive for bacteria
- Coagulation studies may show prolonged PT, prolonged PTT, and \downarrow fibrinogen, which may indicate DIC
- ABGs may show lactic acidosis, \downarrow blood oxygen levels, or respiratory alkalosis
- Cytologic analysis of cerebrospinal fluid (CSF) may indicate meningitis

› **Other Diagnostic Tests/Studies**

- Chest X-ray may be ordered to assess for pneumonia, if suspected
- Ultrasound, CT scan, or MRI may be ordered to identify the site of infection

Treatment Goals

› **Promote Goal-Directed Therapy and Return to Normal Physiologic Function**

- Frequently monitor vital signs, oxygen levels, cardiac output, neurologic status, skin color, laboratory/other diagnostic test results, urine output, glucose level, and level of consciousness (LOC)
 - Maintain patent airway and provide supplemental oxygen as ordered; maintain mechanical ventilation or intubation if ordered
 - Infuse prescribed intravenous fluids (e.g., normal saline, Ringer's lactate solution) or colloids (e.g., albumin) to maintain electrolytes and restore circulating fluids

- Transfuse prescribed blood products (e.g., whole blood, plasma products or packed red blood cells), and monitor closely for an adverse transfusion reaction
- Administer prescribed medications, as ordered; monitor treatment efficacy and for adverse effects
 - Administer antimicrobials as ordered to treat infection
 - The type of medication used will depend on the type of bacteria or other organism and the site of infection; combination therapy may be ordered
 - Broad-spectrum intravenous (IV) antibiotics should be initiated as quickly as possible (ideally within the first hour) in patients who present with sepsis-like signs and symptoms, even before diagnosis of sepsis is confirmed and/or the source of infection is identified
 - Administer vasopressors (e.g., DOPamine, norepinephrine, vasopressin) and/or inotropics (e.g., DOBUTamine) if ordered to treat hypotension
 - Administer corticosteroids (e.g., hydrocortisone) if ordered to reduce systemic inflammation
 - Administer sodium bicarbonate if ordered to treat acidosis
 - Administer prophylactic medications if ordered to prevent complications, including
 - heparin to prevent deep vein thrombosis (DVT)
 - H2 receptor antagonists to prevent stress ulcers
 - Administer recombinant activated protein C if ordered to treat coagulopathy, if present
- If applicable, remove the source of infection (e.g., catheter); assist with drainage of abscess or debridement at a site of infection if ordered
- Use aseptic techniques for patient care according to facility protocol and maintain skin integrity
- Monitor for complications, including organ failure, DIC, respiratory distress, and DVT
- Promote adequate bed rest and provide enteral nutritional support, as ordered
- Follow facility pre- and posttreatment protocols if patient becomes a candidate for dialysis or surgery; reinforce pre- and posttreatment education and verify completion of facility informed consent documents. Closely monitor for treatment-related complications
- Assess patient anxiety level and for knowledge deficits regarding sepsis and septic shock; provide emotional support and educate about sepsis/septic shock pathophysiology, potential complications, treatment risks and benefits, and individualized prognosis

Food for Thought

- › Although corticosteroids are commonly used in the treatment of patients with septic shock, researchers in a study of 6,663 patients treated for septic shock in 28 ICUs in three countries reported that administration of low-dose corticosteroids within 48 hours of diagnosis of septic shock was not associated with a decreased 30-day mortality rate overall. However, the investigators did find that early administration of low-dose corticosteroids reduced the 30-day mortality rate by 19% in the patients with the highest severity of illness (Funk et al., 2014)
 - The Surviving Sepsis Campaign guidelines recommend corticosteroid use only in patients with refractory shock with hemodynamic instability despite adequate fluid resuscitation and vasopressor use
- › Prompt recognition of sepsis and septic shock is crucial to the provision of potentially life-saving interventions. Nurses are the healthcare providers that typically spend the most time with patients and are, therefore, well positioned to identify signs and symptoms of these conditions. Investigators who conducted a study involving 242 acute and critical care pediatric nurses found that the participants could easily recognize septic shock, but were less adept at recognizing patients with earlier stages of sepsis (Jeffery et al., 2014)

Red Flags

- › Closely monitor for tachycardia when using vasopressor or inotropic therapy (i.e., pharmacologic agent use to change the force/strength and speed of a muscle contraction [e.g., heart])
- › Severe sepsis is the most common cause of death in noncoronary critical care units

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

- › Provide discharge instructions and verify the patient's understanding of the prescribed medication regimen, including potential adverse effects
- › Educate about the importance of continued medical surveillance and seeking immediate medical attention for new or worsening signs and symptoms

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