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Identifying Acute Organ Dysfunction as a Marker of Severe Sepsis
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Introduction
The current definition of sepsis is suspected or documented infection plus at least one systemic manifestation of infection. Identifying acute organ dysfunction is a marker of severe sepsis. This topic was chosen after witnessing a number of patients fall into septic shock before severe sepsis was diagnosed and treatment initiated. Diagnosis of severe sepsis is important for specific protocol to be implemented in a timely fashion. The current differentiation between sepsis and severe sepsis is evidence of organ dysfunction. There are many examples of organ dysfunction that are not commonly considered when doing a patient workup. Having knowledge of acute organ dysfunction markers could potentially lead to earlier diagnosis of severe sepsis. The earlier it is diagnosed, the sooner treatment protocols can be initiated. Research showed that if severe sepsis is diagnosed timely, administration of timely and improved cardiovascular performance, lowered the inflammatory response, tissue hypoperfusion and multi-organ injury, and most importantly reduced mortality. (Lee, & Wu, 2013).

Signs and Symptoms
The individual patient response to severe sepsis is dependent on characteristics of both the host (comorbidities and immunosuppression) and the pathogen (intravenous drug use and organism load). Coagulation abnormalities form severe sepsis; such as intravascular coagulation and fibrinolysis that result in endothelial dysfunction, microvascular thrombosis, and impaired tissue perfusion. This impairment, combined with the systemic vasoconstriction and hypotension, causes tissue hypoxia and decreased tissue oxygenation, further complicated by impaired myocardial oxygen utilization secondary to oxidative stress. These mechanisms result in further tissue damage and ultimately contribute to multi-organ failure. Signs and symptoms of organ dysfunction commonly includes hypotension, acute respiratory distress syndrome, altered mental status, acute kidney injury, fever, hepatic dysfunction, disseminated intravascular coagulation, arterial hypotension, and encephalopathy. The syndrome will have multiple indicators of organ dysfunction. Examples include:

- altered consciousness
- confusion
- tachypnea, SO2 decreased
- decreased oxygen saturation ratio
- tachycardia, hypotension
- jaundice, decreased hepatic function evidenced by increased bilirubin
- oliguria, decreased platelets and reduced kidney function evidenced by increased creatinine
- platelets of 60-100k will show increase (Tutak, Ozer, Jun, & Wu, 2014)
- increased lactate/albumin ratio is an additional value that could be used, but it is considered because it correlates with the mortality in patients with severe sepsis and septic shock (Wang, Chen, Cao, Xue, & Wu, 2015)

Underlying Pathophysiology
Sepsis, severe sepsis, and septic shock may be secondary to either community-acquired health care associated or hospital-associated infections. The most common underlying cause are pneumonia, intra-abdominal infections, and urinary tract infections. Ectopic organ systems can serve as the spectrum of pathogens, with bacteria and fungi being predominant. However, Staphylococcus aureus, Staphylococcus epidermidis, Enterococcus species, Streptococcus pneumoniae, Escherichia coli, Pseudomonas aeruginosa, species within the Klebsiella family, and Candida species account for most of the pathogens described (Cawcutt & Peters, 2014). Infection triggers both pro-inflammatory and anti-inflammatory processes that ultimately contribute to the inflammation of the infection and the tissue damage that lead to organ failure. In general, the pro-inflammatory processes are triggered by the infectious agent and focused on the elimination of the pathogen, whereas the anti-inflammatory processes are triggered by the host to promote tissue repair and healing. An imbalance of these mechanisms lead to excess tissue damage.

Significance of Pathophysiology
Understanding the pathophysiology of sepsis is significant to good patient outcomes. The number of septic cases in the United States exceeds 750,000 per year and was recently reported to be rising. Sepsis is the 10th leading cause of death in the United States and the leading cause of death in non-cardiac ICUs. One patient in the United States presents to an emergency department every minute with severe sepsis and accounts for 20% of all ED admissions (Park, Kim, Lee, & Yu, 2014). Knowledge of organ dysfunction markers could help identify severe sepsis quickly which means that treatment protocol can be initiated earlier. Comprehending the etiologic origins of sepsis and infectious process they take, means appropriate anti-infective measures can be implemented and patient outcome improved. One example of the significance of severe sepsis is the symptom of low oxygen extraction ratio. Recent research shows initial low OER oxygen extraction ratio was associated with severe organ dysfunction that evolved in high mortality with severe sepsis and septic shock. When patients had initial abnormally low OER, their in-hospital mortality was higher than in normal OER patients. Therefore, the OER should be considered when attempting to predict the outcome of septic patients (Kim, Lee, Lee, Han, Misro, & Hong, 2015).

Sepsis leading to Organ Failure
Nursing Considerations
Increased nursing knowledge of organ dysfunction markers could improve severe septic patient outcomes. The earlier the patient is identified as severe sepsis, the sooner that they can receive appropriate treatment. Recent studies show that nurses play a key role in the initial care and management of patients with potentially life-threatening sepsis. A study showed the impact of a nurse-initiated emergency department sepsis protocol to initial antibiotic administration, and had an impact in in-hospital mortality rate (Bruce, McSweeney, Im, & Xue, 2010). A recent study by Gatelens and colleagues supported the nursing clinical relevance by showing that elapsed time from triage to administration of antibiotics was the primary determinant of mortality of patients with severe sepsis and septic shock (Gatelens, Cawcutt, & Peters, 2010). The knowledge of a severe sepsis screening tool significantly decreased the mean time to antibiotics in patients presenting to the ED with suspected severe sepsis or septic shock (Patelka, Turner, & Segal, 2014). The research demonstrates that increased nursing understanding of sepsis and severe sepsis markers can significantly improve patient care outcomes.

Conclusion
Despite advances in the development of numerous drugs and supportive care therapies, severe sepsis remains an unachieved challenge for clinical investigators and physicians with an unacceptably high mortality rate of 28% to 50%. Sepsis is the most common cause of death in the non-cardiac intensive care unit (Minnang, Zhao, Jin, Zh, & Chen, 2015). Treatment protocol differs when a patient is determined to have severe sepsis as opposed to sepsis. For this reason, it is significant that health care professionals be knowledgeable of severe sepsis markers of organ dysfunction as a sign of severe sepsis. Knowledge of these markers and the association between organ dysfunction and severe sepsis can improve patient outcomes significantly.

References
doi:10.1016/j.mayocp.2014.07.009
Gelmeti, D. F., Mikkelsen, M. E., Band, R. A., Arora, J. M., Massoner, K., Faria, F. T., et al. (2010). Impact of time to antibiotics on survival in patients with severe sepsis or septic shock in whom early goal-directed therapy was initiated in the emergency department. Critical Care Medicine, 38, 1046-1053. doi:10.1097/CCM.0b013e3181e58742

Table 1: OER/DYSFUNCTION DEFINITIONS

<table>
<thead>
<tr>
<th>OER/DYSFUNCTION</th>
<th>MILD</th>
<th>MODERATE</th>
<th>SEVERE</th>
<th>EXTREME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Index (cardiac output/systemic flow)</td>
<td>&lt; 40</td>
<td>40-90</td>
<td>90-110</td>
<td>&gt; 110</td>
</tr>
<tr>
<td>Pulmonary (Pao2/Fio2, ratio)</td>
<td>&lt; 200</td>
<td>200-300</td>
<td>300-400</td>
<td>&gt; 400</td>
</tr>
<tr>
<td>Neurologic (GCS)</td>
<td>9-12</td>
<td>7-8</td>
<td>4-6</td>
<td>≤ 3</td>
</tr>
<tr>
<td>Renal (creatinine, mg/dl)</td>
<td>1.2-1.4</td>
<td>1.5-1.9</td>
<td>2.0-2.4</td>
<td>&gt; 2.5</td>
</tr>
<tr>
<td>Hepatic (bilirubin, mg/dl)</td>
<td>1.2-1.9</td>
<td>2.0-2.9</td>
<td>3.0-3.9</td>
<td>&gt; 4.0</td>
</tr>
</tbody>
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