

Assessment and Improvement of Sepsis Bundle Compliance at Geisinger Community Medical Center

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Abstract

Sepsis is a life-threatening emergency resulting from the body's overwhelming response to infection. Annually, 1.7 million American adults develop sepsis, and nearly 270,000 will die as a result (1, 2). In an effort to improve patient outcomes, Geisinger Community Medical Center (GCMC) has adopted the recommendations of The Society of Critical Care Medicine and the European Society of Intensive Care Medicine's Surviving Sepsis Campaign. The campaign consists of a definition of sepsis, severe sepsis, and septic shock as well as prescribed 3-hour and 6-hour treatment bundles (3). We have conducted a retrospective chart review of cases in which criteria for sepsis, severe sepsis, or septic shock was met and in which patients had a poor outcome defined as mortality or hospital readmission within 30 days. Our results demonstrated that in cases of sepsis, the 3-hour bundle compliance was 40.91% with the greatest deficit in proper fluid bolus administration. In cases of severe sepsis and septic shock, 3-hour bundle compliance was 53.13% and 79.17% respectively with deficits in appropriate fluid bolus administration. Six-hour bundle compliance in severe sepsis and septic shock was 31.25% and 33.33% respectively, with deficits in appropriate vasopressor use. Our team has identified multiple avenues for improvement. We suggest the development and implementation of an interdisciplinary sepsis team. Use of interdisciplinary teams is already widely established in the hospital, notably in patients experiencing cardiac arrest or trauma. By involving nonphysician providers in direct patient care, teams may be more effective in mobilizing and delivering hospital resources for patient care. We contend that it is both possible and reasonable to consider the development of an interdisciplinary sepsis team at Geisinger Community Medical Center to increase successful compliance with SCC guidelines.

Introduction

Sepsis is the result of the body's overwhelming response to infection. It is a life-threatening medical emergency that can result in local or diffuse tissue damage, organ failure, and death. These complications can develop quickly and thus physicians must intervene quickly and efficiently when sepsis is suspected. Annually, 1.7 million American adults develop sepsis, and nearly 270,000 will die as a result. Approximately 1 in 3 patients who die in a hospital will have sepsis (1, 2). The Society of Critical Care Medicine and the European Society of Intensive Care Medicine developed the Surviving Sepsis

Campaign (SSC) (3). These guidelines offer a succinct and specific definition of sepsis consisting of vital sign parameters and infection source. Additionally, their efforts resulted in the creation of sepsis bundles: designated orders consisting of laboratory specimens, intravenous fluids, and medication administration designed to maximally improve survivability in sepsis (3). A significant number of observational studies have been conducted regarding compliance with the SCC guidelines and sepsis bundles. These studies demonstrate the compliance is a critical challenge to the success of the SCC in reducing morbidity and mortality (4). One study conducted as a survey of critical care physicians, emergency medicine physicians, and internal medicine physicians demonstrated that compliance with individual bundle components could vary with personal preference. For example, only 62% of respondents reported always giving appropriate antibiotics in compliance with the 3-hour bundle (5). Systematic review and meta-analysis of implemented quality improvement programs demonstrate that these improvement programs are associated with both increased adherence to the sepsis bundles and reduced morbidity and mortality in patients with sepsis, severe sepsis, and septic shock (6). Geisinger Community Medical Center (GCMC) has adopted the Surviving Sepsis Campaign bundles in their effort to minimize mortality and readmission following a diagnosis of sepsis, severe sepsis, or septic shock.

Per the SSC, sepsis is defined as: meeting two severe inflammatory response syndrome (SIRS) criteria in the setting of an identified source of infection. Criteria must be met within a 6-hour timeframe to qualify as sepsis (Figure 1). SIRS criteria consist of the following: fever greater than 38° C or hypothermia below 36° C; heart rate greater than 90 beats per minute; respiratory rate less than 20 breaths per minute; serum white cell abnormality defined as either greater than 12,000 wbc/mm³, less than 4,000 wbc/mm³, or greater than 10% band cells (3, 7). If sepsis is identified per the stated parameters, physicians are to initiate the 3-hour sepsis bundle consisting of four steps.

1. Measure blood lactate level.
2. Obtain blood cultures prior to the administration of antibiotics.
3. Administer a broad-spectrum antibiotic.
4. Administer 30 ml/kg crystalloid intravenous fluid bolus.

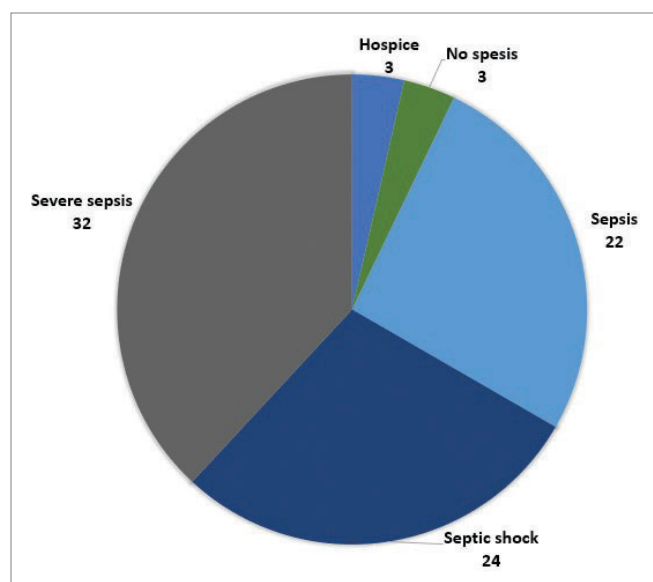


Figure 1. Criteria for diagnosis of sepsis, severe sepsis, and septic shock.

Bundle compliance is achieved only if all four steps are implemented correctly within three hours of the patient meeting sepsis criteria (3, 8). One caveat to the 3-hour bundle is in the administration of the 30 ml/kg bolus. Physicians may decline to administer the required fluid amount based on clinical judgment if they feel the volume of fluid specified in the bundle would cause harm to the patient, for example in the case of a patient with pulmonary edema and respiratory compromise. One additional consideration is that physicians may have defaulted to use ideal body weight for bolus volume determination in the event of obesity, which was considered appropriate (3, 6).

Severe sepsis and septic shock require further management due to the increased severity of disease (Figure 1). Severe sepsis is defined as meeting criteria for sepsis plus evidence of end organ dysfunction (7). Examples of end organ dysfunction include acute kidney injury or lactate greater than four. Septic shock is sepsis in a patient with hypotension defined as a mean arterial pressure less than 65 mmHg (8). In the event of severe sepsis or septic shock, physicians are to complete the steps of the 6-hour bundle:

1. Compliance with the 3-hour bundle as listed above.
2. Repeat measure of blood lactate.
3. Application of a vasopressor in the event of hypotension unresponsive to the initial fluid bolus.
4. Reassessment of volume status and tissue perfusion by a provider.

Compliance is only achieved if the steps of the 3-hour bundle are achieved as described above, and if the additional steps of the 6-hour bundle are performed within 6 hours of when the patient met criteria for severe sepsis or septic shock (3, 8).

We retrospectively analyzed prior sepsis cases at GCMC to assess compliance with sepsis bundle items to identify and address areas of improvement in bundle compliance with the goal of enhancing morbidity and mortality of sepsis patients.

Methods

Preliminary discussion with staff at GCMC aligned with published studies across multiple Geisinger institutions, which directed investigation toward barriers to bundle compliance. Barriers consisted primarily of uncertainty as to appropriate sepsis alert usage, information overload, and burdensome order sets. We set out to find where bundle compliance may be lacking in our sample population.

Geisinger monitors patients with diagnosed sepsis that results in poor outcome defined as readmission or mortality within 30 days of hospital discharge. Sample size was drawn from Geisinger's established database of sepsis patients from January 2019 to February 2020. Exclusion criteria included patients who were included in the data set but failed to meet criteria for sepsis, patients admitted to hospice following discharge, and non-unique cases previously reviewed for sepsis bundle compliance by a Geisinger employee. Meeting criteria for sepsis was defined based on the SCC guidelines as well as cases where SCC criteria were not met but the physician diagnosed sepsis. The rationale behind the choice to include diagnosed sepsis that does not meet criteria is to ensure that clinical judgment is appreciated and to analyze all situations in which the bundle should be completed. Seventy-eight cases were found to meet inclusion criteria of both having sepsis/severe sepsis/septic shock and being unique. Of note, our definitions of severe sepsis & septic shock differ from the official SCC guidelines to align with established Geisinger protocol. Thus, the definitions were expanded to include severe sepsis as having a lactate between 2 to 4 and septic shock also having lactate greater than 4.

Using a standardized review method, patient charts were evaluated for sepsis-related admissions in the period of January 2019 to February 2020. Cases were evaluated for the following:

1. Presence or absence of sepsis alert in electronic health record.
2. Hospital fulfillment of overall 3-hour bundle, and its individual bundle components.
3. Hospital fulfillment of overall 6-hour bundle applied exclusively to severe sepsis/septic shock cases where appropriate, and its individual bundle components.

Results

The initial data set containing the list of patients with poor outcome following sepsis diagnosis contained 132 patients. Eighty-four patient charts remained after removing charts that had previously been analyzed for bundle compliance. Of these, three patients were sent to hospice and were not included in analysis. Three additional patients were found after systematic chart review to not qualify as meeting criteria for sepsis or carry a sepsis diagnosis and were excluded. The total number of patients meeting inclusion criteria was 78. Of these, 22 met criteria for sepsis, 32 for severe sepsis, and 24 for septic shock (Figure 2).

Figure 2 outlines results of sepsis case analysis (Figure 3). Sepsis alert was called in 18.18% of cases. Blood cultures were drawn in 77.27%. Appropriate broad-spectrum antibiotic was delivered after cultures were drawn in 81.82% of cases. And serum lactate was measured in 77.27% of cases. The appropriate 30 ml/kg bolus was delivered in 40.91% of patients. Three-hour bundle compliance was obtained in 40.91% of cases.

Figures 3 and 4 outline results of severe sepsis and septic shock case analysis respectively (Figures 4 and 5). Sepsis alert was called in 34.38% and 58.33% of cases, respectively. Blood cultures were drawn in 71.88% and 87.50%, respectively. Appropriate broad-spectrum antibiotic was delivered after cultures were drawn in 75.00% and 91.67% of cases, respectively. Initial serum lactate was measured in 87.50% and 91.67% of cases. The appropriate 30 ml/kg bolus was delivered to patients in 37.50% and 58.33%, respectively. Three-hour bundle compliance was 53.13% and 79.17% for

severe sepsis and septic shock, respectively. Additionally, these cases were analyzed for 6-hour bundle compliance in which lactate was remeasured, vasopressor given, and the patient was reexamined. In severe sepsis cases the percentages were 53.13%, 0.00%, and 68.75%, which combined with 3-hour compliance resulted in an overall 6-hour bundle compliance of 31.25%. In septic shock cases the percentages were 79.17%, 8.33%, and 83.33%, which combined with 3-hour bundle compliance resulted in an overall 6-hour bundle compliance of 33.33%.

Discussion

Mortality rates for sepsis range from 10–50% (9). Given the high mortality rate, an algorithmic approach may help streamline treatment, thus improving patient outcomes (6, 8). Physicians at GCMC have a high rate of success with

several components of the bundle. Providers are largely compliant in collecting blood cultures, administering appropriate antibiotics, and measuring blood lactate levels.

The data additionally suggests several potential areas of improvement in bundle compliance. The sepsis alert tool available in Epic is underutilized, being called in only 18.18% of sepsis cases. The sepsis alert tool has been experimentally demonstrated to enhance a provider's ability to acknowledge sepsis criteria and rapidly place appropriate orders (10, 11). To date, Geisinger already employs several of the techniques described in papers detailing quality improvement measures at other hospitals, namely the use of a built in EHR sepsis alert, and preformed order sets (11). Tools are not effective however, if they are not utilized appropriately. Our current data is insufficient to establish a cause for the limited use of the sepsis alert. However, possibilities include burdensome interface, redundancy in order sets, and the ability to place necessary orders outside of the sepsis tool.

The administration of the 30 ml/kg bolus is another potential for improvement in overall bundle compliance. The administration of this specified fluid bolus had the lowest rate of compliance of all necessary 3-hour bundle components, even when considering provider discretion for comorbid conditions. The research team noted that in many cases of diagnosed sepsis, severe sepsis, and septic shock, there was a fluid bolus delivered to the patient. In many of these cases however, the bolus fell short of 30ml/kg even when considering the patient's ideal body weight. It is possible that physicians are under-dosing bolus fluid resuscitation in favor of using readily available or recognizable IV fluid volumes. The frequent use of 1-liter or 2-liter bolus volumes reinforces this possibility. Considering the finding, the research team has proposed the creation and addition of a built-in fluid bolus calculator that will automatically calculate a bundle complaint fluid volume. This

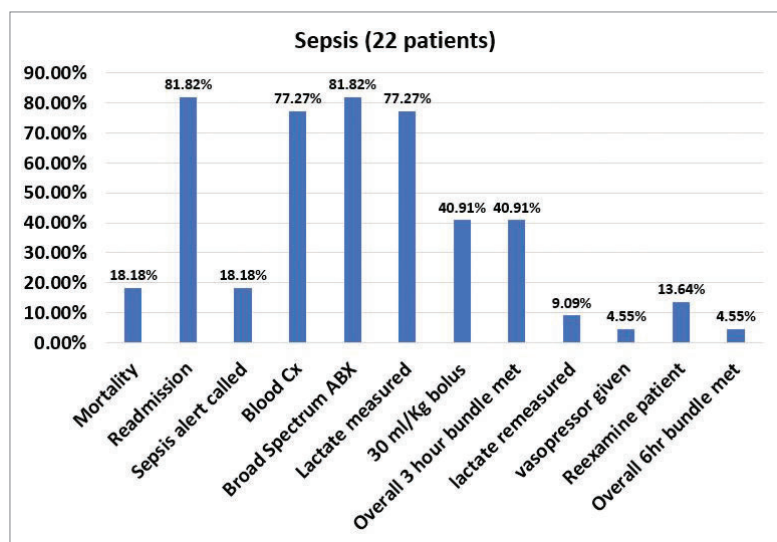


Figure 2. Breakdown of patients assessed.

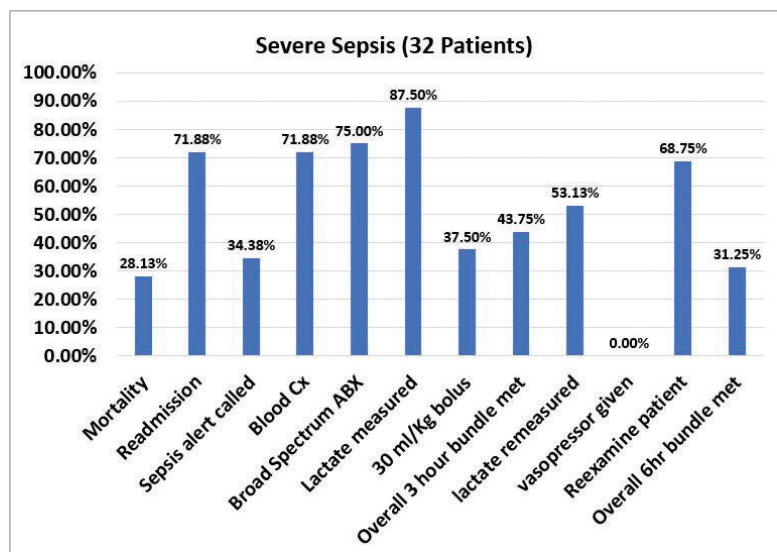


Figure 3. Bundle compliance by required intervention for sepsis patients.

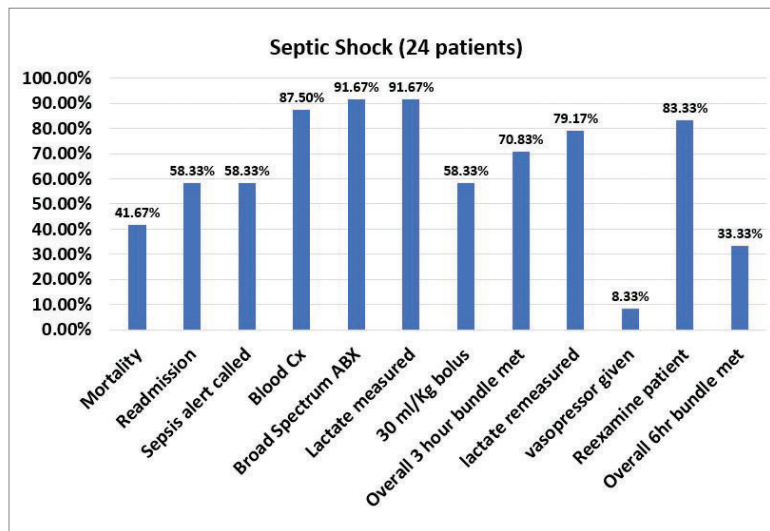


Figure 4. Bundle compliance by required intervention for severe sepsis.

Diagnosis	Criteria for Diagnosis	Required Bundle
Sepsis	A. Meeting any two SIRS criteria: 1. Hypothermia <36C or Hyperthermia >38C 2. Tachycardia >90 beats/min 3. Tachypnea >20 Breaths/min 4. Lymphocytosis > 12,000 wbc/mm3 or lymphopenia <4,000 wbc/mm3 or >10% band cells B. Identified Source of Infection C. Criteria A and B must be met within 6 hours timeframe for diagnosis.	3 Hour Bundle
Severe Sepsis	A. All criteria met for diagnosis of sepsis. B. Evidence of end organ dysfunction. Examples include: 1. Lactate > 2* 2. Presence of new AKI 3. Encephalopathy *This reflects deviation from the SCC guidelines, which define Severe Sepsis as lactate > 4.	3 Hour Bundle 6 Hour Bundle
Septic Shock	A. All criteria met for diagnosis of sepsis. B. Hypotension defined as mean arterial pressure <65 mmHg. C. Lactate > 4* *This reflects deviation from the SCC guidelines, which define Severe Sepsis as lactate > 4.	3 Hour Bundle 6 Hour Bundle

Figure 5. Bundle compliance by required intervention for septic shock patients.

novel function would serve as a reminder to use the required volumes as well as decrease the effort involved in calculation.

Regarding the 6-hour bundle in the case of severe sepsis and septic shock, vasopressors appear critically ignored. Severe sepsis & septic shock can present with dangerously low blood pressures for which fluid boluses are insufficient. We believe clinicians who use decline vasopressors rely on multiple boluses for quick, ephemeral boosts in blood pressure rather than transitioning to long-term pressors. Because the use of

pressors is dependent on individual patient status and provider comfort, improving compliance with these issues requires a multi-faceted approach.

Given the complexity of sepsis management as well as the high demand on provider time and attention in the emergency department, where most sepsis cases are first recognized, the implementation of an interdisciplinary team model may increase bundle compliance. Other institutions have made successful use of an interdisciplinary team approach to managing sepsis (12). One study demonstrated, using 3 months' data pre- and post-intervention, that not only was compliance improved, but the time to completion of individual bundle components was also improved (13). These interdisciplinary teams are generally composed of emergency or internal medicine physicians, nurses, pharmacists, and may include imaging technicians or infectious disease specialists. These teams are available 24/7 and typically operate in a dedicated role, allowing them to focus time and energy on the sepsis cases that present. (12, 13, 14, 15, 16). The

use of interdisciplinary teams is already widely established in the hospital, notably in patients experiencing cardiac arrest or trauma. By involving nonphysician providers in direct patient care, teams may be more effective in mobilizing and delivering hospital resources for patient care (16). We believe that it is both possible and reasonable to consider the development of an interdisciplinary sepsis team at GCMC to increase successful compliance with SCC guidelines.

Limitations to this study include a limited sample size. Cases were excluded from the data set if they had been previously analyzed by a Geisinger employee. This was done to expand the overall understanding of 3- and 6-hour bundle compliance at GCMC. It is important that moving forward, our data is joined with the additionally analyzed data to produce a more robust data pool from which to draw conclusions. Additionally, our initial intent was to develop, implement, and measure the outcome of a specific intervention to improve compliance. Due to the scope of the project and time required for accurate case review, we were unable to implement any quality improvement measure. Thus, our data serves as a foundation for future quality improvement measures.

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Disclosures

Igor Georgievsky, MD, is an employee of and receives compensation through Geisinger Community Medical Center. The authors have no other disclosures.

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