Oncologic Emergencies Related to Infectious Processes:
Sepsis and Septic Shock

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Definition:

Sepsis is the clinical evidence of infection plus evidence of a systemic response to infection. This systemic response is manifested by two or more of the following conditions:
- temperature >38 °C or <36 °C
- heart rate >90 beats per minute
- respiratory rate >20 breaths per minute or a PaCO₂ <32 mmHg
- white blood cell (WBC) counts >12,000/mm³, <4,000/mm³, or >10% immature (band) forms.

Septic shock (A – 1) is sepsis with hypotension (despite adequate fluid resuscitation) along with the presence of perfusion abnormalities that may include but are not limited to lactic acidosis, oliguria or acute alteration of mental status. Endotoxins (A – 2) that are produced by the bacterial pathogen can trigger fever, tachycardia and hypotension and may be fatal if left untreated.

Children and adolescents undergoing treatment for cancer are at great risk for infection and sepsis. The chemotherapy damages the tumor cells and the normal cells, especially those that have a rapid turnover rate such as the cells of the oral mucosa and gastrointestinal tract; damage to these cells results in breakdown of the mucosa. The breakdown of skin and mucosa provides a portal of entry for bacteria. In addition, the destruction of rapidly dividing neutrophils and monocytes (WBCs within the bone marrow) leaves patients with a low number of these infection-fighting cells and thus increases their risk for infection.

Risk Factors:

Although gram-positive microorganisms are the most common cause of infection, the common cause of septic shock is gram-negative bacteria that arise from the endogenous flora. Examples of these pathogens are Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa.
Other pathogens that can cause septic shock are viruses (such as herpes virus) and fungi (such as *Candida* spp.).

The most common risk factor associated with sepsis is neutropenia, and the risk is greatest in those with an absolute neutrophil count (ANC) <500/mm$^3$. Other associated risk factors include the duration of neutropenia or aplasia (the longer the neutropenia lasts, the greater the risk of infection), prior microbial colonization (which can be altered by frequent or previous use of antibiotics), previous infections by gram-negative microorganisms, disruption in the integrity of the skin or mucous membranes, central venous access and disorders of immune function.

Malnourished children and adolescents are at risk of sepsis and septic shock. In malnourished patients, there are often reduced neutrophil activity, lymphocyte function and macrophage mobilization. This condition creates a susceptibility to microbial infection and a risk of disseminated infection.

**Clinical Presentation:**

Sepsis is a systemic inflammatory response to invading pathogens and results in the manifestation of local and systemic symptoms (A – 3). Antibiotic therapy in a febrile, neutropenic patient might worsen the signs and symptoms caused by endotoxins released upon bacterial death and cell breakdown. The inflammatory response interferes with oxygen uptake and transport, and this interference leads to decreased tissue perfusion, hypoxemia and eventually death.

The initial assessment should include evaluation of the patient’s hemodynamic stability and organ perfusion. This evaluation is best accomplished by physical assessment of the heart rate, respiration, blood pressure and capillary perfusion. The progression of sepsis can be viewed as a continuum (A – 4) from early/compensatory to late/refractory stages and is associated with increasing severity of organ dysfunction and failure.

It should be noted that the temperature of the patient is often above normal; however, the patient could present with “cold shock” and a temperature <36°C. Cold shock is often associated with a higher mortality rate.

**Medical Management:**

The first treatment for sepsis (A - 5) is maintenance of hemodynamic stability through the intravenous administration of isotonic fluids such as normal saline or lactated Ringers solution. Blood cultures should be obtained, and the patient should be given broad-spectrum antimicrobial therapy that provides coverage for gram-negative and gram-positive bacteria and fungi, if these pathogens are suspected. If the symptoms of shock are not reversed by hydration, it may be necessary to administer vasopressors (dopamine, dobutamine, epinephrine) to prevent circulatory compromise. The outcome of the patient depends on the efficient initiation of therapy, the nature of the infection and the response to therapy.
Nursing Intervention:

Nursing intervention is very important in the management of children and adolescents with sepsis. The nurse should obtain cultures of blood, urine, sputum and from wounds from the febrile patient with neutropenia as soon as possible. In addition, the nurse should administer antimicrobial therapy as ordered and as soon as cultures are obtained. Vital signs, respiratory effort, and perfusion are closely monitored. Oxygenation must be monitored and maintained, and the nurse should assess the patient’s level of consciousness and promptly reports any signs of deterioration. The nurse is expected to efficiently administer fluids, antimicrobial therapy and volume expanders as indicated. Therefore, the nurse plays a vital role in the assessment and communication of clinical status.

Patient and Family Education:

The immunocompromised patient and caregivers should be taught ways to prevent infection and reduce the risk of infection. In the event that fever develops, the patient and family should be taught to seek medical help immediately.

The patient and family should be taught to watch for and report early symptoms of progression of sepsis and septic shock. Information about the patient’s condition and the treatments being implemented should be provided. Allowing the patient and family to participate in the care provides them with confidence and a sense of greater control over the situation.

Although septic shock has a high mortality rate, it is not considered to be a terminal condition. Patients and families may need clarification about this issue and “advance directives.” In addition, they may need more information about the condition and probable prognosis.

Helpful Web Links:

Merck & Co., Inc. Global Headquarters, Whitehouse Station, NJ
Merck Manual of Diagnosis and Therapy
Bacteremia and Sepsis
http://www.merck.com/mrkshared/mmanual/section13/chapter156/156c.jsp

National Library of Medicine
Medline Plus – Sepsis
Oncologic Emergencies Related to Infection:
Sepsis and Septic Shock

APPENDIX:

A – 1 Consensus Definitions of Sepsis, Severe Sepsis and Septic Shock

Systemic Inflammatory Response Syndrome (SIRS) – The systemic inflammatory response to a wide variety of clinical insults is manifested by two or more of the following conditions.
1. temperature >38 °C or <36 °C
2. heart rate >90 beats per minute
3. respiratory rate >20 breaths per minute or PaCO₂ <32 mm Hg
4. WBC count >12,000/mm³, <4000/mm³ or >10% immature (band) forms

Sepsis – the systemic inflammatory response to a documented infection. Two or more of the following conditions would result from the documented infection.
1. temperature >38° C or <36° C
2. heart rate >90 beats per minute
3. respiratory rate >20 breaths per minute or PaCO₂ <32 mm Hg
4. WBC count >12,000/mm³, <4000/mm³ or >10% immature (band) forms

Severe Sepsis – sepsis associated with organ dysfunction, hypoperfusion or hypotension. Also associated with severe sepsis are lactic acidosis, oliguria and an acute alteration in mental status.

Sepsis-Induced Hypotension – a systolic blood pressure <90 mm Hg or a reduction of at least 40 mm Hg from the baseline value in the absence of other causes of the hypotension.

Septic Shock – a subset of severe sepsis in which sepsis-induced hypotension occurs despite adequate fluid resuscitation and in which perfusion abnormalities (lactic acidosis, oliguria and/or an acute alteration in mental status) are present.

Multiorgan Dysfunction Syndrome (MODS) – the presence of altered organ dysfunction in an acutely ill patient such that homeostasis cannot be maintained without intervention.

A – 2 Endotoxins

Endotoxin is the lipopolysaccharide (LPS) component of the outer cell wall of gram-negative bacteria. Toxic and immunogenic, LPS retains activity after the bacteria die.

iaqms.com, Air Quality News
www.iaqms.com/floods/flood_bacteria_data.html
A – 3 Local and Systemic Symptoms of Sepsis and Septic Shock

Warm, dry, flushed skin that becomes cold, pale and cyanotic
Agitation, restlessness and confusion
Tachycardia, tachypnea
Fever, chills, malaise
Hypotension
Decreased urine output

A – 4 Septic/Septic Shock Continuum
Clinical Presentations of Sepsis
(Shelton, B. 1999, Seminars in Oncology Nursing)

<table>
<thead>
<tr>
<th>Category</th>
<th>Early/Compensatory</th>
<th>Late/Refractory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs and Symptoms</td>
<td>Blood pressure &lt;90 or &gt;40 mm Hg below the baseline value</td>
<td>Profound hypotension</td>
</tr>
<tr>
<td></td>
<td>High cardiac output</td>
<td>Low cardiac output</td>
</tr>
<tr>
<td></td>
<td>Low systemic vascular resistance</td>
<td>High systemic vascular resistance</td>
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<tr>
<td></td>
<td>Urine output &lt;0.5 mL/kg per hour</td>
<td>Anuria</td>
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<tr>
<td></td>
<td>Warm, flushed, dry skin</td>
<td>Cold, pale, clammy skin</td>
</tr>
<tr>
<td></td>
<td>Increased heart rate</td>
<td>Tachycardia, arrhythmias</td>
</tr>
<tr>
<td></td>
<td>Bounding pulse</td>
<td>Weak, thready pulse</td>
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<tr>
<td></td>
<td>Fever</td>
<td>Decreased core body temperature</td>
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<tr>
<td></td>
<td>Decreased levels of consciousness (LOC)</td>
<td>Decreased LOC</td>
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<tr>
<td></td>
<td>Increased respiratory rate</td>
<td>Shortness of breath</td>
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<tr>
<td></td>
<td>Decreased respiratory depth</td>
<td>Decreased respiratory depth</td>
</tr>
<tr>
<td></td>
<td>Cracksles</td>
<td>Crackles, wheezes</td>
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<tr>
<td>Diagnostic Tests</td>
<td>Increased WBC count</td>
<td>Increased or decreased WBC count</td>
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<tr>
<td></td>
<td>Hyperglycemia</td>
<td>Hypoglycemia</td>
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<td></td>
<td>Metabolic acidosis/respiratory alkalosis</td>
<td>Increased serum lipase, amylase, hepatic transaminase</td>
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<td></td>
<td>Hypoxemia (SVO$_2$ &gt; 80%)</td>
<td>Metabolic and respiratory acidosis</td>
</tr>
<tr>
<td></td>
<td>Thrombin time prolonged</td>
<td>Refractory hypoxemia SVO$_2$ &lt; 60%</td>
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<tr>
<td></td>
<td>Decreased clotting factors</td>
<td>Decreased clotting factors</td>
</tr>
<tr>
<td></td>
<td>Increased fibrin split products</td>
<td>Increased bilirubin, BUN and Creatinine</td>
</tr>
</tbody>
</table>
A – 5 Stepwise Medical Management of Septic Shock

Critical Care Medicine Tutorials
Patrick Neligan, University of Pennsylvania
http://www.ccmtutorials.com/infection/sepsisrx/page01.htm
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