THE ROLE OF THE ACUTE CARE NURSE PRACTITIONER
IN THE EARLY IDENTIFICATION AND MANAGEMENT OF SEPSIS

By

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Statement by the Author

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This master’s report has been approved on the date shown below:

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Shu-Fen Wung, PhD, MS, RN, ACNP, FAHA, FAAN                         Date
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To Patrick, my husband, whose sacrifices to allow me to complete this degree will never truly be known but will forever be appreciated and who held me up when I didn’t have the strength myself.

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To Mary Ann, my preceptor, mentor, and friend, whose gentle words of encouragement and prayers have been more help than anyone will ever know.
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ABSTRACT

Sepsis is a significant health care issue due to increasing incidence and continued high mortality rates. International organizations have come together to improve awareness and outcomes through the Surviving Sepsis Campaign. Integral to the success of the initiatives of this campaign is the early recognition of the development of sepsis and the implementation of early, goal-directed therapy. The Acute Care Nurse Practitioner plays an important role in prevention and early identification of sepsis as well as implementation of early-goal directed therapy for sepsis.
I. The Importance of Sepsis

Sepsis is a significant health care problem with over 750,000 cases of severe sepsis in the United States annually, resulting in over 210,000 deaths per year (Angus et al., 2001). The population-based incidence of sepsis and severe sepsis are 2.4 and 3 per 1,000 respectively (Martin, Mannino, Eaton & Moss, 2003; Angus et al., 2001) and severe sepsis is ranked as the tenth leading cause of death in the United States (Minino & Smith, 2001) with an estimated annual cost of $17 billion (Angus et al., 2001). The incidence of sepsis is projected to increase 1.5% annually (Angus et al., 2001; Martin et al., 2003; Dobrovsky et al., 2007). The increased incidence of sepsis is attributed to several factors. These include increased awareness, increased number of individuals living with an immuno-compromised status, such as human immunodeficiency virus (HIV) infection or those taking immunosuppressant agents, increased individuals living longer with various malignancies, increased number of individuals with co-morbidities such as diabetes mellitus, increasing numbers of elderly, increased use of invasive procedures for diagnosis and treatment of health problems, and increased number of resistant microorganisms (Balk, 2000). The mortality rate of sepsis continues to be high with a rate up to 64% (Martin et al., 2003; Angus et al., 2001; Sundararajan et al., 2005; Padkin et al., 2003; Alberti et al., 2002; Brun-Buisson et al., 2004; Alberti et al., 2005; Annane et al., 2003; Gestel, Bakker, Veraart, & van Hout, 2004; Vincent et al., 2006; Flaatten, 2004; Esteban et al., 2007).
II. Definition of Sepsis

Sepsis, originated in Greeks, has been used for over 2,500 years (Geroulanous & Douka, 2006; Singh & Evans, 2006; Vincent & Abraham, 2006). The terminology used to describe the pathology of sepsis has varied over time. Terms, such as “infection”, “bacteremia”, “septicemia”, “septic syndrome”, “septic shock”, and “sepsis,” have all been used interchangeably to describe a host response to infection (Nathens & Marshall, 1996; Bone et al., 1992).

In 1992, acknowledging inconsistency in terminology, the American College of Chest Physicians and the Society of Critical Care Medicine (ACCP/SCCM) developed and published a set of definitions to describe a continuum of severity of illness applied to patients with sepsis and its sequelae (Bone et al., 1992). The purpose was to improve identification and treatment of patients, as well as improve the design of research studies in this area. For the purposes of clarity within this paper, the term “sepsis continuum” will be used to refer to the natural history and progression of a disease in which sepsis is just one phase (Figure 1), the others being sepsis, severe sepsis and septic shock. The word “continuum” suggests progression. The sepsis continuum identifies progression of pathology with increasing severity resulting in increasing mortality (Martin et al., 2003; Angus et al., 2001; Sundararajan et al., 2005; Padkin et al., 2003; Alberti et al., 2002; Brun-Buisson et al., 2004; Alberti et al., 2005; Annane et al., 2003; Gestel, Bakker, Veraart, & van Hout, 2004; Vincent et al., 2006; Flaatten, 2004; Esteban et al., 2007).
Figure 1. The Sepsis Continuum of increasing severity as evidenced by greater derangements of physiologic parameters.
The first phase of the sepsis continuum is infection, either suspected or documented. The most commonly identified sites of infection related to sepsis are in the pulmonary, intra-abdominal, and genitourinary systems (Martin et al., 2003; Angus et al., 2001; Sundararajan et al., 2005; Padkin et al., 2003; Alberti et al., 2002; Brun-Buisson et al., 2004; Alberti et al., 2005; Annane et al., 2003; Gestel, Bakker, Veraart, & van Hout, 2004; Vincent et al., 2006; Flaatten, 2004).

Sepsis is further along the continuum and defined as possessing two or more “systemic inflammatory response syndrome” (SIRS) criteria in the setting of a suspected or identified infection (Figure 1). SIRS was introduced by Bone et al. (1992) to describe an inflammatory response independent of the cause. This inflammatory response can be triggered by noninfectious etiologies such as trauma, pancreatitis, burns, and myocardial infarction (Marik & Lipman, 2007; Nathens & Marshall, 1996). SIRS criteria include: 1) core temperature less than 96.8°F or greater than 100.4°F, 2) heart rate greater than 90 beats per minute, 3) respiratory rate greater than 20 breaths per minute, 4) arterial partial pressure of carbon dioxide (PaCO2) less than 32 mmHg, 5) white blood cell count less than 4,000/mm³ or greater than 12,000/mm³.

Severe sepsis (Figure 1) refers to sepsis complicated by an organ dysfunction, hypoperfusion, or sepsis-induced hypotension (Bone et al., 1992; Levy et al., 2003). Sepsis-induced hypotension is defined clinically as a systolic blood pressure less than 90 mmHg or a decrease of more than 40 mmHg from the patient’s baseline, without other possible causes such as cardiogenic shock (Bone et al., 1992; Levy et al., 2003). In
addition, others suggest that a mean arterial pressure (MAP) of less than 65 mmHg be used to define hypotension due to sepsis (Marik & Lipman, 2007).

Finally, septic shock is defined as severe sepsis with hypotension that does not respond to adequate fluid resuscitation (Bone et al., 1992; Levy et al., 2003). Adequate fluid resuscitation is defined as 20-30 mL/kg of a crystalloid fluid bolus (Nguyen & Smith, 2007).
III. Importance of Sepsis Related to the Practice of an Acute Care Nurse Practitioner

The Acute Care Nurse Practitioner (ACNP) cares for patients who are experiencing an acute episodic illness or acute exacerbation of a chronic condition. Many of these patients have several risk factors for the development of sepsis including advanced age, chronic illness, and receiving invasive medical procedures. The ACNP plays an important role in preventing, monitoring at risk patients, early identifying, and initiating evidence-based interventions for a sepsis (Kleinpell, 2005). In addition, the treatment of patients with sepsis often requires advanced knowledge of hemodynamic principles for which the ACNP is well trained and qualified to initiate, interpret, and intervene. The ACNP is uniquely qualified as a provider to take care of patients with sepsis. In addition, the ACNP also serves as an educator to the nursing staff to share advanced evidence-based practice knowledge. Further, the ACNP is well suited to function as a multi-disciplinary team member, as he/she is able to speak the language of all involved, including the patient, family, nurse, physician, and other allied health care professionals. With this ability to bridge the variety of disciplines, the ACNP brings a unifying force to the identification and management of patients with sepsis.

The purpose of this paper is to present current research related to the early identification and appropriate intervention of sepsis. A computerized search using the Ovid and EBSCO host databases was completed using the following key words: sepsis, severe sepsis, septic shock, ACNP, early identification, and research studies. A manual search of relevant references was also conducted to identify additional sources.
The goal of this review was to identify research validating the use of commonly monitored physiologic parameters as they relate to the early identification of sepsis and the role of the ACNP. No research specifically addressed the role of the ACNP in early identification of sepsis. Only limited research studies are available on commonly monitored physiologic parameters and on correlating these measurements to the diagnosis of sepsis. However, a common and agreed upon definition of sepsis as well as current, evidence-based interventions for the treatment of sepsis were identified.
IV. Lack of Agreement on Presentations and Management of Sepsis

In 2000, a prospective survey in 1058 intensive care and other specialist physicians caring for patients in the intensive care unit was conducted. The purpose of the survey was to evaluate physician awareness of severe sepsis and septic shock (Poeze, Ramsay, Gerlach, & Rubulotta, Levy, 2004). The survey found that less than 17% of physicians agreed on a definition of sepsis despite the definition published by the American College of Chest Physicians (ACCP) and the Society of Critical Care Medicine (SCCM) in 1992 (Bone et al., 1992) and 67% were concerned that a common definition was lacking. However, the respondents did agree that sepsis is a leading cause of mortality with increasing incidence. Further, 83% of respondents agreed that sepsis is a frequently missed diagnosis because the signs and symptoms could be attributed to other etiologies resulting in under-identification.

Response to a lack of agreement on definition of sepsis

In the 2001 International Sepsis Definition Conference, 29 representatives from the SCCM, ACCP, European Society of Intensive Care Medicine (ESICM), American Thoracic Society (ATS), and the Surgical Infection Society (SIS) met in Washington D.C. to review the strength and weakness of current definitions of sepsis, identify ways to improve current definitions, and to identify methodologies for increasing accuracy, reliability and/or clinical utility of the diagnostic tools of sepsis (Levy et al., 2003). The result (Table 1) was updated and expanded definitions of sepsis with the addition of clinical signs and symptoms to facilitate recognition, while the definitions of severe sepsis and septic shock were maintained (Levy et al., 2003).
<table>
<thead>
<tr>
<th></th>
<th>1992</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIRS</td>
<td>The systemic inflammatory response to a variety of severe clinical insults. The response is manifested by two or more of the following conditions:</td>
<td>SIRS remains a useful concept, the diagnostic criteria for SIRS published in 1992 are overly sensitive and nonspecific; therefore an expanded list of signs and symptoms (see below) are included with the definition of sepsis.</td>
</tr>
<tr>
<td></td>
<td>- Temperature &gt;36°C or &lt; 36°C</td>
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<tr>
<td></td>
<td>- Heart rate &gt; 90 beats per minute</td>
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<td></td>
<td>- Respiratory rate &gt; 20 breaths per minute or PaCO₂ &lt; 32 mmHg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- WBC count &lt; 4,000/mm³ or &gt; 12,000/mm³ or &gt; 10% immature (band) forms</td>
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<tr>
<td>Sepsis</td>
<td>The systemic response to infection, manifested by two or more of the SIRS criteria</td>
<td>Infection, documented or suspected, includes some of the following:</td>
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<tr>
<td></td>
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<td>- General variables</td>
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<tr>
<td></td>
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<td>- Fever (core temperature &gt;38.3°C)</td>
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<td></td>
<td></td>
<td>- Hypothermia (core temperature &lt; 36°C)</td>
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<td></td>
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<td>- Heart rate &gt; 90 beats per min</td>
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<td></td>
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<td>- Tachypnea</td>
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<td>- Altered mental status</td>
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<td>- Significant edema or positive fluid balance (&gt;20 mL/kg over 24 hrs)</td>
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<td>- Hyperglycemia (fasting plasma glucose &gt;120 mg/dL in the absence of diabetes)</td>
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<td>- Inflammatory variables</td>
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<td>- Leukocytosis (WBC count &gt; 12,000/mm³)</td>
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<td></td>
<td></td>
<td>- Leukopenia (WBC count &lt; 4000/mm³)</td>
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<td></td>
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<td>- Normal WBC count with &gt;10% immature forms</td>
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<td>- Plasma C-reactive protein &gt; 2 SD above the normal value</td>
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<td>- Plasma procalcitonin &gt; 2 SD above the normal value</td>
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<td>- Hemodynamic variables</td>
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<td></td>
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<td>- Arterial hypotension (SBP &lt; 90 mm Hg, MAP &lt;70, or a decreased SBP &gt; 40 mm Hg)</td>
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<td></td>
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<td>- SvO₂ &gt; 70%</td>
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<td></td>
<td></td>
<td>- Cardiac index &gt; 3.5 L/min·mmH²</td>
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<td>- Organ dysfunction variables</td>
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<td></td>
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<td>- Arterial hypoxemia (PaO₂/FIO₂ &lt; 300)</td>
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<td></td>
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<td>- Acute oliguria (urine output &lt; 0.5 mL/kg/hr for at least 2 hrs)</td>
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<td>- Creatinine increase &gt; 0.5 mg/dl</td>
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<td></td>
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<td>- Coagulation abnormalities (INR &gt; 1.5 or aPTT &gt; 60 secs)</td>
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<tr>
<td></td>
<td></td>
<td>- Leuко (absent bowel sounds)</td>
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<tr>
<td></td>
<td></td>
<td>- Thrombocytopenia (platelet count &lt; 100,000/mL)</td>
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<tr>
<td></td>
<td></td>
<td>- Hyperbilirubinemia (total bilirubin &gt; 4 mg/dL)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Tissue perfusion variables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Hyperlactatemia (&gt; 5 mmol/L)</td>
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<tr>
<td></td>
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<td>- Decreased capillary refill or mottling</td>
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Severe Sepsis: Sepsis associated with organ dysfunction, hypoperfusion, or hypotension. Hypoperfusion and perfusion abnormalities may include, but are not limited to, lactic acidosis, oliguria, or an acute alteration in mental status.

Septic Shock: Sepsis-induced hypotension despite adequate fluid resuscitation along with the presence of perfusion abnormalities that may include, but are not limited to, lactic acidosis, oliguria, or an acute alteration in mental status. Patients who are receiving inotropic or vasopressor agents may not be hypotensive at the time that perfusion abnormalities are measured.

Septic Shock-induced hypotension: A systolic blood pressure < 90 mm Hg or a reduction of > 40 mm Hg from baseline in the absence of other causes for hypotension.

aPTT, activated partial thromboplastin time; INR, international normalized ratio; MAP, mean arterial blood pressure; PaCO₂, arterial partial pressure of carbon dioxide; PaO₂/FIO₂, ratio of partial pressure of oxygen to fraction of inspired oxygen; SBP, systolic blood pressure; SD, xxxx; SvO₂, mixed venous oxygen saturation; WBC, white blood cell. *Infection defined as microbial phenomenon characterized by an inflammatory response to the presence of microorganisms or the invasion of normally sterile host tissue by those organisms. Bacteremia: presence of viable bacteria in the blood; †Infection defined as a pathologic process induced by a microorganism.
**Toward increased awareness and decreased mortality**

In response to lack of consensus on definitions of sepsis, an international collaboration, the Surviving Sepsis Campaign (SSC), was formed to increase awareness of the sepsis continuum thus to decrease mortality. The overall purpose of the campaign is a 5% decrease in mortality over a 5-year period (Osborn et al., 2005). The SSC was under the direction of the Society of Critical Care Medicine, the European Society of Intensive Care Medicine, and the International Sepsis Forum. In addition, eight international multidisciplinary organizations also joined the initiative, including the American Association of Critical Care Nurses, American College of Chest Physician’s, American College of Emergency Physicians, American Thoracic Society, Australian and New Zealand Intensive Care Society, European Society of Clinical Microbiology and Infectious Disease, European Respiratory Society, and the Surgical Infection Society (Osborn, Nguyen, & Rivers, 2005).

**Continued lack of awareness of sepsis and its treatment in both physicians and nurses**

More recently, a small study from South America demonstrated continued lack of awareness of sepsis and its recommended treatment (Fernandez et al., 2006). A validated questionnaire, consisted of 13 questions related to therapeutic interventions and important elements of the guidelines set forth by the SSC, was administered to 160 physicians practicing in internal medicine and general surgery from public and private hospitals. Of the physicians surveyed, 90% were aware of the published guidelines for the management of sepsis but only 60% were aware of the SSC. Furthermore, only 37% knew of the recommended evidence-based interventions and only 31% correctly
identified SIRS criteria as defined by Levy et al. (2003). Weaknesses of this study include small sample size, lack of inclusion of physicians who practice in critical care, and geographic location that may impart specific cultural dimensions that limit generalizability. However, despite the weakness, this study highlights continued concern regarding general awareness of sepsis that may adversely affect prompt recognition, diagnosis, and implementation of appropriate interventions.

A small study conducted by Robinson, Beavis, and Spittle (2007) sought to identify and compare nurses’ knowledge of sepsis against standard definitions and evidence-based management. A three-phase survey was administered to 73 nurses attending an annual basic life support education program. The respondents consisted of nursing staff from medical, surgical, and orthopedic units with various levels of clinical experience. The first phase survey included a list of signs and symptoms for respondents to identify those suggestive a sepsis or severe sepsis. The second phase consisted of five short case studies for respondents to indicate if the patient had sepsis or severe sepsis. In addition, they were asked to indicate what treatment should be administered. Finally, the questionnaire ended with 10 statements about sepsis for respondents to decide if these statements were true or false. These researchers concluded that these respondents had a poor knowledge of signs and symptoms as well as immediate management of sepsis. Furthermore, they suggested that this lack of knowledge might result in late diagnosis and suboptimal treatment of vulnerable patients with severe sepsis. This study is limited by lack of inclusion of critical care nurses and the small sample size. However, the results
suggest that a larger, more inclusive study needs to be conducted to assess nursing knowledge and awareness of sepsis.
V. Progression of the Sepsis Continuum

Lack of awareness and knowledge about sepsis and its natural history, pathology, and progression through the continuum can significantly delay appropriate interventions. Forty percent of patients with sepsis develop severe sepsis (Table 1), with two-thirds of these patients meeting criteria for both sepsis and severe sepsis within 24-hour period. Of the patients with severe sepsis, approximately 15% develop septic shock with half meeting the criteria for both severe sepsis and septic shock on the same day (Alberti et al., 2005; Esteban et al., 2007; Sundararajan et al., 2005). Theses findings underscore the need to identify the subtle signs and symptoms of sepsis as patients can progress quickly through the sepsis continuum. In addition, of the patients admitted to the Intensive Care Unit (ICU) for sepsis, almost half are admitted from a general ward versus the emergency department (ED) (Esteban et al., 2007; Kumar et al., 2006) underscoring the need for vigilant monitoring of inpatients throughout the hospital not only in the critical care areas.

The location where the patient was diagnosed with sepsis influences outcomes. Lundberg et al. (1998) compared outcomes in patients with septic shock, based on the location within the hospital where sepsis was identified. They compared age and the Acute Physiology and Chronic Health Evaluation (APACHE) II score between survivors and non-survivors. The APACHE II score is a severity of disease classification system with a range of 0 to 71. The point score is calculated from 12 routine physiological measurements (Table 2) during the first 24 hours of hospital admission, information about previous health status, and some information obtained at admission (such as age). A higher score implies a more severe disease and a higher risk of death (Knaus et al.,
1991). Lundberg et al. (1998) found that despite younger ages and lower APACHE scores, patients developed septic shock on a general medical unit had higher mortality rates than those developed septic shock in the ICU.
Table 2. Acute Physiology and Chronic Health Evaluation (APACHE) II scoring system from Merck Manuals Online Medical Library

APACHE II score = (acute physiology score) + (age points) + (chronic health points)

### Acute Physiology Score

<table>
<thead>
<tr>
<th><strong>1</strong></th>
<th><strong>2</strong></th>
<th><strong>3</strong></th>
<th><strong>4</strong></th>
<th><strong>5</strong></th>
<th><strong>6</strong></th>
<th><strong>7</strong></th>
<th><strong>8</strong></th>
<th><strong>9</strong></th>
<th><strong>10</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectal temp (°C)</td>
<td>Mean arterial pressure (mmHg)</td>
<td>Heart rate (bpm)</td>
<td>Oxygen delivery (ml/min)</td>
<td>PO2 (mmHg)</td>
<td>arterial pH</td>
<td>Serum sodium (mmol/l)</td>
<td>Serum potassium (mmol/l)</td>
<td>Serum creatinine (mg/dl)</td>
<td>Hematocrit (%)</td>
</tr>
</tbody>
</table>

### Scores

<table>
<thead>
<tr>
<th>Scores</th>
<th>+4</th>
<th>+3</th>
<th>+2</th>
<th>+1</th>
<th>0</th>
<th>+1</th>
<th>+2</th>
<th>+3</th>
<th>+4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Rectal temp (°C)</td>
<td>39-40.9</td>
<td>38-38.9</td>
<td>36-38.4</td>
<td>34-35.9</td>
<td>32-33.9</td>
<td>30-31.9</td>
<td>&lt;29.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = Mean arterial pressure (mmHg)</td>
<td>130-159</td>
<td>110-129</td>
<td>70-109</td>
<td>50-69</td>
<td>&lt;49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 = Heart rate (bpm)</td>
<td>140-179</td>
<td>110-139</td>
<td>70-109</td>
<td>55-69</td>
<td>40-54</td>
<td>&lt;39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 = Oxygen delivery (ml/min)</td>
<td>35-49</td>
<td>25-34</td>
<td>12-24</td>
<td>10-11</td>
<td>6-9</td>
<td>&lt;5</td>
<td></td>
<td></td>
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<tr>
<td>5 = PO2 (mmHg)</td>
<td>350-499</td>
<td>200-349</td>
<td>&lt;200</td>
<td></td>
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<td></td>
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<tr>
<td>6 = arterial pH</td>
<td>&gt;70</td>
<td>61-70</td>
<td>55-60</td>
<td>&lt;55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 = Serum sodium (mmol/l)</td>
<td>7.6-7.69</td>
<td>7.5-7.59</td>
<td>7.3-7.49</td>
<td>7.25-7.3</td>
<td>7.15-7.2</td>
<td>&lt;7.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 = Serum potassium (mmol/l)</td>
<td>160-179</td>
<td>150-154</td>
<td>130-149</td>
<td>120-129</td>
<td>111-119</td>
<td>&lt;110</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 = Serum creatinine (mg/dl)</td>
<td>6-6.9</td>
<td>5.5-5.9</td>
<td>3.5-5.4</td>
<td>3-3.4</td>
<td>2.5-2.9</td>
<td>&lt;2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 = Hematocrit (%)</td>
<td>3-14.9</td>
<td>15-19.9</td>
<td>3-14.9</td>
<td>1-2.9</td>
<td>&lt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 = White cell count (10^3/ml)</td>
<td>&gt;40</td>
<td>20-39.9</td>
<td>15-19.9</td>
<td>3-14.9</td>
<td>1-2.9</td>
<td>&lt;1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Age Points

- < 44, 0 points
- 45-54, 2 points
- 55-64, 3 points
- 65-74, 5 points
- >75, 6 points

### Chronic Health Points

<table>
<thead>
<tr>
<th>History of severe organ insufficiency (as defined below) and:</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-operative patients</td>
<td>5</td>
</tr>
<tr>
<td>Emergency postoperative patients</td>
<td>5</td>
</tr>
<tr>
<td>Elective postoperative patients</td>
<td>2</td>
</tr>
</tbody>
</table>

Severe organ insufficiency is present if one or more of the following criteria are met:
Organ insufficiency or immunocompromised state must have preceded the current admission and one of the following: 1) Immunocompromised if receiving therapy reducing host defenses (immunosuppression, chemotherapy, radiation therapy, long term steroid use, high dose steroid therapy) or has a disease interfering with immune function such as malignant lymphoma or leukemia; 2) Hepatic insufficiency if biopsy proven cirrhosis or portal hypertension or episodes of upper GI bleeding due to portal hypertension or prior episodes of hepatic failure, coma or encephalopathy; 3) Cardiovascular insufficiency if New York Heart Association Class IV; 4) Respiratory insufficiency if severe exercise restriction due to chronic restrictive, obstructive or vascular disease or documented chronic hypoxia, hypercapnia, secondary polycythemia, severe pulmonary hypertension, or respirator dependency; 5) Renal insufficiency if on chronic dialysis
Chalfin et al. (2007) found that patients transferred from the ED to the ICU with a time delay of greater than six hours had a longer length of stay and higher ICU and hospital mortality. These findings may be due in part to a delay in transfer to the ICU where definitive therapy could have been initiated. Kumar et al. (2006) found that each hour that appropriate antibiotic therapy was delayed, there was a 7.6% decrease in survival in patients with severe sepsis further underscoring the need for appropriate and timely intervention to improve outcomes.

Since patients with sepsis can quickly progress to more severe phases on the sepsis continuum, it is important to identify those who display derangements of physiologic parameters indicative of sepsis. In addition, delay in transfer to the ICU, where definitive treatment can be administered, can result in increased mortality. It is important to develop a process to improve transfer of care once a patient with sepsis is identified.
VI. Early Detection of Sepsis

Sepsis is defined by various subtle alterations of clinical parameters such as temperature, blood pressure, heart rate, and respiratory rate (Bone et al., 1992). Unlike a patient suffering from traumatic injuries that can be identified by radiograph or a patient suffering an acute coronary event evidenced by changes on an electrocardiogram, sepsis is identified by vague and not specific changes, making a definitive clinical diagnosis difficult. Measures used to increase early identification of sepsis include screening and monitoring of physiologic parameters.

Screening

Early identification of sepsis begins with identifying risk factors for sepsis that do cause the disease directly but are highly associated with it. Risk factors for the development of sepsis include: extremes of age (very young or very old), compromised immune system due to chemotherapy, steroids use, HIV infection, addictive habits such as alcohol or drug abuse; receiving invasive procedures such as surgery and in-dwelling intravenous catheters, and chronic illnesses such as diabetes and chronic obstructive pulmonary disease (Balk, 2000; Dhainaut, Claessens, Janes, & Nelson, 2005). Currently, no screening tools are available to identify patients with sepsis. Further work is needed to develop a valid screening tool with high specificity and sensitivity to be used in the acute care setting.

Physiologic monitoring

Clinical physiologic parameters used to identify patients with sepsis, severe sepsis, and septic shock have been proposed by the ACCP/SCCM in 1992 (Bone et al., 1992) for
However, these parameters have been criticized for being overly sensitive and minimally specific (Vincent, 1997). In response, the updated and expanded definitions by Levy et al. (2003) sought to provide more clinically relevant and applicable criteria to improve early identification of sepsis. Improved sepsis identification depends on use of these criteria; however, the accuracy and reliability of these physiologic parameters used to define sepsis and severe sepsis are unclear.

A descriptive study by Giuliano and Klienpell (2005) sought to gain an understanding of clinical practice related to routine continuous physiologic monitoring in patients with sepsis. They surveyed a group of 517 critical care clinicians, both physicians and nurses, using a convenience sampling method. They found, among electrocardiographic, invasive blood pressure, pulmonary artery pressure, and pulse oximeter monitoring, that physicians believed intra-arterial pressure monitoring, whereas nurses believed pulmonary artery pressure monitoring to be most important. Both groups believed electrocardiographic monitoring to be the least important for the patient with sepsis. They further identify that nurses at the bedside, who are responsible for the continuous monitoring of patients at risk for sepsis, are most likely to recognize the early onset of sepsis by use of basic physiologic monitoring parameters.

It is important to identify the value of common, continuously monitored parameters in the early identification of sepsis. Giuliano (2007) assessed the predictive value of five commonly monitored physiologic parameters for sepsis detection using an international database and criteria recommended by the SSC. Five parameters selected were elevated body temperature, decreased body temperature, increased heart rate,
increased respiratory rate, and decreased mean arterial pressure (MAP). Of these, an elevated temperature greater or equal to 38°C and a MAP less than 70 mmHg were significant predictors with odds ratios of 2.12 and 3.87 for sepsis, respectively. The odds ratio for sepsis increased to 4.63 if both predictors were present. Giuliano (2007) concluded that these results provide some support for the use of currently recommended physiologic monitoring criteria in the early identification of patients at risk for developing sepsis. Further research is required to validate what monitoring parameters recommended by the SSC guidelines are most important in the progression of sepsis.
VI. Sepsis Treatment

Part of the SSC included publication of guidelines for the management of severe sepsis and septic shock (Dellinger et al., 2004). These guidelines were developed by representatives from eleven international multidisciplinary organizations, through careful review of current research, based on grading of research evidence. The term early-goal directed therapy was used to define an organized method using evidence-based practice targeted at optimizing hemodynamics initiated with the detection of severe sepsis or septic shock (Osborn et al., 2005). Rivers et al. (2001) showed that when implementing early goal-directed therapy in a timely and organized manner, outcomes improved with an absolute decrease in mortality by 16%.

In order to translate the guidelines set forth by the SSC (Dellinger et al., 2004) into practical application, the SSC collaborated with the Institute for Healthcare Improvement (IHI). The IHI, founded in 1991, is a non-profit organization with the goal of leading healthcare improvement initiatives throughout the world (Institute, n.d.). The IHI developed the concept of “bundles” to help health care providers deliver more consistently quality care to patients undergoing particular treatments. A bundle is a structured group of usually three to five small sets of practices meant to improve the processes of care and patient outcomes. The bundles are based on a body of science and established best practices. Bundles also depend on consistent implementation for improved outcomes (Institute, n.d.). This IHI and SSC partnership was to incorporate the “bundles” concept in the application of sepsis treatment guidelines.
The guidelines for the treatment of severe sepsis and septic shock published by Levy et al. (2003) have been grouped into two sets of time-sensitive bundles, the 6-hour bundle, and the 24-hour bundle. These bundles are a group of interventions shown to improve outcomes when implemented as a group during a defined period of time (Severe Sepsis Bundles, 2007).

Sepsis bundles

The 6-hour bundle (Figure 2) incorporates early detection through identification of high-risk patients, presence of suspected or documented infection and two or more SIRS criteria. Once identification and diagnosis is made through this screening process, several interventions are recommended. Early detection of hypoperfusion through measurement of lactate levels is indicative of micro-vascular derangements, which can exist despite normal hemodynamic parameters such as blood pressure. Early identification and treatment microbiological causative organisms through obtaining appropriate cultures and administration of broad-spectrum antibiotics is an important step, with bundle suggesting administration of antibiotics within one hour of severe sepsis diagnosis. Early and aggressive treatment of hypotension initially through fluid resuscitation and monitoring of MAP and central venous pressure (CVP) is an integral part of early goal-directed therapy, and if required, the use of vassopressors with additional guidance from central venous oxygenation saturation (ScVO2) values (Implement the 6-hour bundle, 2007).
Figure 2. Six-hour treatment algorithm

Patient identification through screening of risk factors, SIRS criteria, and suspected or documented infection

- Appropriate cultures and antibiotics within 1 hour of identification
- Placement of central line for CVP and ScVO2

Initial fluid bolus 25 mL/kg

- CVP < 8 mmHg
  - 0.9 NS IVF boluses over 15 minutes
- CVP > 8 mmHg
  - MAP < 65 mmHg
    - Vassopressors to reach goal
  - MAP > 65 mmHg
    - ScVO2 < 70%
      - HCT < 30
        - Transfuse PRBC
      - HCT > 30
        - Dobutamine to max of 20mcg/kg/min
  - ScVO2 > 70%
    - Goals of CVP > 8, MAP > 65, ScVO2 > 70%
      - In addition to lactate < 2 mMol/L

CVP, central venous pressure; MAP, mean arterial pressure; ScVO2, central venous mixed oxygen saturation; NS IVF, normal saline intravenous fluid bolus; PRBC, packed red blood cells; SIRS, systemic inflammatory response syndrome; HCT, hematocrit
The 24-hour bundle includes several additional interventions shown to improve outcomes if completed within the first 24 hours after diagnosis of severe sepsis (Dellinger et al., 2004; Implement the 24-hour bundle, 2007). First, low-dose steroids are recommended for patients requiring continued vasopressor support despite adequate fluid resuscitation because it may facilitate reduction and withdrawal of vasopressor support. Low-dose steroids should be considered after completion of the 6-hour bundle. Hydrocortisone 200-300 mg per day for seven days in divided doses and/or fludrocortisone 50 mcg per day for seven days (Annane et al., 2002; Dellinger et al., 2004; Keh & Sprung, 2004).

The only drug approved specifically for the treatment of sepsis is recombinant human activated protein C (rhAPC) which targets micro-vascular dysfunction by decreasing inflammation, coagulation, and increasing fibrinolysis (Vincent et al., 2003; Debacker et al., 2006). In the Recombinant Human Activated Protein C Worldwide Evaluation in Severe Sepsis (PROWESS) trial, a statistically significant 6.1% reduction in all case mortality at 28 days was demonstrated with the administration of rhAPC for 96 hours (Vincent et al., 2003; Debacker et al., 2006). As part of the SSC 6-hour bundle guidelines, consideration of rhAPC is recommended after adequate fluid resuscitation and vasopressor support if the patient’s APACHE II score is ≥ 25.

In addition to steroids and rhAPC, several other recommended interventions include glycemic control, deep vein thrombosis (DVT) prophylaxis, stress ulcer prophylaxis, and lung protective strategies for mechanically ventilated patients. Glycemic control is defined as serum glucose levels of 70-150 mg/dL and may best be achieved
through continuous insulin infusion in light of the microvascular derangements that occur in severe sepsis (Dellinger et al., 2004). No studies specifically address DVT and stress ulcer prophylaxis in severe sepsis, even though benefit has been shown in general ICU patients (Dellinger et al., 2004). DVT prophylaxis can be achieved non-pharmacologically with the use of pneumatic compression devices or pharmacologically with administration of low molecular weight or unfractionated heparin. Prophylaxis for stress ulcers can be addressed through histamine blocking agents or proton pump inhibitors. Finally, lung protective measures, including maintaining plateau pressures of less than 30 cm H2O, for mechanically ventilated patients are recommended (Implement the 24-hour bundle, 2007).

Patients with severe sepsis are at risk for organ dysfunction. Pulmonary system is one system that is especially at risk for the development of acute lung injury (ALI) and acute respiratory dysfunction syndrome (ARDS) (Rivers et al., 2001). ALI is defined as a syndrome of acute persistent lung inflammation with increased vascular permeability. ALI is characterized by four clinical features including: 1) acute onset, 2) bilateral infiltrates consistent with pulmonary edema, 3) a ratio of the partial pressure of arterial oxygen to the fraction of inspired oxygen (PaO2/FiO2) between 201 and 300 mmHg, regardless of the level of positive end-expiratory pressure (PEEP), and 4) no clinical evidence of an elevated left atrial pressure as suggested by a pulmonary capillary wedge pressure of 18 mmHg or less. ARDS uses the same four criteria as ALI except that the hypoxemia is worse (PaO2/FiO2 ≤ 200 mmHg), regardless of the level of PEEP (Mortellini & Manning, 2002; Udobi, Childs, & Touijer, 2003). Despite advances in the
supportive care and mechanical ventilation strategies, sepsis-associated ARDS carries the highest mortality rates ranging from 18 to 38% (Fein et al., 1983; Hudson et al., 1995; Bernard et al., 1997). ARDS occurs more frequently in patients who develop septic shock and whose sepsis is caused by a pulmonary rather than a non-pulmonary source (Hyres, 1993; Luce, 1998).

The SSC guidelines follow the ARDSNET recommendations for ventilator management (Ventilation, 2000) including decreasing tidal volume to 6 mL/kg to achieve a plateau pressure < 30 mmHg, permissive hypercapnea if needed to reach plateau pressure goals, minimizing the amount of PEEP, consideration of prone positioning, and daily weaning trials to facilitate early extubation (Dellinger et al., 2004). In addition to the 6-hour and 24-hour bundles, it is important to note that the SSC guidelines recommend re-evaluation of antibiotic therapy at 24 to 72 hours based on culture results to narrow the spectrum of antibiotic coverage to effectively treat identified microorganisms and minimize the potential development of resistant pathogens (Dellinger et al., 2004). Furthermore, the guidelines recommend setting and communicating realistic goals of treatment with patients and families through early and frequent discussions. At times, decisions for less aggressive support or withdrawal of support may be in the patient’s best interest (Dellinger et al., 2004).
VIII. Discussion

Sepsis is an important health care issue due to increased incidence, continued high morbidity and mortality, and high utilization of health care resources. In response to these issues, an international effort, through the SSC, is underway to increase awareness of the problem, improve recognition of the disease, and apply evidence-based strategies to improve outcomes. The ACNP plays a vital role in the prevention, early identification, and initiation of early goal-directed interventions for patients with sepsis.

Prevention

Health promotion and disease prevention are core competencies of the ACNP (National Panel, 2004). Health promotion is limited in the acute phase of sepsis. Health promotion issues such as smoking cessation, blood pressure control, diet and exercise, and health maintenance and screening activities can be identified during the acute phase of sepsis; however can only be intervened after the patient’s condition is improves. However, practices to prevent infection, such as maintaining hand hygiene and adhering to institutional infection control policies, are vital to stop the progression of sepsis. It is important for the ACNP to practice meticulous hand hygiene to protect patients seen as well as to provide a good role model for other health care professionals and allied health care providers.

Specific recommended infection control practices are related to the prevention of nosocomial infections including catheter-related blood stream infections (CRBSI) and ventilator-associated pneumonia (VAP). CRBSI is defined as a bacterial or fungal infection of the blood in a patient with an intravascular catheter with at least one positive
blood culture obtained from a peripheral vein and clinical manifestations of infection (Mermel, 2000). The use of full barrier protection is the primary strategy in the prevention of CRBSI. Full barrier protection is defined as the use of mask, gloves, gown, and drapes to provide the largest area of sterility when placing invasive lines, such as central venous catheters. In addition, use of chlorhexidine skin cleanser and choosing the subclavian area for insertion of a central venous catheter reduces the occurrence of CRBSI (Mermel, 2000).

VAP is defined as an airways infection more than 48 hours after an intubation (Institute for healthcare, n.d.). Practices recommended to prevent VAP include elevating the head of bed greater than 30 degrees, daily interruption of sedation to evaluate for possible extubation, and DVT and stress ulcer prophylaxis. Through adherence to these evidence-based guidelines, the ACNP can decrease the incidence of CRSBI and VAP in their patients. It is also important for the ACNP to evaluate the need for continuation of invasive lines, catheters, and tubes, such as central lines, foley catheters, and endotracheal tubes. As previously discussed, invasive procedures put patients at greater risk for developing sepsis and timely removal of these devices should be considered.

**Diagnosis**

In addition to prevention, it is important for the ACNP to diagnose conditions that may result in rapid physiologic deterioration or life-threatening instability (National Panel, 2004). As an integral part of the multi-disciplinary team, the ACNP can help to develop screening methods to identify patients at risk for developing sepsis. Sepsis is a heterogeneous disease process so the approach to early identification must be
multifaceted. Early identification must take into consideration risk factors that predispose an individual to the development of sepsis. In addition, early identification, must utilize evidence supported monitoring parameters. Therefore development of a screening tool should incorporate risk factors, most commonly identified sites of infection, and the physiologic monitoring parameters associated with the development of sepsis. The usefulness of a screening tool is improved when it can be used in a variety of settings, including where continuous monitoring is not available, such as the general medical unit. Such a tool would require validation of accuracy and ease of use before it could be used on a wide-scale. Furthermore, the ACNP plays an important role in assuring that the parameters chosen for monitoring provide an accurate reflection of the clinical status. Interpretation of selected physiological parameters requires sound clinical judgment to include or exclude sepsis as part of the working differential diagnosis.

*Education*

The ACNP participates in formal and informal education of other health care professionals (National Panel, 2004). Education of nurses regarding definitions, treatment, and physiologic parameters that best identify patients developing sepsis is important. The nursing staff at the bedside provides care and monitors patients around the clock, thus are in a unique position to identify patients suffering from sepsis, severe sepsis, and septic shock early. Kliempell (2003) suggests that through careful observation, assessment, and communication of the clinical evidence of sepsis, nurses can facilitate prompt diagnosis and treatment. Through development and implementation of education regarding sepsis
screening criteria and treatment bundles, the ACNP can improve early detection and appropriate rapid intervention.

*Evidenced-based practice*

The ACNP must also be involved in the development and implementation of evidence-based protocol-driven care to provide timely and consistent application of the sepsis bundles. Working with physician colleagues, the ACNP can develop protocols that facilitate implementation of evidenced-based practice to improve outcomes. For example, the ACNP can translate the sepsis bundles into order-sets/protocols that are consistent with current institutional practices. Implementation of these protocols and order-sets will require the ACNP to educate nursing staff and other multi-disciplinary team members about the evidence that supports these measures. The ACNP can also teach nursing staff on how to obtain and interpret recommended parameters such as CVP and ScVO2. Research has shown an improved compliance by bedside nurses with ACNP promotion of adherence to evidenced-based practice guidelines (Kleinpell, 2005).

*Quality management*

The ACNP plays a role in quality management by tracking and collecting data related to quality indicators (Table 3) and outcomes of sepsis care (Kleinpell, 2005). Tracking data may require the ACNP to review charts and input data or develop and oversee a process that can be accomplished by support staff. The ACNP also need to interpret data collected and respond to the result accordingly. Further education of the nursing staff or alterations of previously developed protocols may be needed.
### Table 3. Severe Sepsis Quality Indicators

<table>
<thead>
<tr>
<th>Quality Indicator #1</th>
<th>Definition of Indicator</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose values below the lower limit of normal and with a median value &lt; 150 mg/dL (8.3 mmol/L) for severe sepsis and/or septic shock over the period 6 hours to 24 hours following the time of presentation.</td>
<td>The percent of patients for whom glucose values were maintained greater than the lower limit of normal and with a median value &lt; 150 mg/dL (8.3 mmol/L) for severe sepsis and/or septic shock over the period 6 hours to 24 hours following the time of presentation.</td>
<td>Numerator: the number of patients for whom glucose values were maintained greater than the lower limit of normal and with a median value &lt; 150 mg/dL (8.3 mmol/L) for severe sepsis and/or septic shock over the period 6 hours to 24 hours following the time of presentation. Denominator: the number of patients presenting with severe sepsis and/or septic shock.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Indicator #2</th>
<th>Definition of Indicator</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean time in minutes to broad-spectrum antibiotic(s) administration for severe sepsis and/or septic shock following the time of presentation.</td>
<td>The median time in minutes to broad-spectrum antibiotics) administration for severe sepsis and/or septic shock following the time of presentation.</td>
<td>Note: For this indicator, time of presentation is determined as follows: (i) If the patient presented to the ED with severe sepsis and/or septic shock, the time of presentation is the ED triage time. (ii) If the management of severe sepsis and/or septic shock is started in the patient who is transferred to the ICU, the time of presentation is the time of transfer. (iii) If the time of presentation is the date in thechart, the patient was transferred to the ICU, the ICU admission time is the default value for the time of presentation. (iv) If the patient was newly treated for severe sepsis and/or septic shock while in the ICU, the first time in minutes of the date of diagnosis was also used to determine the time of presentation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Indicator #3</th>
<th>Definition of Indicator</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central venous oxygen saturation (SvO₂) ≤ 70% or arterial lactate ≥ 4 mmol/L (36 mg/dL) over the first 6 hours following the time of presentation.</td>
<td>The percent of patients for whom a goal SvO₂ ≥ 70% (or arterial lactate ≤ 4 mmol/L (36 mg/dL)) was achieved for septic shock or lactate ≥ 4 mmol/L (36 mg/dL) over the first 6 hours following the time of presentation.</td>
<td>Numerator: the number of patients for whom a goal SvO₂ ≥ 70% (or arterial lactate ≤ 4 mmol/L (36 mg/dL)) was achieved for septic shock or lactate ≥ 4 mmol/L (36 mg/dL) over the first 6 hours following the time of presentation. Denominator: the number of patients with septic shock or severe sepsis with lactate ≥ 4 mmol/L (36 mg/dL). Exclusion: patients with non-severe sepsis or severe sepsis with lactate ≤ 4 mmol/L (36 mg/dL).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Indicator #4</th>
<th>Definition of Indicator</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration of low-dose glucocorticoids for septic shock determined in accordance with a standardized ICU policy over the first 24 hours following the time of presentation.</td>
<td>The percent of patients for whom administration of low-dose glucocorticoids was determined in accordance with a standardized ICU policy over the first 24 hours following the time of presentation.</td>
<td>Numerator: the number of patients for whom administration of low-dose glucocorticoids was determined in accordance with a standardized ICU policy over the first 24 hours following the time of presentation. Denominator: total number of patients with septic shock. Low-dose glucocorticoids refer to a daily dose of 200–300 mg of hydrocortisone or equivalent.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Indicator #5</th>
<th>Definition of Indicator</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration of drotrecog alfa (activated) for severe sepsis and/or septic shock determined in accordance with a standardized ICU policy over the first 24 hours following the time of presentation.</td>
<td>The percent of patients for whom administration of drotrecog alfa (activated) was determined in accordance with a standardized ICU policy over the first 24 hours following the time of presentation.</td>
<td>Numerator: the number of patients for whom administration of drotrecog alfa (activated) was determined in accordance with a standardized ICU policy over the first 24 hours following the time of presentation. Denominator: total number of patients presenting with severe sepsis and/or septic shock. Exclusion: non-severe sepsis.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Quality Indicator #6</th>
<th>Definition of Indicator</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Glucose values maintained greater than the lower limit of normal and with a median value &lt; 150 mg/dL (8.3 mmol/L) for severe sepsis and/or septic shock over the period 6 hours to 24 hours following the time of presentation.</td>
<td>The percent of patients for whom glucose values were maintained greater than the lower limit of normal and with a median value &lt; 150 mg/dL (8.3 mmol/L) for severe sepsis and/or septic shock over the period 6 hours to 24 hours following the time of presentation.</td>
<td>Numerator: the number of patients for whom glucose values were maintained greater than the lower limit of normal and with a median value &lt; 150 mg/dL (8.3 mmol/L) for severe sepsis and/or septic shock over the period 6 hours to 24 hours following the time of presentation. Denominator: the number of patients presenting with severe sepsis and/or septic shock.</td>
</tr>
</tbody>
</table>
Managing the sepsis continuum requires a wide breadth and depth of clinical competencies. The ACNP is optimally suited to manage this complex, uncertain, and resource-exhausting clinical condition (AACN, 2006). Early identification of patients at risk allows the ACNP to initiate prompt evidence-based interventions early in the disease process. The impact that the ACNP can make on outcomes of patients suffering from sepsis depends on a solid knowledge base of incidence, pathophysiology, clinical presentations, and current evidence-based interventions.

<table>
<thead>
<tr>
<th>Quality Indicator #3</th>
<th>Definition of indicator</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintaining respiratory pressure plateau maintained &lt; 30 cm H₂O for mechanically ventilated patients with severe sepsis and/or septic shock over the first 24 hours following the time of presentation</td>
<td>The percent of mechanically ventilated patients with severe sepsis and/or septic shock over the first 24 hours following the time of presentation</td>
<td>Numerator: number of mechanically ventilated patients with severe sepsis and/or septic shock over the first 24 hours following the time of presentation Denominator: number of mechanically ventilated patients presenting with severe sepsis and/or septic shock. Exclusion: Patients who were not mechanically ventilated</td>
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<thead>
<tr>
<th>Quality Indicator #8</th>
<th>Definition of Measure</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Reliability of compliance with all elements of the severe sepsis management bundle</td>
<td>The percent of cases of severe sepsis and/or septic shock that completed all applicable severe sepsis management bundle elements</td>
<td>Numerator: the number of cases of severe sepsis and/or septic shock that completed all applicable severe sepsis management bundle elements Denominator: number of patients with severe sepsis and/or septic shock Exclusion: non-severe sepsis</td>
</tr>
</tbody>
</table>

Note:
1. Monthly reporting of results is recommended for all indicators.
2. The definition of severe sepsis, for purposes of the severe sepsis quality indicators, follows the algorithm used in the Evaluation for Severe Sepsis Screening Tool.
3. The definition of septic shock, for purposes of severe sepsis quality indicators, assumes failure to maintain MAP > 85 despite compliance with and completion of all elements in the Severe Sepsis Resuscitation Bundle.


*Intensive Care Medicine, 32*, 2077


http://ssc.sccm.org/24hr_bundles


http://www.ihi.org/ihi/about


http://www.ihi.org/IHI/Topics/CriticalCare/IntensiveCare/ImprovementStories/WhatIsaBundle.htm


