Implementation of a Sepsis Alert to Improve Timely Sepsis Care: A Quality Improvement Project

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Abstract

Background: Sepsis is a leading cause of mortality in the hospital setting and early recognition and treatment is essential.

Objective: The goal of this quality improvement project was to implement an interdisciplinary designed sepsis alert protocol and guideline flowsheet to promote early recognition of sepsis, increase compliance with CMS bundle guidelines, and decrease mortality and length of stay.

Methods: A retrospective chart review was performed on emergency department patients who were diagnosed with severe sepsis or septic shock during a 3 month pre- and post-alert time period. Evaluation included time to interventions, completion of CMS bundle components, mortality rates and length of stay.

Results: The CMS bundle compliance improved from 33.3% in the pre-alert group to 45.5% in the post-alert group, closer to the national average of 51% at the time of this project. There was no significant change in mortality for this cohort, but there was a decrease in mean length of stay.

Conclusions: There was improvement with CMS bundle compliance, demonstrating that quality improvement initiatives can improve patient outcomes. There is still further work to be done to continue to improve sepsis care and ongoing evaluation is needed.

Implications for Nursing: In the emergency department, nurses are often the first member of the healthcare team to evaluate these patients and must be able to recognize potential infection and concern for sepsis.

Keywords: Sepsis Alert; Emergency Department; CMS bundle; Mortality

Implementation of a Sepsis Alert to Improve Timely Sepsis Care

Sepsis is a life-threatening emergency that can be attributed to one in three deaths in hospitalized patients and is responsible for over a quarter of a million American deaths each year (Centers for Disease Control [CDC], 2019). It is the body's response to an infectious process that can occur from a number of sources including but not limited to the lungs, abdomen, urinary tract or skin. This response to an infection causes a chain reaction in the body, which can have dire consequences leading to organ dysfunction, tissue damage or untimely death (Mayr, Yende, & Angus, 2014). Sepsis has become a costly burden on the healthcare system due to rising incidence and poor outcomes. Therefore, guidelines have been developed to assist in early recognition and treatment of sepsis (Dellinger et al., 2008).

Surviving Sepsis Campaign. In 2002, the Surviving Sepsis Campaign (SSC) was a joint collaboration established by the Society of Critical Care Medicine (SCCM), the European Society of Intensive Care Medicine (ESICM) and the International Sepsis Forum to develop treatment guidelines for sepsis care (Society of Critical Care Medicine, 2018). Initially, the SSC evaluated multiple studies referencing sepsis care and preceded to evaluate the evidence and formulate recommendations (Dellinger et al., 2004). One of the studies reviewed included Rivers et al. (2001) who showed an improvement in hospital mortality with early goal-directed therapy (EGDT) in treatment for severe sepsis and septic shock. The EGDT protocol in that study included central venous monitoring, crystalloid fluid bolus at 30-minute intervals, vasopressor initiation, transfusion of blood products, and inotropic agents based on findings from constant monitoring of the patient. Based on the findings by Rivers et al. (2001) and many others, the SSC published its first set of recommended treatment guidelines for sepsis care in 2004 (Dellinger et al., 2004). These guidelines created the sepsis bundles, a group of therapeutic

interventions aimed at treating severe sepsis and septic shock. The goal of these bundles is to reduce morbidity and mortality (Society of Critical Care Medicine, 2018).

The original and SSC guidelines introduced a 6- and 24-hour sepsis bundle and recommended that within the first six hours that an initial lactic acid be drawn and blood cultures be obtained prior to antibiotics. Within 3 hours of presentation to the ED, it was recommended that broad-spectrum antibiotics were administered, and these were to be completed within the 6-hour time. Also, within the first six hours, intravenous fluids are recommended if patient has persistent hypotension or initial lactic acid was greater than 4 mmol/L. Table 1 addresses further requirements for the 6-and 24-hour bundle. Other recommendations during initial evaluation and treatment included measurement and achievement of specified central venous pressure goal, central venous oxygen saturation goal and placement of a central venous line (Dellinger et al., 2008).

As evidence continues to emerge, some studies determined that there was no consensus on the use of a central line in septic patients and the placement of a central line may actually increase risk of infection. Further findings demonstrated that the measurements of central venous pressure and central venous oxygen saturation were as not beneficial in the management of sepsis as initially suggested (Grek et al., 2017). In 2012, the SSC updated sepsis guidelines introducing the 3- and 6-hour bundle related to severe sepsis and septic shock care. Within the first three hours, the recommendations include measuring an initial lactate acid, obtaining blood cultures, providing broad-spectrum antibiotics and intravenous fluid administration. In the 2012 update, there are recommendations about measurement of central venous pressure and central venous oxygen saturation but the same goal measurements within a set timeframe is not defined as seen in the original guidelines (Dellinger et al., 2012). Table 1 displays both the original and

2012 guidelines, which include obtaining an initial lactic acid, blood cultures, antibiotic administration and intravenous (IV) fluids within defined time periods of sepsis presentation.

The study of sepsis care is ongoing; therefore, the guidelines continue to evolve as more evidence emerges. For example, the ProCESS, ARISE and ProMISE trials did not replicate the original findings of the Rivers et al. (2001) study (Grek, et al., 2017). These three trials did not find a significant difference in outcomes between septic patients who received EGDT and those that did not (Kalantari, Mallemat, & Weingart, 2017). The SSC continually updates their recommendations and published the fourth edition of the guidelines to manage sepsis and septic shock in 2016 (Rhodes et al., 2017). However, in 2018, a revision was proposed to include obtaining an initial lactic acid and blood cultures and administering broad-spectrum antibiotics and intravenous fluids within one hour as opposed to three hours (Society of Critical Care Medicine, 2018). As new guidelines continue to transpire, the challenge is for healthcare teams to stay apprised and implement these new evidence-based practice recommendations.

Sepsis core measure. The U.S. Department of Health and Human Services, Centers for Medicare and Medicaid (CMS), developed a core measure to treat severe sepsis and septic shock (Kalantari et al., 2017; CMS, 2019). CMS identifies quality or core measures based on morbidity, mortality, and costs to Medicare. These measures are evaluated by individual hospitals and displayed on the CMS Hospital Compare website (CMS, 2019). In 2015, CMS identified that the management of sepsis needed to be based on the treatment guidelines, the sepsis bundle (SEP-1), which has proven to improve patient outcomes. CMS rationale states "the evidence cited for all components of this measure is directly related to decreases in organ failure, overall reductions in hospital mortality, length of stay and costs of care" (CMS, 2020, p.

160). Currently, the recommended treatment is based on the 2012 SSC guidelines for the 3- and 6-hour sepsis bundle.

Based on the reportable quality indicators as established by CMS, multiple quality improvement projects have been created to improve timely and effective sepsis treatment. Evidence demonstrates that implementation of a sepsis bundle can improve patient outcomes, but the actual application currently falls short of expectations (CMS, 2019). One current recommendation includes the development of a multidisciplinary team to review current practice and develop interventions to improve sepsis care within facilities (Rhodes et al., 2017).

Problem Description

The early recognition and timely treatment of sepsis is imperative, because sepsis is both costly and deadly. Sepsis is estimated to cost more than $20 billion annually (Jorgenson, 2019) and the calculated mortality rate for septic shock is approaching 50% (Mayr et al., 2014). Thereby, CMS established sepsis care as a reportable quality measure with plans for it to be a pay-for-performance incentive for hospitals in the future (Jorgenson, 2019).

In April 2019, a community hospital in the Mid-Atlantic region showed that only one-quarter (26%) of patients were treated with the recommended sepsis CMS guidelines compared to the national average of 51% (CMS, 2019). Therefore, an interdisciplinary team was created to evaluate and address sepsis care in the ED of this community hospital.

Quality Improvement Question

In adult patients diagnosed with severe sepsis or septic shock in a community emergency department (ED), how does implementation of a quality improvement project aimed at improving sepsis treatment compared to the current standard of care impact compliance with the CMS SEP-1 bundle, in-hospital sepsis mortality and length of stay?

Available Knowledge

Sepsis is a disease with significant mortality and the evidence demonstrates that early intervention decreases mortality rates (Rhodes et al., 2017). A review of current literature was performed to identify and evaluate quality improvement projects, in the ED setting, that promote early recognition and treatment of sepsis in adult patients. The recommended timing and completion of interventions was evaluated to determine the effect on CMS bundle compliance, in-hospital mortality and length of stay.

Three databases were searched to find articles pertaining to sepsis bundles and utilization in the ED including PubMed, CINAHL and Web of Science. A comprehensive review was undertaken using search terms “sepsis”, “severe sepsis”, “septic shock”, “bundle”, “quality improvement”, and “mortality”. The updated 2016 SSC guidelines have removed the term severe sepsis from their classification system, but for the purposes of this review it was included as CMS continues to support their taxonomy of sepsis, severe sepsis and septic shock. The terms above were searched using a variety of Boolean operators, specifically “and” and “or”. Based on the SSC updates, the dates for article publications were from 2010 to present, in order to include the original SSC guidelines for sepsis bundles. The search was further defined by English language only and those available in full text. A gray literature search was also performed using Google Scholar that was limited to three hours. The search sought guidelines pertaining to sepsis management and treatment and CMS core measure (SEP-1) information. The search was specific to articles referencing the SSC and/or the SEP-1 bundle.

Following the extensive search, 286 articles were returned. After the removal of duplicate articles, 181 articles remained for a title and abstract review (Figure 1). The inclusion criteria for title and abstract review are patients diagnosed with sepsis, severe sepsis or septic

shock, patients greater than 18 years of age, setting in the ED, implementation of a quality improvement project, and outcomes measures including mortality and compliance with sepsis bundles. Compliance with the original (6- and 24-hour bundles) and 2012 (3- and 6-hour bundles) sepsis bundle guidelines were both included in this review, because the interventions and treatment are similar. The majority of studies examined individual components and/or the entire sepsis bundle. One hundred fifty-nine articles were removed based on inclusion and exclusion criteria, leaving 17 articles that were read in full. Another five articles were eliminated, including one that was specific to patients receiving care in the Intensive Care unit. Three evaluated only bundle compliance and did not evaluate mortality, and the last article only provided methods for reducing mortality.

Included were one systematic review with meta-analysis, four retrospective cohort studies, five pre and post-intervention study, one pre-post implementation study with a 2-step implementation process, and a retrospective time-series cohort examination (Table 2). Additionally, two clinical practice guidelines and CMS SEP-1 (Table 3) underwent a final evidence analysis. After the initial literature review, another article was included after adding the search term “length of stay”, resulting in an article specifically related to a sepsis alert in the emergency department and its impact on the length of stay and mortality and therefore was included in the final review. The articles were also graded using evidence level and quality guide by the Johns Hopkins Nursing Evidence-Based Practice guideline (Dearholt & Dang, 2012).

One systematic review and meta-analysis examined the implementation of quality improvement projects and compliance with the original SSC guidelines and mortality. The remaining studies examined mortality rates, ten of the studies specifically defined mortality as

in-hospital sepsis deaths and two studies stated mortality but did not clarify whether it was in the hospital or within 30-days of hospital discharge. Five of the studies utilized the original SSC guidelines for bundle measurements, which included obtaining a lactic acid and blood cultures, administering broad-spectrum antibiotics and crystalloid fluid bolus, measurement of central venous pressure and central venous oxygen, and the use of vasopressors. One of the studies utilized the 2012 SSC guidelines but noted concern for emerging data regarding an increased rate of central line infections, therefore the compliance with central venous pressure measurement and central venous oxygen measurement were not studied. Six articles used the 2012 SSC guidelines, which evaluated lactic acid measurement, blood culture collection, fluid and antibiotic administration, repeat lactate acid and initiation of vasopressor, if needed. The last study examined only the first three components of the CMS sepsis bundle. Out of the 13 studies, eight showed a decreased in mortality after the implementation of the intervention while five of the studies showed a decrease in mortality that was not statistically significant. All 12 studies showed improvement in bundle compliance among either set of guidelines, and the last study showed improvement specifically related to time to antibiotics.

Dearhold and Dang (2012) developed Johns Hopkins nursing evidence-based practice guidelines which evaluates the level of evidence produced by each study. Among the thirteen articles included, there were seven at the II-A level, five at the II-B level, two at the IV-A level and one at the IV-B level, displayed in Table 2 and 3. The Level II represents quasi-experimental studies while Level IV includes clinical practice guidelines and consensus panels determinations. There were no Level I or Level III studies which would reflect an experimental study and randomized controlled trial or a non-experimental study and qualitative studies. There were no

studies found that were experimental or a randomized controlled trial specifically related to CMS bundle compliance, mortality and length of stay completed in the emergency department.

Performance improvement projects. The performance improvement projects were wide ranging, but the majority of the studies noted development of a multidisciplinary team to create the interventions applied. The interventions ranged from education programs, to improved sepsis sniffers (electronic programs identifying SIRS criteria), electronic alerts in the medical records, creation of pre-defined sepsis order sets and templates for approved provider documentation.

Damiani et al. (2015) report a systematic review and meta-analysis of 50 studies, which identified the quality improvement project as an education and/or protocol change. Mortality rates varied among the studies, but overall a decrease in the mortality was determined. They showed that with combined educational and process changes, the mortality rate was affected greater than if only one of those interventions was utilized. The study also examined compliance with the SSC sepsis bundle including lactate measurement, blood culture collection, antibiotic administration and fluid resuscitation. Studies varied on whether individual measures were evaluated, or the entire bundle completion was examined. Also examined were other components of the 6-hour bundle including measurement of central venous pressure and central venous oxygenation which revealed that the majority of the studies showed compliance with the SSC sepsis bundle increased.

Sepsis response teams. Ferguson, Coates, Osborn, Blackmore, and Williams (2019), Arabi et al. (2017), Grek et al. (2017) and Rosenqvist, Fagerstrand, Lanbeck, Melander, and Akersson (2017) developed a sepsis response team who would be alerted if a patient with sepsis was in the ED. The response team would provide quick assessment of the patient (generally by

the provider) and the team would ensure compliance with the bundle components. The first three studies demonstrated improvement with compliance measures of lactic acid and blood culture collection, and antibiotic administration and a statistically significant decrease in mortality. Both Arabi et al. (2017) and Rosenqvist et al. (2017) showed a decrease in the length of stay (LOS) for patients. Rosenqvist et al. (2017) also showed a decrease in time to antibiotic treatment, but no statistical difference in mortality.

Sepsis order sets. Arabi et al. (2017), Grek et al. (2017), McDonald et al. (2018), Gatewood, Wemple, Greco, Kritek, and Durvasula (2015), and Ramsdell, Smith, and Kerkhove (2017) established pre-defined sepsis order sets, that the nurse or the provider could use to promote increased compliance with the sepsis bundle. The order sets could be used for patients that were identified as septic and would include the interventions based on SSC guidelines. Two of these studies, Arabi et al. (2017) and Grek et al. (2017) showed a decrease in the mortality rate while the other three showed no statistical difference.

Sepsis education. There were eight studies that provided education as a component of the intervention. Arabi et al. (2017) developed an educational campaign targeted at ED providers. Hughes et al. (2019) provided staff education during staff meetings that focused on maintaining compliance with the sepsis bundle. Kuan, Mahadevan, Tan, Guo and Ibrahim (2013) utilized a small group teaching session as well as lectures including information on the early recognition and treatment of severe sepsis and septic shock. Levy et al. (2010) created education materials which were then distributed to multiple organizations. McColl et al. (2017) named their education program “Target Sepsis” and made that their slogan. McDonald et al. (2018) and Ramsdell et al. (2017) provided extensive staff education throughout the intervention timeframe. Rosenqvist et al. (2017) had a one-hour interactive education sessions for the ED

providers and nurses prior to implementation of their triage alert. Four of these studies, Arabi et al. (2017), Kuan et al. (2013), Levy et al. (2010) and McColl et al. (2017) showed a decrease in hospital mortality.

Electronic sepsis alerts. Sepsis alerts were created in the electronic medical records in seven of the studies, either as an automatic electronic alert to the nurse or an alert to the entire team. Arabi et al. (2017), Hughes et al. (2019), and McDonald et al. (2018) instituted an e-alert or sepsis flag as a reminder if specific criteria were met indicating potential sepsis. Grek et al. (2017), Gatewood et al. (2015) and Ramsdell et al. (2017) utilized a computer-assisted care identification alert for caretakers. McColl et al. (2017) placed a target sign on the patient's chart to help the provider identify a potential septic patient. Out of the seven studies above, three demonstrated a decrease in hospital mortality including Arabi et al. (2017), Grek et al. (2017), and McColl et al. (2107).

Sepsis bundle feedback. Three studies, Nortitomi et al. (2013), Arabi et al. (2017) and Hughes et al. (2019) provided continuous feedback on compliance. Nortitomi et al. (2013) created a committee to develop screening procedures and a treatment protocol that included a specific antibiotic guideline and laboratory sampling. Every three months, the committee visited the hospital to provide updated compliance reports to the staff. All of the studies showed increased improvement of their bundle compliance. Although Arabi et al. (2017) and Noritomi et al. (2013) demonstrated a decrease of in-hospital mortality of sepsis patients, Hughes et al. (2019) showed a decrease in mortality that was not statistically significant.

Sepsis guidelines. In Table 3, the updated SSC guidelines from 2016 are included for the treatment of sepsis and septic shock. The second recommendation states that the program should comprise of a multidisciplinary team that creates protocols, evaluates metrics and

provides ongoing feedback to clinicians. The committee also recommends continued and ongoing education efforts. Schmidt and Mandel (2019) discuss evidence-based practice solutions for the evaluation and management of sepsis and septic shock and define the appropriate interventions. Lastly, the CMS (2016) early management bundle for severe sepsis and septic shock version 5.0a is outlined as consistent with the 2012 SSC guidelines. Version 5.0a includes obtaining a lactic acid, blood cultures, and administration of broad-spectrum antibiotics, fluid resuscitation, vasopressor administration, as well as volume status assessment and reassessment and repeat lactic acid collection (Appendix A).

Summary of Available Knowledge

The review of literature examined quality improvement projects that were implemented in the ED and were aimed at improving sepsis treatment. Guidelines for sepsis management have changed over the past couple years as more studies are published, contributing to evidence-based practice. A synthesis of multiple studies and guidelines recommend that a multidisciplinary team be formed and consist of important key members including physicians, nurses, pharmacists, leadership, quality improvement coordinators, and data or process analysts. The interdisciplinary team can identify barriers to appropriate care, improve and create protocols to assist with care, and evaluate the intervention (Rhodes et al., 2017). Evidence also suggests that education is another element that improves the early recognition and treatment of sepsis for providers and the nurses at the bedside. An ongoing education effort for staff can contribute to timely sepsis identification and commencement of evidence-based interventions. As sepsis guidelines and recommendations are continually updated, providing updates, perpetual education of current employees and education of new employees will be essential.

Technology is constantly evolving and changing the way patients are cared for. There are tools available to screen patients in the electronic health record and identify those that are at risk for developing sepsis. An electronic screening program examines vital signs and laboratory values for SIRS criteria and notifies the nurse or provider (Hughes et al., 2019). Clinicians are responsible for identifying the source of infection, if present, and diagnosis sepsis, if applicable. Other tools within the electronic record include development of defined order sets for sepsis treatment that include laboratory tests, specifically blood cultures and serum lactic acid, fluid resuscitation, antibiotic coverage, and vasopressors as needed. Use of an order set, ensures that all the components of the bundle are met, thereby improving the likelihood of survival.

Clinical Practice Knowledge and Gaps

Early recognition and treatment of sepsis patients should have an urgency similar to recognition and treatment of myocardial infarctions (MI) and cerebrovascular accidents (CVA). Multiple interventions are set up to treat these medical emergencies, including rapid identification, stroke teams or cardiac catheterization teams. Similarly, a sepsis alert team or rapid response team could be utilized to promote the same expedient care that is in practice for a CVA or MI. Four studies utilized a sepsis team, and three showed decreased mortality rates. Still, further clarification is needed, as based on the literature one intervention could not be proven to be superior to another. The quality improvement projects were a combination of multiple interventions ranging from education to process change to new technology. It was the combination of multiple interventions that produced a significant decrease in mortality for septic patients.

With the recent SSC update in 2018, the new recommendations establish a 1-hour bundle, recommending drawing lactic acid and blood cultures, administering broad-spectrum antibiotics,

IV fluids and vasopressors (as needed) within the first hour of recognition of sepsis (Society of Critical Care Medicine, 2018). At that time, the SSC also changed the definition of sepsis and septic shock and removed the terms SIRS and severe sepsis (Table 5). Research studies or quality improvement projects have not been published employing these new recommendations due to publication delay and time needed to complete the project. CMS has not updated the current sepsis core measure and continues to endorse the three- and six-hour bundles for treatment of sepsis and continues to use sepsis, severe sepsis and septic shock definitions. Further examination to promote treatment of sepsis based on these new guidelines is essential as evidence continues to support improved patient outcomes.

One of the important findings of this research is the involvement of frontline team members, the nurses and the providers in the ED, and the ability to recognize and rapidly treat sepsis. There are quality improvement programs that develop standardized order sets both for physicians and nurses to follow an established pathway in treatment of sepsis which has shown to reduce mortality. There continues to be controversy regarding some of the interventions in the bundle pertaining to fluid resuscitation, however there is consensus for early treatment with broad-spectrum antibiotics as well as obtaining blood cultures and lactic acid. Development of a multidisciplinary team approach to recognizing appropriate interventions including staff education, a sepsis alert team, customized order sets and documentation templates can decrease the mortality rate and LOS in a community hospital and increase compliance with the CMS sepsis bundle.

Rationale

Theoretical framework. Avedis Donabedian (1988) developed a model to evaluate the quality of health care by utilizing three components: structure, process and outcome. The

concepts identified in his initial article in 1966 are still utilized today for quality assessment (Ayanian and Markel, 2016). Donabedian defined "structure" as the setting in which the health care takes place as well as the qualifications of the providers and the administrative support. The second component "process" refers to provider, patient, and the components of care. Lastly, the final part refers to the "outcome" of the healthcare that was delivered and how it affects the patient care or outcome. One of the most important components of this model is to evaluate measurable outcomes to determine quality improvement (Donabedian, 1988).

According to Donabedian (1988), the structure of the environment can be assessed by evaluating the certification of the providers and the accreditation of the organization. The other two components, process and outcomes, can be measured and identified as required by governmental agencies, like CMS. The setting is the ED of a community hospital which employs physicians, advanced practice providers and nurses licensed by nursing or medical boards. The process is the timely and effective care of patients with sepsis. There are many things that can impact care including knowledge of nurses and providers, bed availability in the ED, patient acuity and the electronic medical record. By utilizing protocols and evidence-based processes, quality, effective and timely care can be provided. The outcome is measurement of SEP-1 bundle compliance as set by a CMS core measure as well as mortality and length of stay which is a direct reflection of patient outcome (Figure 2).

Specific Aims

The foundation of this quality improvement project was built from an enterprise-wide project aimed at improving sepsis care, specifically focused on decreasing in-hospital sepsis mortality. A sub-committee of the hospital-wide sepsis committee implemented a sepsis alert and guideline flowsheet in the ED. The primary purpose of this project was to improve CMS bundle

compliance utilizing the new sepsis alert when compared to the previous standard of practice within the institution. The secondary goals of the project were to decrease in-hospital sepsis mortality and hospital length of stay.

Methods

Timely and effective care is essential in providing evidence-based treatments for the clinically complex syndrome of sepsis. The SSC outlined clinical guidelines and interventions that improve patient care and decrease adverse clinical outcomes and mortality (Rhodes et al., 2017). CMS has mandated a set of measures, the SEP-1 bundle, as a core measure that has demonstrated improved patient outcomes although a reimbursement strategy for Medicare and Medicaid patients has yet to be established (Ramsdell, et al. 2017).

A retrospective cohort review was undertaken to determine the effect of implementing a sepsis alert in the ED on SEP-1 bundle compliance, mortality, and LOS. The review of charts for patients identified with severe sepsis or septic shock occurred both pre- and post-implementation. The sepsis alert officially was implemented July 1, 2019. The measurement period prior to the implementation of the sepsis alert was from August 1, 2018 to October 31, 2018. The measurement period after the implementation of the sepsis alert was August 1, 2019 to October 31, 2019.

Context

The sample was a convenience sample from a community hospital ED. The hospital is a 176-bed not-for-profit community hospital in the Mid-Atlantic Region that is part of a larger organization containing 12 acute care hospitals and over 300 sites of care. The ED has 24 beds which is staffed by physicians, nurse practitioners, physician assistants, nurses and patient technicians and sees an average of 50,000 patients per year. In a 12-month period, the hospital

saw a total of 746 patients who were identified as having sepsis, in which 97% (723) of them were diagnosed in the ED with sepsis.

The sample population was randomly selected by an outside vendor, Truven Health Analytics, who applied a specific methodology and created a monthly cohort of sepsis patients. The sepsis patients were placed into the specific month based upon which month they were discharged from the hospital. The sample size was reflective of the requirements set forth by CMS for display on the Hospital Compare interactive website (Appendix A). The inclusion criteria for the vendors sampling determination included those patients that were age 18 years or older and were diagnosed with severe sepsis or septic shock. Further exclusion criteria per CMS guidelines included implementation of comfort care measures within three hours of severe sepsis or six hours of septic shock, length of stay greater than 120 days, transfer from an outside hospital or the free-standing ED, and patients that expire within three hours of severe sepsis or six hours of septic shock (Appendix A). For the purpose of this project, patients who are diagnosed with severe sepsis and septic shock after admission to the hospital were also excluded from this evaluation.

Interventions

The community hospital is part of a larger enterprise, composed of 12 other acute care hospitals, that established multiple interdisciplinary committees to promote early recognition and treatment of sepsis in each individual facility as well as committees composed of multiple sites. The individual hospital sepsis committee focused on outcomes set forth by the enterprise to improve in-hospital mortality rates and decrease expenses between July 1, 2019 and November 30, 2019. The hospital-wide committee was an interprofessional team including administrators, intensivists, hospitalists, pharmacists, ED physicians and nurses, nurse educators, process team

engineer, quality improvement coordinator, respiratory therapy manager, and laboratory manager. The committee was further divided into sub-committees to address certain aspects including sepsis alert in the ED, sepsis care for the inpatient, electronic medical record updates, sepsis mortality reviews, and sepsis financials. The sepsis alert sub-committee comprised of an ED physician, a hospitalist/DNP student, two ED educators/nurses, a pharmacist, a quality improvement coordinator, and a process improvement engineer. The sub-committee met over five months in weekly and bi-weekly meetings and developed a sepsis alert process which was initiated in the ED. In addition to the sepsis alert protocol, a guideline flowsheet comprised of CMS guidelines was created identifying the alert triggers and listed evidence-based guidelines and interventions for care of the septic patient (Appendix B). The sepsis alert is called by the ED physician and triggered a call to the operator who then paged the sepsis alert team. The sepsis alert notified the ED charge nurse, bedside nurse, ED technician, laboratory department, radiology department, respiratory therapist, nursing supervisor, and quality improvement coordinator. The team members and their individual contribution are defined in Table 4. The ED nurses were educated during a mandatory nursing education day two weeks prior to implementation by the two nursing educators who were also members of the sub-committee. The ED physicians were educated by the ED physician team member during a monthly staff meeting. The nurses and physicians were provided a copy of the guideline flowsheet during their education sessions as well. There was an initial provisional period between June 3 and June 30, 2019 in which the first version of the guideline flowsheet was printed and posted throughout the ED. The sub-committee reconvened and updated the guideline flowsheet based on feedback from the staff prior to official go-live date (Appendix B). The official measurement period for

the hospital wide initiatives started on July 1, 2019, therefore this is when the sepsis alert and guideline flowsheet became protocol.

Study of Interventions

A retrospective chart review was performed utilizing the sample of septic patients identified by the research database vendor for the measurement period identified above. The data was entered in SPSS (v. 26) to calculate the rate of compliance with the CMS bundle, in-hospital mortality rate and the average LOS in the hospital. The escalating degrees of sepsis, as well as the sepsis bundle, mortality and LOS are further defined in Table 5. A comparison between pre-alert and post-alert data was evaluated to identify any significant change or correlation among the primary and secondary outcomes.

Measures

There were specific data elements collected from the electronic health record of the patients identified by the outside research database vendor. The data points included demographics, bundle components, mortality and length of stay. The demographic information included age, race and gender to determine the homogeneity of the pre- and post-alert groups. The first set of measurements identified the completion of the bundle elements including lactic acid, blood cultures and broad-spectrum antibiotics within the first three hours of presentation. The remaining bundle elements measured depended upon results of the initial blood work and patient condition. A repeat lactic acid is required within 6 hours of sepsis, if the first lactic acid was greater than 2 mmol/L. For patients who were persistently hypotensive or the initial lactate was greater than or equal to 4 mmol/L, then resuscitation with crystalloid fluids is required to equal a total volume of 30 mL/kg. If the patient remained persistently hypotensive after one hour following fluid resuscitation then vasopressors are initiated. Finally, if the patient received

the resuscitation fluids then a provider must evaluate document an evaluation of volume status and tissue perfusion utilizing certain criteria (Table 1). The completion of the first three interventions were measured and these are defined as the SEP3T bundle. If the patient required the remaining elements then those interventions were recorded and evaluated to determine completion of the entire bundle (SEP-1). As CMS mandates that the initial interventions be completed within 3 hours of sepsis recognition, the time from arrival to the ED to completion of interventions were also measured. In the second measurement period, the post-implementation phase, it was also noted if a sepsis alert was called in the ED. The last two measures collected included the secondary outcomes of in-hospital sepsis mortality and length of stay.

Analysis

The data was entered into the SPSS (v. 26) program and discussed with an academic statistician. Each measure was defined by year to include data from August, September, and October and then was further divided into demographics, completion and time to bundle elements, overall bundle compliance, sepsis alert, in-hospital sepsis mortality and length of stay. Descriptive statistics was used to identify differences between the pre- and post-alert groups. Inferential statistics was used to calculate differences in the completion of and time to bundle elements, mortality and length of stay between the two groups. The age of the patient, time to completion, and length of stay are continuous variables and were evaluated using the Mann Whitney *U* test. The other measures including race, gender, bundle element completion, overall bundle compliance, and in-hospital mortality are categorical variables and were evaluated using the chi-square test or Fisher's exact test depending on the sample size.

Ethical Considerations

This scholarly project evaluation was approved by the Doctor of Nursing Practice (DNP) program faculty at the University. After approval by faculty, subsequent approval was obtained from the Nursing Research Coordinator and the IMPACT manager from the community hospital (Appendix C). The project was deemed a quality improvement project thereby per policy of the hospital, this project did not require approval by the Institutional Review Board (IRB). The potential breach of patient confidentiality was the most significant threat and therefore only essential data elements were collected and stored on a password protected device approved by the institution, thus ensuring protected patient information.

Results

The sepsis alert and guideline flowsheet with CMS guidelines was initiated on July 1st, 2019 in coordination with the beginning of the hospital wide initiative. During the month of August 2019, a spreadsheet was obtained from the quality improvement coordinator for the patients that were evaluated for CMS compliance during August, September and October 2018. The charts were abstracted and information was recorded for the previously determined measures. There was an update to the guideline flowsheet in August 2019 clarifying that it was for patients greater than or equal to 18 years of age. A change was also made to the sepsis bolus section to further clarify when a sepsis bolus should be given and moved within the zero to three-hour timeframe window (Appendix B). The quality improvement coordinator kept record of all of the sepsis alerts that were called and monitored the database for sepsis patients selected by the outside vendor. A list of the selected records was provided to the DNP student approximately one to two months after the month was completed per the turnaround time of the vendor. The final evaluation and statistical analysis were performed in December 2019 and January 2020.

In 2018, there were a total of 24 patients that were randomly chosen by the outside vendor to be evaluated for compliance with the SEP-1 bundle. Three patients were excluded from the pre-alert period, two did not meet CMS criteria for severe sepsis or septic shock and one met sepsis criteria after being admitted to the hospital, leaving 21 patients for further evaluation. In 2019, there were 33 patients chosen by the outside vendor and 11 patients were excluded, therefore 22 patients were evaluated in the post-alert period. Based on CMS exclusion criteria, two were excluded because they received antibiotics prior to arrival to the ED, one patient was excluded because they arrived from an outside hospital and two were excluded due to not meeting severe sepsis or septic shock criteria. In addition to CMS exclusion criteria, six more were excluded because five of the patients included in the sample developed sepsis after admission to the hospital and one patient was excluded because even though they were discharged during the measurement period, they were admitted prior to the official go-live date of the sepsis alert. The last six patients were included in CMS compliance measures for the hospital, but not for the purposes of this project because the focus was on the ED care of the septic patient.

The time measures including time to lactic acid, time to blood culture, time to antibiotics, and length of stay did not meet normality assumptions based on Fisher's measures of skewness and kurtosis. A histogram and Q-Q plot were also created confirming non-normality, therefore all of these measures were examined using the Mann Whitney *U*. The median was evaluated on all of the above measures due to extreme outliers in the post-alert group, in attempt to allow for more similar comparison.

Demographics

As demonstrated in Table 5, the mean age of the pre-alert group was 66.86 years (*SD* = 18.05) which was not statistically different from the post-alert group at 72.45 years (*SD* = 17.41), $U = 187.5$, $p = 0.29$. There were more males in the post-alert group (72.73%) compared to the pre-alert group (47.62%), χ^2 (1) = 1.88, $p = .17$, two-tailed. The race of the pre-alert group was composed only of white patients (100%) and the post-alert group was composed of 6 non-white patients (27.27%), which did demonstrate a difference in the homogeneity of the groups, χ^2 (1) = 6.66, $p = .021$, two-tailed.

Bundle Compliance

There were ten separate components measured in terms of sepsis interventions. The first four were related to the SEP3T bundle compliance and included whether an initial lactic acid and blood cultures was drawn, whether the patient received a recommended antibiotic and whether blood cultures were drawn prior to receiving the antibiotic. The blood culture compliance increased to 90.91% (post-alert) from 80.95% (pre-alert), χ^2 (1) = .887, $p = .412$, two-tailed. These three measures were then evaluated to determine if they were completed in a timely fashion and in the correct order to meet compliance with the first three components of the sepsis bundle also known as the SEP3T bundle. The pre-alert group had 61.90% of patients meet the above requirements and the post-alert group had 68.18%, χ^2 (1) = .012, $p = .911$, two-tailed. The pre-alert group met all required SEP-1 bundle components 33.33% of the time and the post-alert group increased to 45.45% compliance, showing improvement, χ^2 (1) = .251, $p = .617$, two-tailed. There was no statistically significant change in any of the above interventions completed.

Secondary Outcomes

The mortality rates for the pre-alert group was 14.29% and for the post-alert group was 18.18%, χ^2 (1) = .120, $p = 1.00$, two-tailed. There was a decrease between pre-alert (6.68 $\pm$ 5.13

days) and post-alert (5.74 $\pm$ 3.54 days) length of stay, $U = 213.00$, $p = .662$, two-tailed. There were 22 patients included in the post-alert period and only 4 patients (18.18%) had a sepsis alert triggered. There was no statistical significance found in mortality or length of stay.

Discussion

Summary

The goal of this project was to implement a sepsis alert and guideline flowsheet with the overall goal of improving CMS bundle compliance and ultimately sepsis care in the ED. The project did demonstrate an increase in the overall compliance with the CMS bundle, however fell short of aligning or surpassing the national average of 51% during that timeframe (CMS, 2019). The mortality rate for the selected CMS cases increased slightly from the pre-alert group to post-alert group, although this was not found to be statistically significant. However, the overall sepsis mortality during this timeframe was evaluated by the hospital-wide committee and the overall mortality rate decreased. The median and mean of LOS was calculated due to a significant outlier in the pre-alert group, while the mean of the LOS decreased, the median stayed the same.

The largest strength of the project was clinical improvement in sepsis care within a community hospital ED. There were other strengths identified during this project including the project being implemented during an organization-wide initiative thereby providing focus on sepsis care. This initiative was beneficial because it increased sepsis awareness, even though the organization was focused on sepsis mortality and finances. Another strength included the utilization of the guideline flowsheet, which guides sepsis care and can also be useful during handoff of septic patients among different units in the hospital. There was an added benefit of having an interdisciplinary team approach, which allowed for multiple perspectives in regard to

timely and effective sepsis care. Finally, the data was extrapolated and evaluated exclusively by two individuals, the quality improvement coordinator and the DNP student.

Interpretation

The primary purpose of this project was to increase compliance of the CMS bundle. The compliance rate with the overall bundle did show an increase in rate of compliance, demonstrating clinical improvement in rapid recognition of sepsis and initiation of recommended interventions. The pre-alert and post-alert group had demographic data collected to determine whether the groups were homogenous, however race was significantly different between the groups and there were more males in the second group, but it is unclear how these differences may have contributed to the overall project.

Individual bundle components. When evaluating individuals bundle components, there were significant outliers in the post-alert group, but progress was made. In the post-alert group, all of the patients had the first lactic acid drawn in a timely manner. A second lactic acid was drawn a majority of the time in both groups, however there is still need for improvement on the repeat lactic acid. There were more blood cultures drawn in the post-alert group when compared to the pre-alert group, however with sepsis patients there should be blood cultures drawn 100% of the time which did not occur. There were the same number of blood cultures drawn prior to antibiotics in both groups. One of the charts reviewed showed that the blood cultures were drawn three minutes after giving antibiotics. This task is generally done by two different people on the team, therefore communication between team members is imperative, and the time of collection charted may be later than the actual time. CMS designates which antibiotics they recommend for treatment of sepsis patients and differentiate monotherapy (only one antibiotic) from dual therapy treatment (two different antibiotics). Two more patients in the post-alert

group received the recommended antibiotics when compared to the pre-alert group, demonstrating improved use of appropriate broad-spectrum antibiotics by the providers in the ED.

For the second part of the bundle, i.e. repeat lactic acid, fluid bolus, vasopressors and reassessment of fluid status, there is still room for improvement. In both the pre-alert and post-alert group, vasopressors were given 100% of the time. There was minimal improvement in the fluid bolus and reassessment status for both groups even though the percentage improved, the numbers were quite small, therefore by adding one more patient to the post-alert group it looked like a larger increase (Table 7).

Time to interventions. The pre-alert and post-alert groups had the time to intervention evaluated because CMS mandates that the first three interventions be completed within 3 hours of meeting sepsis criteria. As noted previously, there are new guidelines recommending the majority of the interventions occur in the first hour after sepsis recognition. The collection time can be used to determine if the hospital is also making progress towards the one-hour time frame even though it is not required by CMS. The time to lactic acid increased when comparing the pre-alert group and post-alert seen in Figure 3. Interestingly, the mean time to blood cultures and lactic acid was the same in the post-alert group which could signify that they are being drawn together as opposed to waiting to draw blood cultures as seen in the pre-alert group. However, in the post-alert group, there were significant outliers in regard to collection of lactic acid and blood cultures. By examining the box plots of blood cultures, time to antibiotics and length of stay there does not appear to increase in time when the outliers are plotted (Figure 4, 5, and 6). In Figure 7, the boxplot shows a decrease to the time of antibiotics and Table 7 shows a decrease in the median time to antibiotics by taking into account the significant outlier. During the hospital-

wide initiative, the pharmacy implemented intravenous push antibiotics as opposed to intravenous piggyback thereby decreasing the time it took for the patient to receive the antibiotics, making it a less time-consuming task for the bedside nurse. Rosenqvist et al. (2017) created a sepsis response team comprised of a physician and a team to ensure completion of the CMS bundle, their study also showed a decrease in time to antibiotic treatment but no change in mortality, similar to this project.

There were two significant outliers in the 2019 group in regard to time to antibiotic and time to lactic acid which skewed the mean of the times. One patient had a significantly increased time to initial antibiotic, but it appears that an appropriate antibiotic was ordered and is seen in the medication administration record (MAR) less than three hours after arrival to the emergency department. Per the MAR, the antibiotic appears to have been canceled instead of administered, therefore the next antibiotic was not given until later the next day almost 17 hours later. Both the emergency department and admitting physician documented that the antibiotic was given, but per the charting it does not appear to be done. There are two potential serious problems identified in this chart review, one being that the patient did not receive an antibiotic in a timely fashion versus improper charting of medications. The second significant outlier in the post-alert group was a patient had a lactic acid drawn six hours after arrival. The patient was quite ill on arrival and had multiple co-morbidities including known pleural effusions, COPD, heart disease and lung cancer thereby treatment was actually started for an MI, as opposed to sepsis which was not identified until the admitting physician noted concern for sepsis approximately six hours after arrival to the ED. Therefore, in attempt to minimize the extreme outliers the median value was taken and compared across the measurement period.

Overall bundle compliance. In terms of completion of the CMS bundle, in Figure 8, the bar graph shows an increase in bundle compliance in the post-alert group compared to the pre-alert group. The two components of the CMS bundle, the fluid bolus and reassessment of fluid status were missed the most in this evaluation. The completion of the first three components of the bundle did show a slight increase between the pre-alert and the post-alert group, but the 6-hour components are still being missed. Arabi et al. (2017) developed a specific sepsis response team similar to the creation of the sepsis alert and showed an improvement in baseline compliance with the bundle, although their study focused more on patients that were getting admitted to the ICU and were followed by the designated team as opposed to just initially while in the emergency department. Therefore, with the multiple initiatives surrounding sepsis care, there was an improvement to CMS bundle compliance, however in the institution is still behind the national average therefore improvements still need to be made.

Sepsis alerts. In 2019, there were 22 patients that would have be appropriate for a sepsis alert but only four (18.18%) of those patients had a sepsis alert called. Therefore, although the sepsis alert protocol was initiated in July 2019, it was not utilized as expected in the months evaluated. In terms of evaluating efficacy of sepsis alerts, there was less than 20% compliance in sepsis alerts being triggered therefore true analysis of the sepsis alert is difficult. Of the four patients that had a sepsis alert called, only one of them met bundle compliance. The other three had a missing component, one had antibiotics given before blood cultures were drawn, one did not have a second lactic acid drawn, and the third did not receive the recommendation sepsis bolus followed by fluid reassessment.

Limitations

During the post-alert timeframe, there was also an enterprise-wide sepsis initiative occurring at the hospital which may have confounded any results demonstrated. One of the strengths of this project was that the sample size was guided by an outside vendor per CMS guidelines, thereby making the sample appropriate for compliance reporting to the government. However, due to the exclusions of this project, patients were removed because they were not diagnosed in the ED, and therefore these different than the reported results to CMS in 2018 and 2019. Another limitation of this project is that CMS uses the time of severe sepsis or septic shock to measure compliance as opposed to the time of arrival to the ED as used in this project.

Lastly, the timeframe of the project was a limitation as it was only a three-month measurement period, although the same three months were utilized in attempt to minimize bias from seasonal variation. This project examined approximately 10% of the patients diagnosed with sepsis based on the CMS reporting guidelines in each month, and therefore further evaluation would be needed to determine whether a sepsis alert was beneficial.

Conclusions

There were many practice implications for the advancement of nursing care in regard to sepsis care stemming from this project. The education provided to the ED nurses assisted with improved sepsis screening for patients in which infection was a potential concern. Secondly, with improved identification skills and sepsis alert triggers, the implication to provide expedited care of the septic patient promoted improved patient outcomes. The knowledge gained by development of the guideline flowsheet and sepsis alert can provide valuable information for development of appropriate interventions of sepsis care in patients that are already admitted to the hospital when sepsis occurs. Currently, the emergency department is the only department in the hospital in which a sepsis alert is called. There were many sepsis alerts called in the post-alert

time period but only four of them were selected for CMS review, therefore in the future it may be helpful to examine the sepsis alert charts to see if there was improvement in CMS bundle compliance when the alert was triggered. There will need to be further training of the sepsis alert team with emphasis placed on the individual roles and importance of completing the interventions in the appropriate order and a timely fashion.

During the measurement period, new technology was integrated during the hospital-wide initiative to alert the nurse and provider to the potential for sepsis development during admission based on SIRS criteria. The procedure currently in place is for the nurse to notify the provider once the electronic notification is received. There is an ongoing discussion about nurses being able to place orders for sepsis care based upon a sepsis alert, but this has not yet been instituted. Initially, this protocol would be started in the ED, because there are other order sets that can be ordered by protocol. The potential to develop a similar treatment pathway on the inpatient units would be beneficial regarding care of patients who develop sepsis after admission. A similar interdisciplinary team approach could be applied on the inpatient units after further adjustment and evaluation of the current process.

CMS has not adopted the current 1-hour bundle recommendations from the SSC, but they may in the future. Therefore, it will be important for the hospital to identify ways to improve time to the sepsis interventions, as in both groups the time to antibiotics was greater than one hour. Another important piece in evaluation of sepsis care would be the creation of an automated reporting system to identify and calculate times to interventions. Each chart was evaluated by the quality coordinator and then reviewed by the DNP student sometimes taking 30-45 minutes on each individual chart. By streamlining the evaluation process, the hospital sepsis

committee could further evaluate whether the patients with the sepsis alert called improved time to intervention and completion of the bundle instead of the only the CMS patients.

One of the most significant products of the larger institutional initiative was the implementation of the sepsis alert and development of the sepsis worksheet. The findings of the evaluation project were disseminated to the sepsis committee, to promote the development of an internal evaluation model that could be replicated overtime within the institution to monitor improvements in sepsis care as processes are refined. Although there are studies that show improvement in sepsis care with a sepsis alert, this could not be properly evaluated in this project as initially proposed. There also needs to be further evaluation and education on the sepsis alert to determine whether to continue the sepsis alert and guideline flowsheet or introduce a new protocol.

Based on the layout of the sepsis algorithm, an electronic order set for the care of sepsis patients is being developed at the enterprise level with the input from multiple hospitals. Further evaluation will need to be undertaken by the hospital to determine how to implement improved sepsis care on the in-patient side as well decrease time from sepsis recognition to recommended sepsis interventions.

There are many studies that demonstrate that efficient and effective care of sepsis can improve patient outcomes. This project identified many areas that still need improvement regarding sepsis care at this hospital, and ongoing evaluation will be beneficial. The sepsis care at this community hospital is not currently meeting national averages, but progress has been made. The information provided is generalizable to other community hospitals that are evaluating ways to improve sepsis care. It will be important in the next couple years as more protocols are developed to continue evaluation procedures to ensure benefit of the protocols.

The dissemination plan is to publish the scholarly project in an academic repository specifically Libra, as well as an academic journal, the Journal of Doctoral Nursing Practice. This journal publishes articles that demonstrate evidence-based practice initiatives at the doctoral level and requirements for submission are shown in Appendix D.

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Table 1

History of Surviving Sepsis Campaign (SSC) sepsis bundles

Original SSC Recommendations	SSC Recommendations (2012)	SSC Recommendations (2018)
Within 6 hours of sepsis: • Measurement of Initial lactate acid • Obtain Blood cultures prior to antibiotic administration • Administer broad spectrum antibiotics within 3 hour of ED admission • Administer 20 ml/kg crystalloid fluids for hypotension or lactate acid ≥ 4 mmol/L • Initiate vasopressors for persistent hypotension • Recommendation includes achieving a central venous pressure of ≥ 8 mmHg and a central venous oxygen saturation ≥ 70%	**Within 3 hours of sepsis:** • Measurement of Initial lactate acid • Obtain Blood cultures prior to antibiotic administration • Administer broad spectrum antibiotics • Administer 30 ml/kg crystalloid fluids for hypotension or lactate acid ≥ 4 mmol/L	**Within 1 hour of sepsis:** • Measurement of initial lactate acid, repeat if > 2 mmol/L • Obtain Blood cultures prior to antibiotic administration • Administer broad spectrum antibiotics • Administer 30 ml/kg crystalloid fluids for hypotension or lactate acid ≥ 4 mmol/L • Initiate vasopressors for persistent hypotension
Within 24 hours of sepsis: • Administer low dose steroids for septic shock • Administer human activated protein C • Maintain glucose control ≥ 70 but ≤ 150 mg/dL Maintain a median inspiratory plateau pressure < 30 cmH2O for ventilated patients	**Within 6 hours of sepsis:** • Initiate vasopressors for persistent hypotension • Reassessment of volume status and tissue perfusion (consider measurement of central venous pressure or oxygen saturation) • Repeat lactic acid if initial result is >2 mmol/L	

Note: As of 2012, the SSC no longer recommends the interventions in the 24-hour bundle. (Dellinger et al., 2008; Dellinger et al., 2012; Society of Critical Care Medicine, 2018)

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
Arabi, et al. (2017)	The impact of a multifaceted intervention including sepsis electronic alert system and sepsis response team on the outcomes of patients with sepsis and septic shock	Pre-post implementation study with a 2-step implementation	Subjects with sepsis or septic shock: Preintervention: 436 patients Intervention phase 1: 195 patients Intervention phase 2: 699 patients Setting: 900-bed tertiary-care academic hospital, Saudi Arabia	Preintervention: 1/1/2011 - 9/24/2012 Intervention phase 1: 9/25/2012-3/3/2013 Intervention phase 2: 3/4/2013-10/30/2013	A multifaceted intervention utilizing an e-alert system and SRT (sepsis response team) providing care compared to standard of care Phase 1 - released a sepsis e-alert and computerized physician order entry sepsis management order-set and an educational campaign targeting ED providers, also weekly text messages about bundle compliance rates to ED and ICU physicians Phase 2 - sepsis response team (SRT) including an ICU physician and nurse with sepsis training if patient prompted an e-alert or bedside nurse was suspicious of	The primary outcome of this study was hospital mortality and secondary outcomes include compliance with the serum lactate collection, blood culture collection, administration of board-spectrum antibiotics and fluid resuscitation individually (based on 2008 SSC guidelines). Following both phases there was improvement in crude hospital mortality from 47.7% in the pre-intervention phase to 16.9% after the	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
					infective process and vital signs	second intervention (*P=.003)*. The secondary outcomes examining individual components improved as well as overall bundle compliance based on 2008 SSC guidelines was 19.3% to 44.6% to 69.4% (p < .0001).	
Damiani et al. (2015)	Effects or performance improvement programs on compliance with sepsis bundles and mortality: A systematic review and meta-analysis of Observational Studies	Systematic Review and Meta-analysis	Studies including adult patients with sepsis, severe sepsis or septic shock that evaluated bundle compliance individually or overall and mortality after the implementation of a performance	1/2004-10/2014	The study evaluated 50 studies between 2006-2014 that implemented education program or process change or both. 48 of the studies evaluated changes in mortality after an improvement program and the majority showed a decrease in mortality (p<0.001) although there was a large amount of inconsistency	There were 48 studies that looked at the mortality after the performance improvement program and showed an odds ratio of 0.66 (P<0.001), even though there was a large inconsistency between the studies. One of the limitations of this study was due to the observational nature	II A

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
			improvement program.			of the study true causation between bundle compliance and mortality cannot be made. There were 25 studies that evaluated compliance with the 6-hour bundle, and even though there was inconsistency, the OR = 4.12 (P<0.001) indicating a positive association between the interventions and compliance with the bundles.	
Ferguson et al. (2019)	Early, Nurse-Direct Sepsis Care	Retrospective, interrupted time-series cohort evaluation	Subjects: Patients discharged with sepsis Preintervention: 3,423 Intervention period: 4,782	Preintervention - 1/2010 -7/2012 Intervention 8/2012-8/2015 Post intervention	A multidisciplinary executive sepsis team of physicians, nurse leaders, and data analysts created two intervention phases for treating sepsis compared to standard of care.	The primary outcome of this study evaluated the in-hospital sepsis related mortality rate and sepsis related deaths per sepsis discharge decreased	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
			Postintervention: 1,483 Setting: Virginia Mason Medical Center in Seattle	9/2015 - 12/2016	1. ED Code sepsis in which the triage nurses screened every patient for SIRS and those meeting criteria got immediate evaluation by ED provider and a point-of-care lactate was measured 2. inpatient power hour - bedside nurses screened all patients once a shift for SIRS criteria and possibility of infection and initiated an order set including blood cultures, point-of-care lactate, 500 ml bolus, and alerted pharmacy for review	from 12.5% to 8.4% (P<0.001). The secondary outcomes were bundle adherence at 3 hours which improved from 40.5% to 73.7% *(p* < .001).	
Gatewood et al. (2015)	A quality improvement to improve early sepsis care in the emergency department	Retrospective cohort study	Subjects: 624 patients who presented to the ED with sepsis on arrival, n=137 in baseline group	Baseline data collection: 5/11-10/11 Measurement period: 3/12-3/14	This study created a multidisciplinary work group including physicians, nurse champions from ED and critical care services, pharmacists, quality	The primary outcome of this study examined overall bundle compliance, individual bundle components and mortality rate for the	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
			Setting: University of Washington Medical Center in Seattle		analysts and computer support personnel that developed a protocol focusing on early screening, computer-assisted case identification, and use of standardized order sets for evaluation, treatment and resuscitation. The created protocol was implemented, and the outcome of those sepsis patients compared to standard of care.	patients from the ED diagnosed with sepsis. Overall the bundle compliance improved from 28% to 71% (peak) during this time the study period. There was an increase in both individual components of blood cultures and antibiotics. The mortality rate decreased from 13.3% prior to implementation to 11.1% after the intervention. This decrease was not statistically significant (p=0.230) but is clinically significant in decreasing the amounts of deaths.	

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
Grek et al. (2017)	Sepsis and shock response team: Impact of a multidisciplinary approach to implementing surviving sepsis campaign guidelines and surviving the process	Pre and Post Intervention Study	Subjects: baseline data: n = 25, diagnosis of sepsis, severe sepsis or septic shock Postintervention group: 424 patients with sepsis, severe sepsis or septic shock Setting: Mayo Clinic ED in Jacksonville, FL, 304-bed tertiary academic medical center	Baseline data collection: 12/28/11 - 2/18/12 Project dates (two goals during this time): 9/1/13 - 9/1/14	A quality improvement team was formed to identify interventions for recognition of sepsis, standardize resuscitation measures, and create triage decisions compared to standard of care. A multidisciplinary sepsis and shock response team (SSRT) was created, an electronic sepsis sniffer was initiated, a sepsis resuscitation checklist was initiated by the ED nurse including specific interventions with time guidelines, and provider pocket cards were created.	The primary outcome of this study examined compliance of the 7-element bundle from the 2008 Surviving Sepsis guidelines in its entirety each individual component. There was improvement in collection of lactate, re-measurement of lactate (although only for > 4 mmol), blood cultures collected prior to antibiotics, and antibiotics administered within first 3 hours. Hospital mortality was also measured and showed improvement from 32% to 9.4%.	II A

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
						However, one of the limitations of this study, was the pre-intervention group was only a sample (n=25) of consecutive patients discharged with a sepsis diagnosis compared to 424 patients in the post-intervention group.	
Hughes et al. (2019)	A quality improvement project to Improve Sepsis-Related Outcomes at an integrated healthcare system	Retrospective cohort study	Subjects: Intervention group: 583 sepsis patients Control group: 3,892 sepsis patients Setting: Intervention group - Trinity Health in North Dakota Control group - two other regional	Intervention implementation period - 1/2017 - 10/2017	The study developed a quality improvement project that consisted of implementation of 1. clinical alerts (an alert went to the nurse if two indicators of SIRS and one element of organ dysfunction was detected and prompted the nurse to notify the physician) 2. audit and feedback of current treatment compared to the other	Two of the study outcomes were sepsis-related mortality and sepsis bundle compliance. There was no significant difference in the sepsis-related mortality between the intervention hospital and the control groups. Sepsis bundle compliance for the	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
			health organizations with similar populations		institutions 3. staff education including weekly meetings, developing new order sets and following the sepsis bundle. The intervention group at one hospital was compared to two other health organizations with similar patient populations.	intervention group increased from 18.6% to 58.8%, although the compliance for the sepsis bundle was not measured at the control hospitals. There was a decrease in the length of stay as well as the cost per stay in the intervention group compared to the control hospital group.	
Kuan et al. (2013)	Feasibility of introduction and implementation of the surviving sepsis campaign bundle in a Singapore emergency department	Pre and Post Intervention study	Subjects: Adults patients with severe sepsis or septic shock (*n* = 117) Setting: National University Hospital, Singapore	7/1/2008 - 12/31/2009	The study provided education programs starting in the second quartile for the ED staff through small group teaching sessions and lectures including information of recognition and treatment of severe sepsis and	The primary outcome for this study was bundle compliance over six quartiles. Over the six periods for those patients who completed the bundle the mortality rate was less than those	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
					septic shock. The last four quartiles included data review and feedback to physicians and nurses as well as frequent mini-lectures and installation of laminated reminder cards at bedside.	that did not (11.1% vs. 18.2%). The study also measure overall bundle compliance which went from 0% to 40% based on the 2008 Surviving Sepsis Campaign guidelines.	
Levy et al. (2010)	The Surviving Sepsis Campaign: results of an international guideline-based performance improvement program targeting severe sepsis	Pre and Post intervention study	Subjects: patients with suspected site of infection, two or more SIRS criteria and one or more organ dysfunction criteria *n* = 15,022 Setting: Between 34 and 165 hospitals internationally (depending on quarter)	1/2005 - 3/2008	The Surviving Sepsis Campaign performance improvement initiative was launched internationally utilizing the evidence-base guidelines developed by the SSC steering committee and Institute for Healthcare Improvement which established bundles of care. The initiative developed the two phase sepsis bundles (6-hr and 24-hr bundles), created	The primary outcome of this study was compliance with the 6-hour and 24-hour bundles, which contain many similar items to the current 3- and 6- hours bundles from the latest SSC guidelines. The authors looked at the bundle as a whole as well as individual components. The rate of compliance in	II A

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
					education material, recruited international sites and recruited local physician and nurse champions, organization of meetings to introduce the initiative and distribute the education materials, distributed the secure application and provided practice audit and feedback to local clinicians. The results were compared to each of the previous quarters through the two years	the 6-hour bundle improved from 10.9% in the first quarter to 31.3% at the end of the second year. One of the secondary outcomes was compliance with the bundles and association with hospital mortality. The overall hospital mortality decreased over the two year period and it was noted that the longer a hospital contributed information to the project the rate of mortality continued to decrease.	
McColl et al. (2017)	Implementation of an emergency department sepsis bundle	Pre and Post intervention study	Subjects: Adult ED patients with infection and two SIRS	Preintervention 1/13-5/13 Postinterven	The interventions were completed and implemented over multiple phases starting	The primary measure for this study was 30-day all-cause mortality and the use	II A

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
	and system redesign: A process improvement initiative		criteria Preintervention: 167 patients Postintervention: 185 patients Setting: Two large Canadian tertiary care EDs	tion 12/2013 - 3/2014	with analysis of current issues with the sepsis protocol, barriers to management of septic patients, then implemented new triage tools, and new protocols for placing patient in a bed, followed by nurse driven treatment intervention and prompt physician assessment. A target sign was placed on the electronic chart to alert the physician. Following that phase, their protocol was updated based on the Surviving Sepsis Guidelines. Lastly, there were extensive education sessions with the slogan "Target Sepsis".	of the sepsis protocol. In sepsis patients, the mortality rate prior to intervention was 30.7% compared to 17.3% in the postintervention group (P = 0.006). Between the two groups there was also a difference in the sepsis protocol use 20.3% vs. 80.5% (P < 0.001).	
McDonald et al. (2018)	Sepsis now a priority: a quality	Retrospective cohort study	Subjects: Preintervention: 346 sepsis	Preintervent ion 4/1/2010 - 3/31/2011	This study developed a sepsis now a priority (SNAP) working group	The primary outcome examined compliance with	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
	improvement initiative for early sepsis recognition and care		patients Postintervention: 270 sepsis patients Setting: Mount Sinai Hospital, Toronto, Ontario	Postintervention 9/1/2014-4/30/2015	which included emergency, infectious disease, intensive care, internal medicine and pharmacy departments that developed an algorithm to identify patients with sepsis in triage, standardize care utilizing electronic sepsis flags and order-sets, and provided staff education. The study compared patients undergoing the intervention to standard of care.	time to assessment by emergency physician, lactate measurement, blood culture collection, fluid and antibiotic administration, and all demonstrated improvement. The secondary measures included admission to the ICU, length of stay and mortality. The mortality rate decreased among patients specifically in the ICU and overall hospital stay, although neither measure was statistically significant (*P=0.75, P=0.25*). One of the limitations for the measurement of mortality was that if	

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
						the SNAP algorithm was selected, but then it was later determined that the patient was not septic, the algorithm needed to be discontinued to be removed from analysis, which reportedly did not happen in approximately 10% of patients in the post-intervention group.	
Noritomi et al. (2013)	Implementation of a multifaceted sepsis education program in an emerging country setting: clinical outcomes and cost-effectiveness in	Pre and Post Intervention study	Subjects: Patients with sepsis in ED, Ward or ICU baseline: n = 203 Postintervention: n = 1917 Setting: 10	Measurement period: 5/2010-1/2012	The program used a two-phase approach to implement care of sepsis patients and compared it to previous patients and standard of care. These two phases were implemented throughout all 10 hospitals with an overall goal to	The primary outcome measure of this study was compliance of the entire 6-hour bundle, including obtaining serum lactate and blood cultures, antibiotic administration, fluid	II A

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
	a long-term follow up study		private hospitals in Brazil		implement a protocol for early detection and treatment of septic patients 1. Each institution formed a committee to identify screening and treatment protocols, guidelines for antibiotic therapy, and development of timely interventions 2. Implementing the above protocols developed in the first phase, continuous performance assessment	challenge, achieving appropriate ScvO2 and CVP. The study also examined compliance with each individual measure and hospital mortality. Overall, there was improved compliance with individual measures, the entire 6-h bundle ($P < .001$), and a significant reduction in crude mortality ($P < 0.001$) from 55% at baseline to 26% by the end of the project period.	
Ramsdell et al. (2017)	Compliance with updated sepsis bundles to meet new sepsis core measure in a tertiary care hospital	Retrospective cohort study	Subjects: Patients diagnosed with severe sepsis or septic shock. 158 patients total,	Pre-intervention: 4/1/2015 - 9/30/2015 Post-intervention:	A multidisciplinary sepsis committee including physicians, pharmacy, nursing, quality and information technology staff was developed to create tools	The study evaluated individual components of the 3 and 6-hour bundle as well as overall, hospitality mortality and length of stay.	II B

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
			48 patients in pre-intervention group and 110 patients post-intervention group Setting: 300-bed tertiary care hospital	10/1/2015-2/29/2016	to improve treatment of sepsis compared to standard of care. 1. created order sets for adult sepsis resuscitation in the ED, sepsis admission to the ICU and sepsis admit to non-ICU 2. templates created to assist providers in documenting severe sepsis and septic shock, fluid status and tissue perfusion assessment 3. implement BPA messages in EMR, if SIRS criteria was met 4. EMR provided a severe sepsis checklist for nursing to complete to ensure all necessary components of SEP-1 measure met 5. Lactic acid order alert if initial was greater than 2 mmol/L and no follow	There was no statistical difference for mortality but there was a decrease (27.1% vs. 14.5%, p = .05) which is clinically significant and appeared to be approaching statistical significance. There was improvement observed in bundle measures including initial lactate measurement (62.5% vs. 88.2%, $p < .01$), receiving IV bolus (36.8% vs. 71.1%, $p = .02$), repeat lactate measurement (32.3 vs. 80.9%, $p < .01$), and reassessment of fluid status (0% vs. 34.8%, $p = 0.01$). There was no change	

Table 2

Qualitative analysis of literature review of sepsis care in the emergency department

Reference	Title of Article	Design	Subjects & Setting	Period of Data Collection	Intervention and Control/Comparison	Outcomes	Evidence Level/ Quality Guide
					up order, alert if no vasopressors for a septic shock patient, or if volume status and tissue perfusions assessment had not been performed 6. Extensive education to all clinical staff	in LOS or ICU LOS (p = .6, p = .56).	

Note. Each article was evaluated for evidence level and quality guide based on Dearhold and Dang (2012) Johns Hopkins nursing evidence-based practice guidelines.

Table 3

Evaluation of gray literature for treating sepsis

Reference: Author (year)	Title	Summary	Evidence Level/ Quality Guide
Rhodes et al. (2017)	Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock 2016	From the Surviving Sepsis Guideline panel providing 93 statements for early treatment of sepsis and severe sepsis: A. Initial Resuscitation - sepsis is a medical emergency, guided resuscitation for hypoperfusion B. screening for sepsis and performance improvement - developing a performance improvement program for identifying sepsis C. Diagnosis - obtaining blood cultures D. Antimicrobial Therapy - Administration of IV antimicrobials within one hour, then de-escalation as source is identified E. Source Control - Identification of source and removal of any devices contributing to infection F. Fluid Therapy - Provide crystalloid fluids for initial resuscitation and fluid challenge techniques G. Vasoactive Medications - First choice vasopressor is norepinephrine H. Corticosteroids - Suggest against using IV hydrocortisone in patients if fluids and vasopressor therapy can restore hemodynamic stability I. Blood products - Use blood products only when hgb < 7 g/dL J. Immunoglobulins - Suggest against the use of IV immunoglobulins K. Blood Purification - no recommendation L. Anticoagulants - Recommend against the use of antithrombin for treatment of sepsis M. Mechanical ventilation - Recommended target tidal volume of 6 ml/kg compared with 12 mL/kg in sepsis-induced ARDS N. Sedation and analgesia - Recommend continuous or intermittent sedation be minimized in mechanically ventilated patients O. Glucose control - Commence insulin dosing with 2 consecutive blood	IV A

Table 3

Evaluation of gray literature for treating sepsis

		glucose levels > 180 mg/dl, with < 180mg/dL being the target upper level blood glucose P. Renal replacement therapy - Suggest continues RRT (CRRT) or intermittent RRT in patients with sepsis and AKI Q. Bicarbonate therapy - Suggest against the use of sodium bicarbonate therapy for hemodynamic improvement R. Venous Thromboembolism Prophylaxis - Recommend pharmacologic prophylaxis S. Stress ulcer prophylaxis - Recommend stress ulcer prophylaxis be given T. Nutrition - Recommend against early parenteral nutrition if enteral feedings are available U. Setting goals of care - recommend goals of care and prognosis be discussed as well as treatment and end-of-life planning incorporated into discussion, palliative care as appropriate	
Schmidt and Mandel (2019)	Evaluation and management of suspected sepsis and septic shock in adults	Treatment of Suspected Sepsis Guidelines 1. Immediate evaluation and management - a. stabilize respiration - oxygen, intubation and mechanical ventilation b. establish venous access - obtain peripheral venous access, or central venous access if required c. initial investigations - labs including CBC with diff, CMP, coagulation studies, serum lactate, ABG, blood cultures, chest or abdomen xray, procalcitonin 2. Initial resuscitative therapy - IV fluids (within 3 hours of diagnosis) and empiric antibiotic therapy (within one hour) 3. Monitor Response - continue monitoring with vital signs, fluid responsiveness and laboratory results 4. Septic focus identification and source control - identification of source and source control (I&D or removal of device) 5. Patients who fail initial therapy - vasopressors, additional therapies generally not recommending including glucocorticoids, inotropic therapy,	IV B

Table 3

Evaluation of gray literature for treating sepsis

		blood transfusions (unless under specific circumstances) 6. Patient who respond to therapy - identification and control of septic focus, de-escalation of fluids and antibiotics, monitor procalcitonin	
Centers for Medicare and Medicaid Services (2018)	NQF-Endorsed voluntary consensus standards for hospital care: Early management bundle, severe sepsis/septic shock	CMS SEP-1 Bundle Within 3 hours of diagnosis of severe sepsis: a. initial lactate b. blood culture drawn prior to antibiotics c. broad spectrum antibiotics Within 6 hours: repeat lactate if initial > 2 If septic shock, all of the above plus a. fluid resuscitation and vasopressors reassessment of volume status after fluids or if initial lactate > 4	IV A

Note. Each article was evaluated for evidence level and quality guide based on Dearhold and Dang (2012) Johns Hopkins nursing evidence-based practice guidelines.

Table 4

Members of the sepsis alert response team in the emergency department

Role	Responsibility
ED physician	Identifies septic patient and initiates alert and appropriate sepsis orders
ED charge nurse/bedside nurse	Initiates order set, obtains sepsis flowsheet, documents on flowsheet and in EHR in accordance with policy
ED patient technician	Assist with IV sticks and blood cultures
Patient Care Supervisor	Establish appropriate room acquisition for the patient. Ensures resources are available to manage the septic patient.
Respiratory Care:	Assist with oxygenation, BiPAP or intubation as needed, and point of care lactic acids.
Pharmacy	Ensure ordered antibiotics are appropriate and broad-spectrum are administered first. If antibiotics are not available in the ED, tube immediately.
ICU Resource Nurse (when available)	Additional nursing resource to obtain blood specimens, vital signs, administer fluids, antibiotics, and start IVs
Laboratory	Run lactic acid stat in the laboratory setting with results immediately back to the sepsis team.
Radiology	Available to do bedside stat imaging tests. (e.g. chest xray)
Quality & Safety Coordinator	Follow-up on forms/support as needed.

Note: ED = emergency department

Table 5

Definition of terms

Term	Definition
Systemic inflammatory response syndrome (SIRS)	CMS definition: a systemic inflammation or response in a person which is characterized by two or more abnormalities in temperature, heart rate, respiration rate and/or white blood cell count (CMS, 2016) Updated definition: SIRS was removed in the latest SSC guidelines (Neviere, 2019)
Sepsis	CMS definition: SIRS criteria plus a source of infection (CMS, 2016) Updated definition: "life-threatening organ dysfunction caused by a dysregulated host response to infection" (Neviere, 2019, p. 6).
Severe Sepsis	CMS definition: sepsis with evidence of end-organ dysfunction by evaluating laboratory blood work (CMS, 2016) Updated definition: Severe sepsis was removed in the latest SSC guidelines (Neviere, 2019)
Septic Shock	CMS definition: SIRS criteria plus a source of infection and an initial lactate of greater than 4 mmol/L OR severe sepsis AND hypotension persisting after recommended sepsis bolus (30 ml/kg) (CMS, 2016) Updated definition: "sepsis that has circulatory, cellular, and metabolic abnormalities that are associated with a greater risk of mortality than sepsis alone" (Neviere, 2019, p.7).
Early Management Bundle, Severe Sepsis/Septic shock or SEP-1 bundle	CMS identified a collection of therapeutic interventions aimed at timely treatment of severe sepsis and septic shock (Ramsdell et al., 2017)
Length of stay (LOS)	number of days the septic patient stays in the hospital for the sepsis admission
In-hospital sepsis mortality	a patient who expired during their hospital stay after being admitted with a diagnosis of sepsis, severe sepsis or septic shock
Sepsis alert	after identification of a septic patient, an alert is triggered by calling the operator to send out a page to a group of individuals needed to promote expedited care to the patient

Table 6

Characteristics and Outcomes of Pre- and Post-alert Groups Over Three-Month Period

	Pre-Alert (*N = 21*)				Post-Alert (*N = 22*)				
	n	%	Mean (*SD*)	Median	n	%	Mean (*SD*)	Median	*p*
Age	21		66.86 (18.05)		22		72.45 (17.41)		0.29[a]
Gender (Male)	10	47.62%			16	72.73%			0.17[b]
Race									
White	21	100%			16	72.73%			0.02[c]
Non-White					6	27.27%			
Mortality	3	14.29%			4	18.18%			1.00[c]
Length of Stay, days	21		6.68 (5.13)	4.85	22		5.74 (3.54)	4.75	0.236[a]
Sepsis Alert					4	18.18%			

Note. *SD* = standard deviation

[a]*p*-value calculated using Mann Whitney *U* test. [b]*p*-value calculated using chi-square test continuity correction. [c]*p*-value calculated using Fisher's Exact Test

Table 7

Sepsis Interventions Completed

	Pre-Intervention (*N* = 21)		Post-Intervention (*N* = 22)		
	n	%	n	%	*p*[a]
Initial Lactic Acid	20	95.24%	22	100.00%	0.49
Blood Cultures	17	80.95%	20	90.91%	0.41
Blood Cultures, prior to Antibiotics	17	80.95%	17	77.27%	1.00
Antibiotics	18	85.71%	20	90.91%	0.91
SEP3T bundle	13	61.90%	15	68.18%	0.92[b]
Repeat Lactic Acid (# required)	12 (14)	85.71%	13 (15)	86.67%	1.00
Fluid Bolus (# required)	3 (10)	30.00%	3 (7)	42.86%	0.64
Vasopressors (# required)	1 (1)	100.00%	4 (4)	100.00%	-
Fluid Status Reassessment (# required)	1 (10)	10.00%	2 (7)	28.57%	0.54
SEP-1 Bundle	7	33.33%	10	45.45%	0.62[b]

[a]*p*-value calculated using Fisher's Exact test. [b]*p*-value calculated using chi-square test, continuity correction

Table 8

Time to Sepsis Intervention from Emergency Department Arrival Time

	Pre-Intervention (*n* = 21)			Post-Intervention (*n* = 22)			
	n	Mean Time (*SD*)	Median Time	n	Mean Time (*SD*)	Median Time	p[a]
Lactic Acid	19	50 (30)	42	22	79 (86)	56	0.40
Blood Cultures	17	71 (71)	57	20	101 (108)	56	0.51
Antibiotics	20	165 (99)	128	22	186 (222)	105	0.24

Note. Mean and Median time are displayed in minutes. *SD* = standard deviation

[a]*p*-value calculated using Mann Whitney *U*

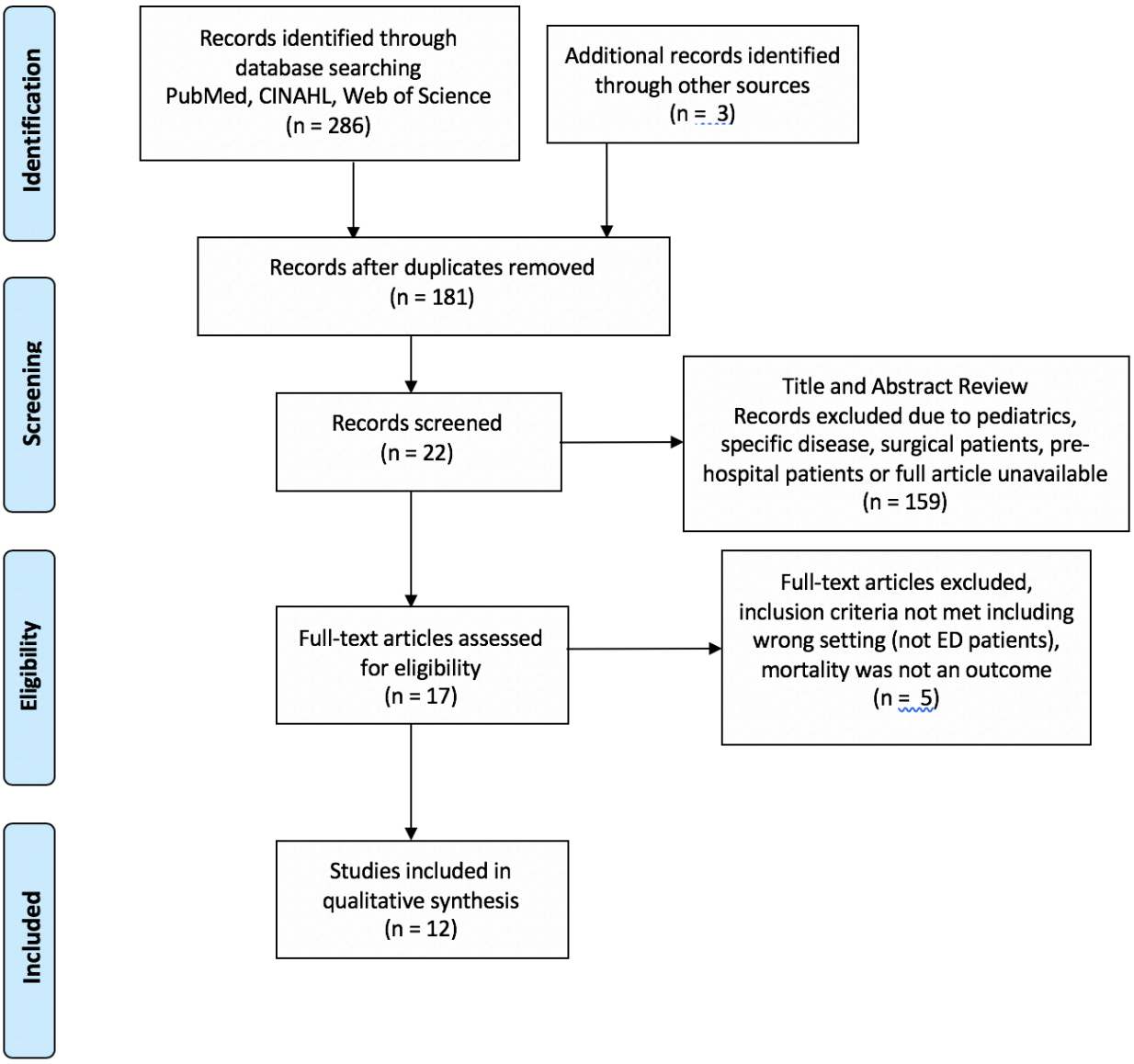

Figure 1. PRISMA diagram for scoping review for quality improvement projects in the emergency department measuring mortality rates and sepsis bundle compliance.

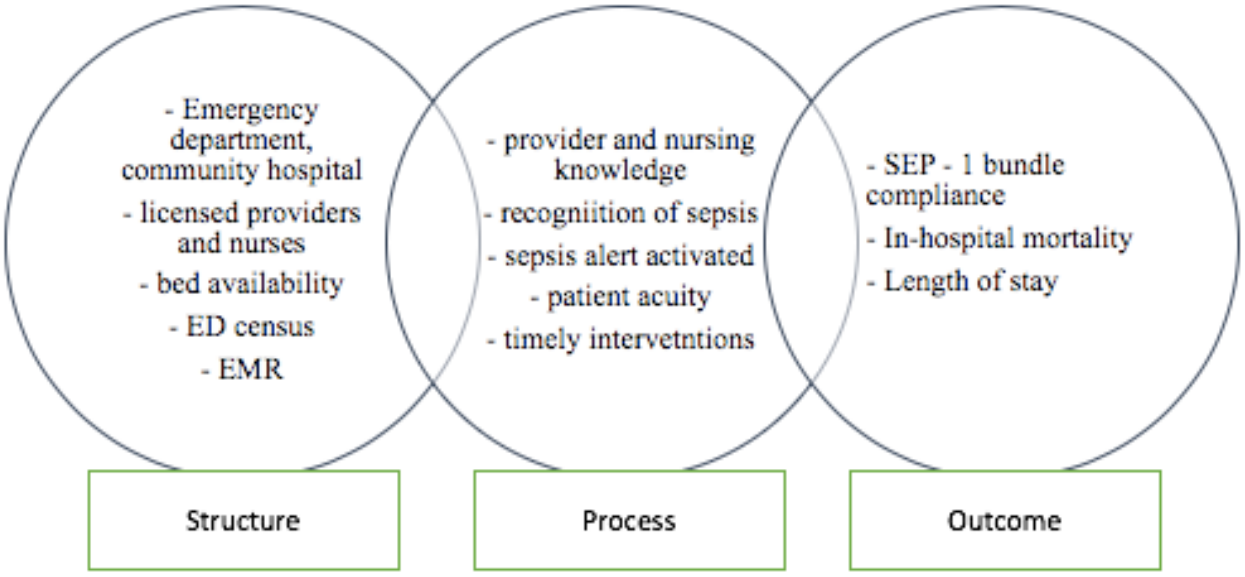

Figure 2. Interpretation of Structure, Process, Outcome Conceptual Framework by Donabedian for sepsis alert evaluation in the emergency department (Donabedian, 1988).

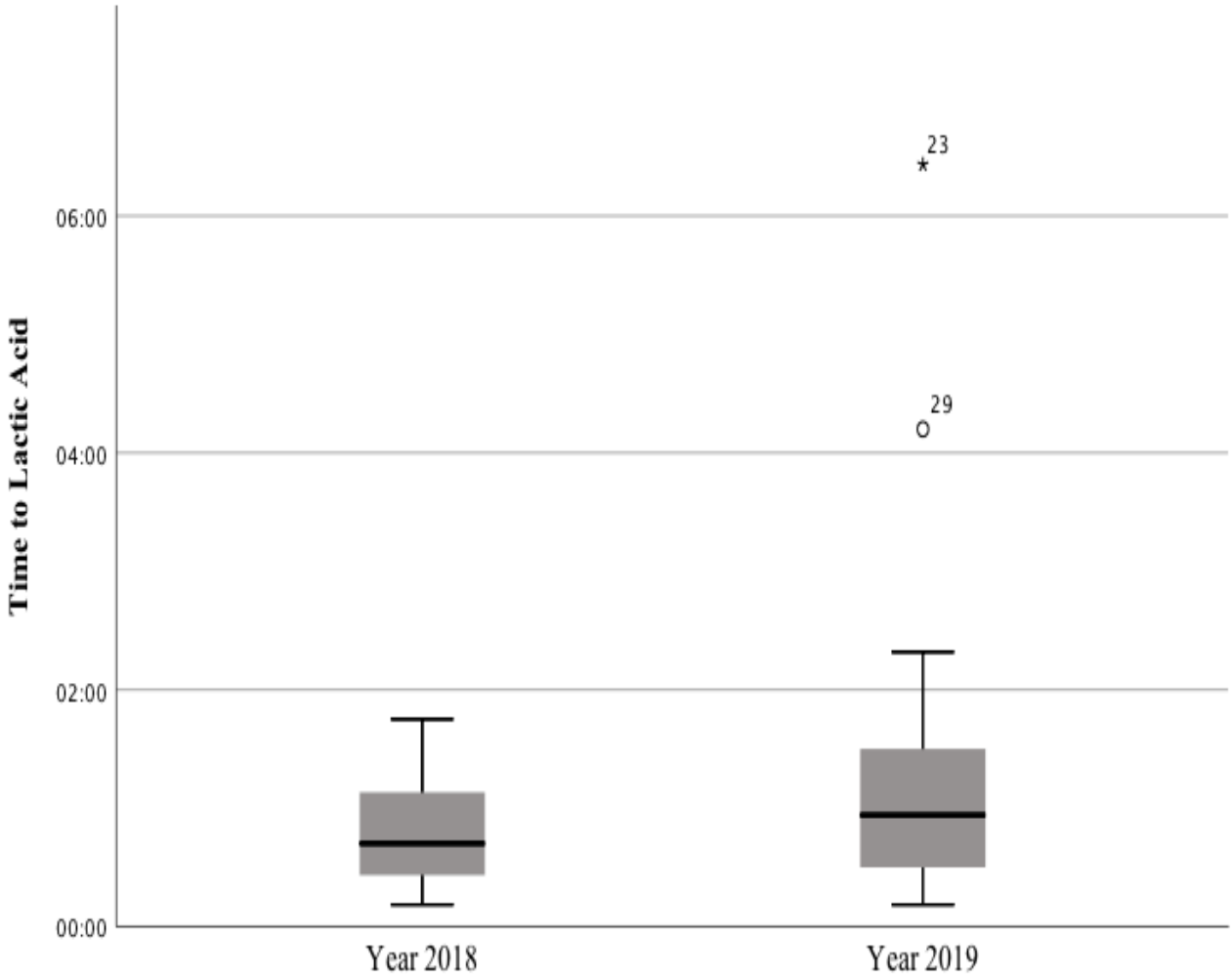

Figure 3. Comparison of the pre-alert group (2018) and the post-alert group (2019) in regards to time to lactic acid from the time of arrival. In the post alert group, there were two significant outliers, but there is an increase in the time to lactic acid compared to the pre-alert group

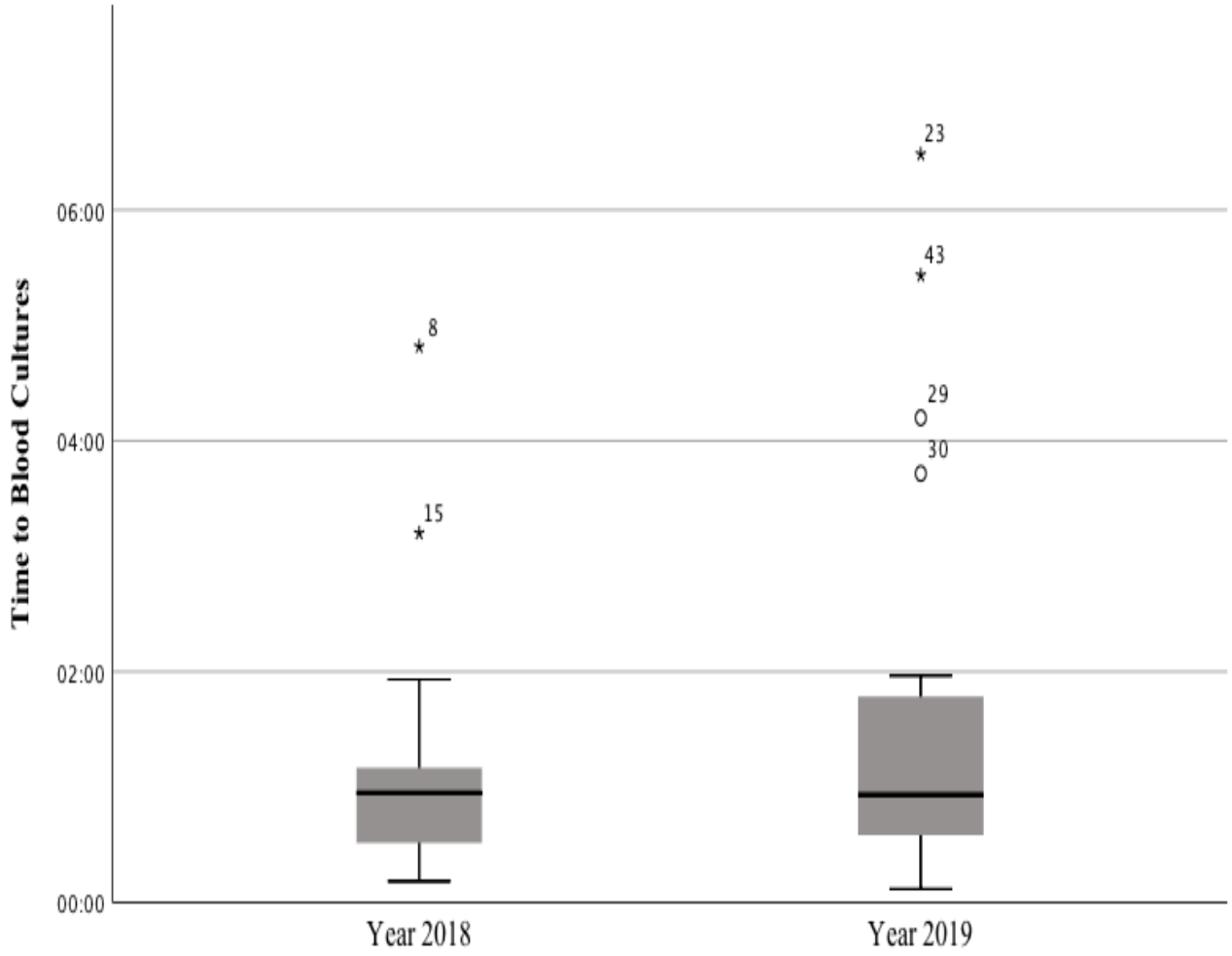

Figure 4. Comparison of the pre-alert group (2018) and the post-alert group (2019) in regard to time to blood cultures from the time of arrival. In the both groups, there were significant outliers, but the time to blood cultures remains similar.

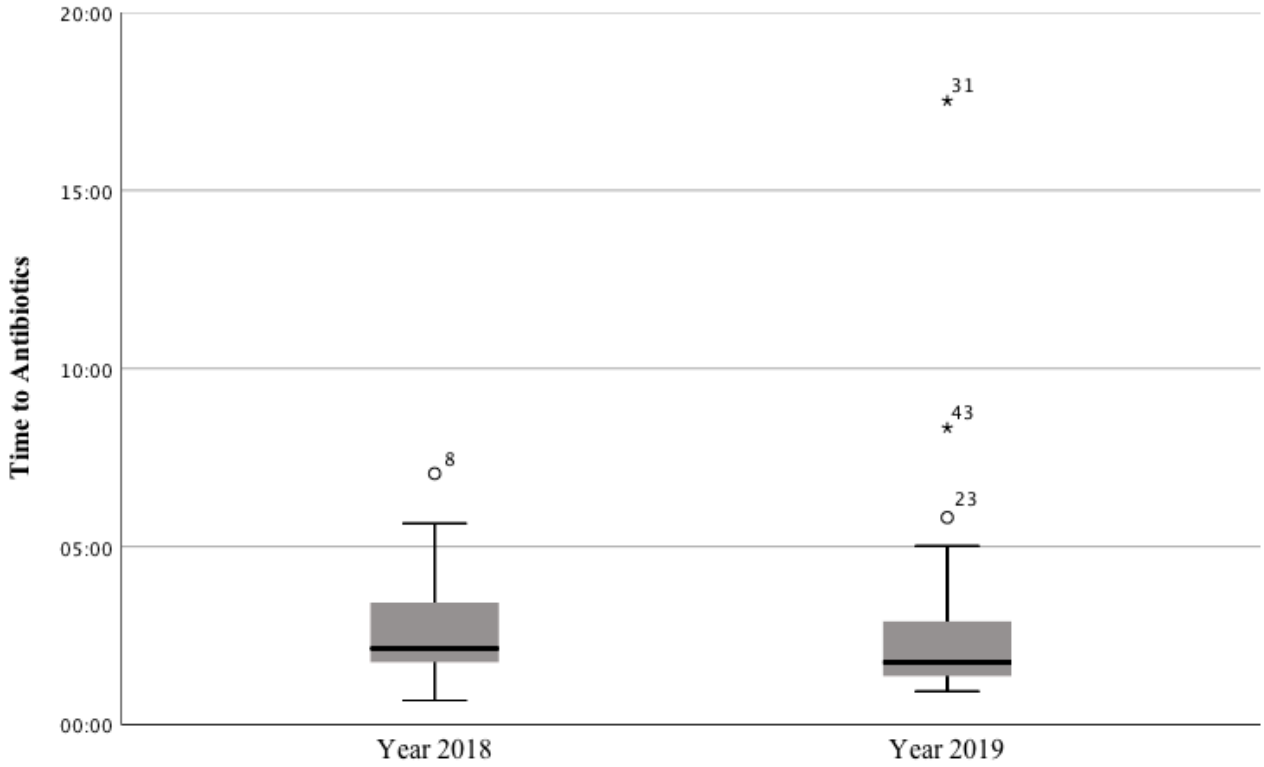

Figure 5. Comparison of the pre-alert group (2018) and the post-alert group (2019) in regard to time to antibiotics from the time of arrival. In the both groups, there were significant outliers, but the time to antibiotics is decreasing in the post-alert group when compared to the pre-alert group.

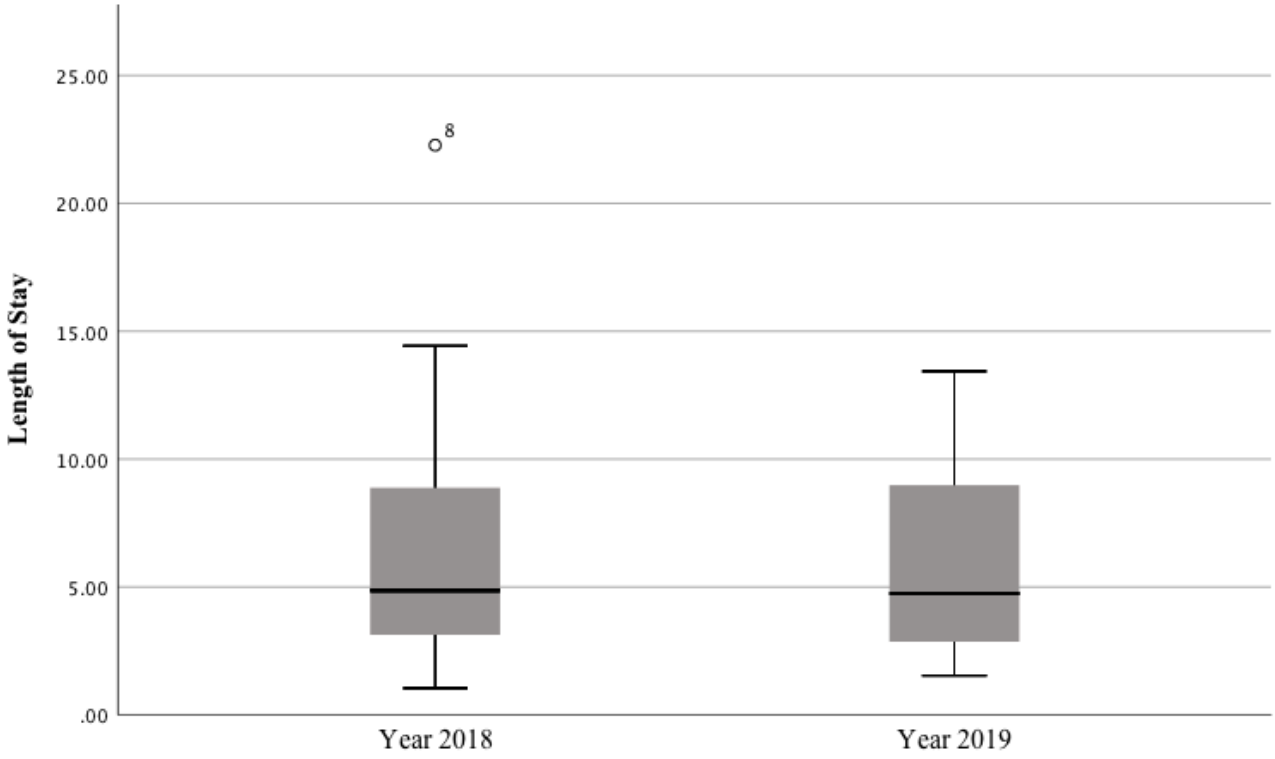

Figure 6. Comparison of the pre-alert group (2018) and the post-alert group (2019) in regard to time to blood cultures from the time of arrival. In the pre-alert group (2018), there is a significant outlier, and the post-alert (2019) group has a decreased range.

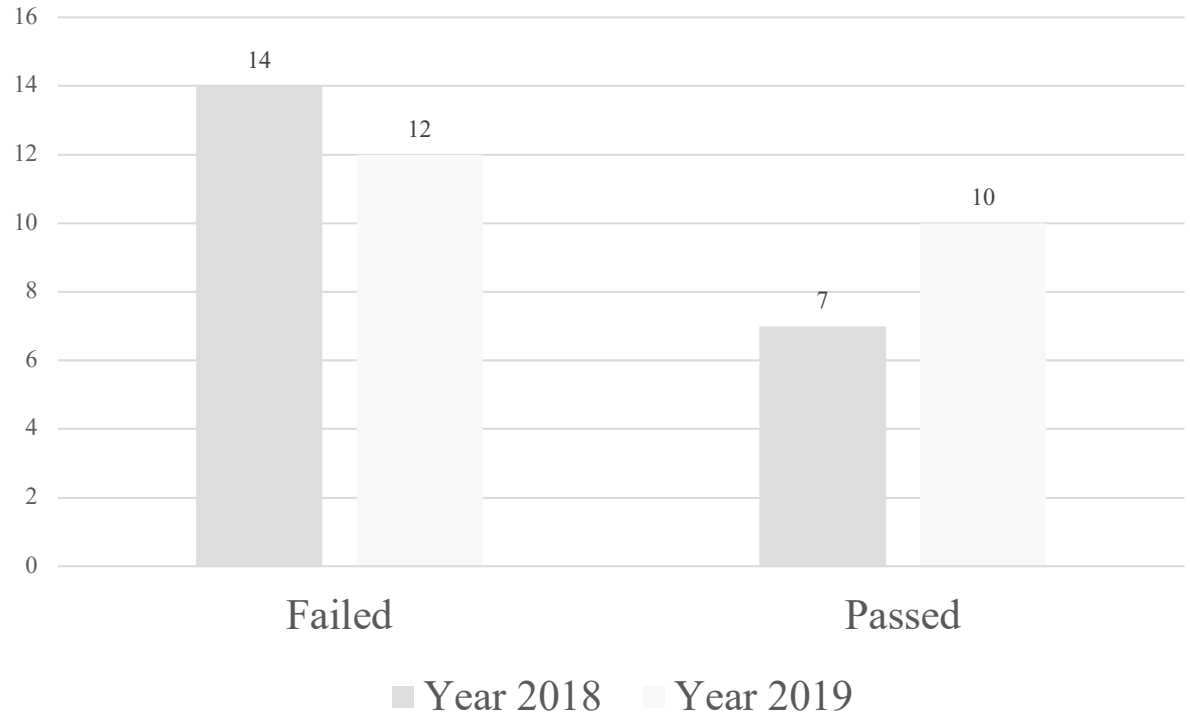

Figure 7. Overall CMS bundle compliance was measured for the pre-alert group (2018) and the post-alert group (2019). The dark gray bar shows the number of patients that met CMS bundle compliance and the light gray bar shows the number of patients that did not meet bundle compliance.

Appendix A

Last Updated: Version 5.7

NQF-ENDORSED VOLUNTARY CONSENSUS STANDARDS FOR HOSPITAL CARE

Measure Information Form
Collected For: CMS Only

Measure Set: Sepsis

Set Measure ID #: SEP-1

Performance Measure Name: Early Management Bundle, Severe Sepsis/Septic Shock

Description: This measure focuses on adults 18 years and older with a diagnosis of severe sepsis or septic shock. Consistent with Surviving Sepsis Campaign guidelines, it assesses measurement of lactate, obtaining blood cultures, administering broad spectrum antibiotics, fluid resuscitation, vasopressor administration, reassessment of volume status and tissue perfusion, and repeat lactate measurement. As reflected in the data elements and their definitions, the first three interventions should occur within 3 hours of presentation of severe sepsis, while the remaining interventions are expected to occur within 6 hours of presentation of septic shock.

Rationale: The evidence cited for all components of this measure is directly related to decreases in organ failure, overall reductions in hospital mortality, length of stay, and costs of care.

A principle of sepsis care is that clinicians must rapidly treat patients with an unknown causative organism and unknown antibiotic susceptibility. Since patients with severe sepsis have little margin for error regarding antimicrobial therapy, initial treatment should be broad spectrum to cover all likely pathogens. As soon as the causative organism is identified, based on subsequent culture and susceptibility testing, de-escalation is encouraged by selecting the most appropriate antimicrobial therapy to cover the identified pathogen, safely and cost effectively (Dellinger, 2012).

Multicenter efforts to promote bundles of care for severe sepsis and septic shock were associated with improved guideline compliance and lower hospital mortality (Ferrer, 2008 and Rhodes, 2015). Even with compliance rates of less than 30%, absolute reductions in mortality of 4-6% have been noted (Levy, 2010 and Ferrer, 2008). Absolute reductions in mortality of over 20% have been seen with compliance rates of 52% (Levy, 2010). Coba et al. has shown that when all bundle elements are completed and compared to patients who do not have bundle completion, the mortality difference is 14% (2011). Thus, there is a direct association between bundle compliance and improved mortality. Without a continuous quality initiative (CQI), even these compliance rates will not improve and will decrease over time (Ferrer, 2008). Multiple studies have shown that, for patients with severe sepsis, standardized order sets, enhanced bedside monitor display, telemedicine, and comprehensive CQI feedback is feasible, modifies clinician behavior, and is associated with decreased hospital mortality (Thiel, 2009; Micek, 2006; Winterbottom, 2011; Schramm, 2011; Nguyen, 2007; Loyola, 2011).

Type of Measure: Process

Improvement Noted As: An increase in the rate

Numerator Statement: Patients who received ALL of the following:
Within three hours of presentation of severe sepsis:

- Initial lactate level measurement
- Broad spectrum or other antibiotics administered
- Blood cultures drawn prior to antibiotics

AND received within six hours of presentation of severe sepsis. ONLY if the initial lactate is elevated:

- Repeat lactate level measurement

AND within three hours of initial hypotension:

- Resuscitation with 30 mL/kg crystalloid fluids

OR within three hours of septic shock:

- Resuscitation with 30 mL/kg crystalloid fluids

AND within six hours of septic shock presentation, ONLY if hypotension persists after fluid administration:

- Vasopressors are administered

AND within six hours of septic shock presentation, if hypotension persists after fluid administration or initial lactate >= 4 mmol/L:

- Repeat volume status and tissue perfusion assessment is performed

Included Populations: As described above

Excluded Populations: None

Data Elements:

- *Blood Culture Collection*
- *Blood Culture Collection Acceptable Delay*
- *Blood Culture Collection Date*
- *Blood Culture Collection Time*
- *Broad Spectrum or Other Antibiotic Administration*
- *Broad Spectrum or Other Antibiotic Administration Date*
- *Broad Spectrum or Other Antibiotic Administration Selection*
- *Broad Spectrum or Other Antibiotic Administration Time*
- *Crystalloid Fluid Administration*
- *Crystalloid Fluid Administration Date*
- *Crystalloid Fluid Administration Time*
- *Initial Hypotension*
- *Initial Hypotension Date*
- *Initial Hypotension Time*
- *Initial Lactate Level Collection*
- *Initial Lactate Level Date*
- *Initial Lactate Level Result*
- *Initial Lactate Level Time*
- *Persistent Hypotension*

- *Repeat Lactate Level Collection*
- *Repeat Lactate Level Date*
- *Repeat Lactate Level Time*
- *Repeat Volume Status and Tissue Perfusion Assessment Performed*
- *Repeat Volume Status and Tissue Perfusion Assessment Performed Date*
- *Repeat Volume Status and Tissue Perfusion Assessment Performed Time*
- *Septic Shock Present*
- *Septic Shock Presentation Date*
- *Septic Shock Presentation Time*
- *Severe Sepsis Present*
- *Severe Sepsis Presentation Date*
- *Severe Sepsis Presentation Time*
- *Vasopressor Administration*
- *Vasopressor Administration Date*
- *Vasopressor Administration Time*

Denominator Statement: Inpatients age 18 and over with an *ICD-10-CM Principal or Other Diagnosis Code* of Sepsis, Severe Sepsis, or Septic Shock.

Included Populations: Discharges age 18 and over with an *ICD-10-CM Principal or Other Diagnosis Code* of Sepsis, Severe Sepsis, or Septic Shock as defined in Appendix A, Table 4.01.

Excluded Populations:

- Directive for Comfort Care or Palliative Care within 6 hours of presentation of severe sepsis
- Directive for Comfort Care or Palliative Care within 6 hours of presentation of septic shock
- Administrative contraindication to care within 6 hours of presentation of severe sepsis
- Administrative contraindication to care within 6 hours of presentation of septic shock
- Length of Stay >120 days
- Transfer in from another acute care facility
- Patients enrolled in a clinical trial for sepsis, severe sepsis or septic shock treatment or intervention
- Patients with severe sepsis who are discharged within 6 hours of presentation
- Patients with septic shock who are discharged within 6 hours of presentation
- Patients receiving IV antibiotics for more than 24 hours prior to presentation of severe sepsis

Data Elements:

- *Administrative Contraindication to Care, Septic Shock*
- *Administrative Contraindication to Care, Severe Sepsis*
- *Admission Date*
- *Birthdate*
- *Clinical Trial*
- *Directive for Comfort Care or Palliative Care, Septic Shock*
- *Directive for Comfort Care or Palliative Care, Severe Sepsis*
- *Discharge Date*
- *Discharge Disposition*
- *Discharge Time*
- *Transfer From Another Hospital or ASC*

Risk Adjustment: None

Data Collection Approach: Retrospective data sources for required data elements include administrative data and medical record documents. Some hospitals may prefer to gather data concurrently by identifying patients in the population of interest. This approach provides opportunity for improvement at the point of care/service. However, complete documentation includes the principal or other ICD-10-CM diagnosis and procedure codes, which require retrospective data entry.

Data Accuracy: Variation may exist in the assignment of ICD-10-CM codes; therefore, coding practices may require evaluation to ensure consistency.

Measure Analysis Suggestions: Hospitals may wish to aggregate the reasons for failure to meet this measure so that gaps in care may be identified and educationally addressed.

Sampling: Yes, please refer to the measure set specific sampling requirements and for additional information see the Population and Sampling Specifications.

Data Reported As: Aggregate rate generated from count data reported as a proportion

Selected References:

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Appendix B

SEPSIS ALERT – EMERGENCY DEPARTMENT

INITIAL SCREEN TO BE COMPLETED AT TRIAGE (IF sepsis screen is positive)

Date:	**Time:**	**Weight (kg):**

Step 1

Does the patient meet ***3 OR MORE*** of these criteria:

- ☐ Respirations > 20/min
- ☐ Temp < 36C (96.8F) or > 38.3C (100.9F)
- ☐ Heart Rate > 90
- ☐ Systolic BP < 90 mmHG
- ☐ Mean arterial pressure (MAP) < 65
- ☐ Altered mental status (change from baseline)
- ☐ High clinical concern/High risk for decompensation
- ☐ WBC > 12k OR < 4k OR > 10% bands
- ☐ Lactic acid > 2 mmol/L

☐ **YES** ☐ **NO**

Step 2

Does the patient have ***1 OR MORE*** indicators of infection:

- ☐ Productive cough/PNA
- ☐ Dysuria/frequency/urgency/UTI
- ☐ Catheter infection (foley/dialysis/PICC/central line)
- ☐ Skin breakdown/wound/cellulitis
- ☐ Acute abdominal pain
- ☐ Bone or joint infection
- ☐ S/S meningitis or endocarditis
- ☐ Surgical procedure in the last 2 weeks
- ☐ Other/site not otherwise specified

☐ **YES** ☐ **NO**

If YES for step 1 AND 2 then ACTIVATE SEPSIS ALERT

Time 0 _____

- ☐ EPIC orders placed (may use SEPSIS NIPS)
  (CBC with diff, CMP, Lactate with reflex, UA + C&S, BC x2, CXR)
- ☐ Q15 min vital signs X 1HR or if persistently hypotensive
- ☐ IV started (2 IVs preferred or central line PRN)
- ☐ 1 liter NS/LR IV given (rapid infusion/pressure bag) End time: _____
- ☐ Give IV sepsis bolus if LA ≥ 4 OR If SBP <90 OR MAP <65 TWICE in 3 hrs
  Weight: _____ (kg) x 30 ml/kg = _____ ml (total amount of fluid required)
  #2 bag _____ (mL) at _____ (time) #3 bag _____ (mL) at _____ (time)
  #4 bag _____ (mL) at _____ (time)
- ☐ Labs collected
- ☐ **Lactic Acid Result:** _____ (if > 2, redrawn w/in 3 hrs of initial LA)
  2nd Lactic Acid Due: _____
- ☐ **Blood culture #1** (prior to antibiotics)
- ☐ **Blood culture #2** (should be from PICC/central line/port if present)

STOP Do NOT delay antibiotics if unsuccessful cultures - DOCUMENT WHY!

Hour 3 _____

- ☐ **Start broad spectrum antibiotics ASAP (preferably w/in 1 hour)**
  (i.e. Ceftriaxone, Zosyn, Meropenem, Cefepime – see back)
- ☐ Second Antibiotic (if warranted)
- ☐ *SEPTIC SHOCK CRITERIA MET* (if initial LA ≥ 4 or SBP<90 or MAP<65 s/p fluids)
- ☐ Start vasopressors if SBP < 90 OR MAP < 65 w/in 1 hour of fluids
- ☐ Repeat fluid volume assessment documented (MD/APP)

Hour 6 _____

- ☐ **Draw Repeat Lactic acid** (if initial LA > 2)

STOP **MAKE SURE TO DOCUMENT EVERYTHING IN EPIC**

Created 4/19, update 6/19 PLACE FORM IN SEPSIS FOLDER

SEPSIS CRITERIA	SEVERE SEPSIS CRITERIA	SEPTIC SHOCK CRITERIA
• Confirmed or Suspected Infection **AND** • Any 2 SIRS CRITERIA ▪ Temp < 36C (96.8F) or > 38.3C (100.9F) ▪ Heart Rate > 90 ▪ Respirations > 20/min ▪ WBC > 12k OR < 4k OR > 10% bands	• Confirmed or Suspected Infection **AND** • Any 2 SIRS CRITERIA ▪ Temp < 36C (96.8F) or > 38.3C (100.9F) ▪ Heart Rate > 90 ▪ Respirations > 20/min ▪ WBC > 12k OR < 4k OR > 10% bands **AND** • Any 1 sign of End Organ Dysfunction ▪ Lactate > 2 mmol/L ▪ Hypotension: SBP < 90 OR > 40 below baseline OR MAP < 65 ▪ Creatinine > 2 ▪ Total Bilirubin > 2.0 mg/dL ▪ Platelets < 100,000 ▪ INR > 1.5 OR aPTT > 60 ▪ Acute Respiratory Failure requiring BIPAP or Intubation **OR** • Severe Sepsis Documentation	• Initial Lactate ≥ 4mmol/L **OR** • Severe sepsis AND hypotension persists one hour after sepsis bolus of 30 mL/kg (crystalloid fluid) **OR** • Septic Shock Documentation

Suggested First Antibiotics for Sepsis*	
Antibiotic	**Suspected Site of Infection**
Ceftriaxone	Urinary, pneumonia (community acquired), meningitis (2g)
Zosyn	Pneumonia (hospital acquired/healthcare associated), intra-abdominal, gangrene/severe cellulitis, urinary (catheter-related or with septic shock). Any patient at risk for pseudomonas infection (prior history, multiple or recent hospitalizations/antibiotics).
Cefepime**	
Meropenem**	

* Actual orders may differ. This is to serve only as a guide for nursing staff to know what to expect.
** IV push preferred for severe sepsis or septic shock in the ED

Sepsis Team (Please write names inside boxes)	
Emergency Department	**Inpatient**
MDs/APPs:	MDs/APPs:
RNs:	RNs:
Techs:	PCAs:
PharmD:	PharmD:

Created 4/19, update 6/19 PLACE FORM IN SEPSIS FOLDER

Appendix C

7. Per procedures, students must de-identify the hospital/division for any work describing the project (papers, posters, etc) within the school classroom setting. Any dissemination beyond the classroom must follow the procedure laid out in *Guidelines for Preparing and Disseminating Scholarly Work.*

Citations

Melnyk, B. M., & Fineout-Overholt, E. (Eds.). (2011). *Evidence-based practice in nursing & healthcare: A guide to best practice*. Lippincott Williams & Wilkins.

Related Documents:

Policy	Privacy of Protected Health Information
Procedure	Guidelines for Preparing and Disseminating Scholarly Work

Quality/Practice Improvement Criteria

x	The intervention being evaluated has a strong evidence-base (i.e. a guideline or Cochrane review).
x	The project purpose explicitly states that the project is a quality or practice improvement and not intended to be generalized.
x	There is a manager or director (above the level of the student) aware of and in support of the project as part of the unit or hospital QI program. Name:

Privacy Criteria

x	No individual protected health data will be collected OR the use of any individualized protected health data is justified in the proposal.
x	The proposal states a plan for ensuring privacy of any protected data consistent with Sentara policy.

_x___ Yes the project for student _____Elizabeth Lawwill_____

qualifies as quality improvement and can proceed with data collection

Nursing Research Coordinator/ date **all projects**

IMPACT Manager / date **student projects only**

ATTENTION: FOR REFERENCE USE ONLY WHEN PRINTED; PLEASE REFER TO ELECTRONIC DOCUMENT FOR MOST CURRENT VERSION

Appendix D

SPRINGER PUBLISHING COMPANY

Author Guidelines for *Journal of Doctoral Nursing Practice*

Journal of Doctoral Nursing Practice is a biannual, peer-reviewed publication focused on clinical excellence of the application of evidence-based practice of doctoral nursing. The mission of the *Journal of Doctoral Nursing Practice* is to support the advancement of the comprehensive and integrated roles doctorally-prepared advanced practice nurses have within the healthcare system

Articles submitted for consideration discuss improving patient experiences and improving the health of populations while reducing costs. They should address areas of health outcomes; case/clinical studies; practice issues including management, scope of practice, health policy, health disparities, and reimbursement; ethical dilemmas; legal issues; and business practices.

Manuscript Preparation and Review

Manuscripts must be submitted electronically as a Word document and should be double-spaced with one-inch margins and the font set to Times New Roman (12 point). A title page separate from the main manuscript must include the title; the names, academic degrees, and primary affiliations of all authors; and the name, mailing address, e-mail address, and telephone number of the corresponding author. The main body of the manuscript should include a title page without author identifiers and should conform to the *Publication Manual of the American Psychological Association*, 6th Edition. Digital files for any figure should conform to tiff at 300 ppi or eps. Please include written permission for previously published materials. A brief (≤ 200 words), structured abstract is required for all manuscripts and should include the following headings: Background, Objective, Methods, Results, Conclusions, and Implications for Nursing. Following the abstract, authors should provide a list of four keywords or phrases which describe the scientific content of the article and will be used for indexing in bibliographic databases.

Manuscripts submitted are for the exclusive use of the *Journal of Doctoral Nursing Practice* and should not have been previously published or be presently under consideration for publication elsewhere. Authors will be asked to submit an electronic copyright agreement during the submission process. All authors are required to read the Springer Publishing Company Journals Policies and Statements found at: http://www.springerpub.com/journals-policies-and-statements

Manuscript Submission

Manuscripts should be submitted electronically using Editorial Manager: www.editorialmanager.com/jdnp.

Authors may direct queries regarding the Editorial Manager system to: Megan Larkin at mlarkin@springerpub.com.

ARTICLE TYPES

Quality Improvement Contribution. These manuscripts identify a clinical practice issue and describe the generally accepted quality improvement steps to achieve the intended outcome towards clinical improvement. Authors are strongly encouraged to use SQUIRE Guidelines for quality improvement reporting (Qual Saf Health Care 2009;17(Suppl I):i13-i32). Maximum length of manuscript: 3,000 words (not including abstract, tables, figures, and references) with no more than a total of eight tables and/or figures.

Clinical Briefs. These manuscripts are short reports that pertain to evidence-based practice, business of practice, clinical case reports, ethics and law, health policy, education, administration/management, leadership/mentorship, or interprofessional practice. Maximum length of manuscript: 1,500 words (not including abstract, tables, figures, and references) with no more than a total of five tables and/or figures.

Clinical Practice Contribution. These manuscripts are full-length, expanded versions of Clinical Briefs and pertain to evidence-based practice, business of practice, clinical case reports, ethics and law, health policy, education, administration/management, leadership/mentorship, or interprofessional practice. Maximum length of manuscript: 3,000 words (not including abstract, tables, figures, and references) with no more than a total of eight tables and/or figures.

Case Studies. These manuscripts present cases of interest related to enhancing clinical practice. The manuscript begins with a paragraph that discusses the reason for selecting the case, which is followed by the case vignette. The remaining portion of the manuscript utilizes scholarly inquiry to define the problem and describe the underlying condition and associated challenges. Best clinical evidence for practice is presented to provide a rationale for therapeutic interventions and actions taken to resolve the case. Recommendations for future practice and building evidence from practice may be presented. Maximum length of manuscript: 2,500 words (not including abstract, tables, figures, references) with no more than a total of four tables and/or figures and no more than 30 references.

Systematic Review with or without Meta-Analysis. These manuscripts critically assess clinical topics in the literature that address factors including cause, diagnosis, prognosis, therapy, or prevention. All data sources should be searched and selected systematically for inclusion. The search, selection, and critical assessment process should be described in the manuscript. Authors are strongly encouraged to use PRISMA Guidelines to guide their reviews (Ann Intern Med 2009;151(4):264-269). For each data source, describe the type of study, population, intervention, exposure, and outcomes. Maximum length of manuscript: 3,000 words (not including abstract, tables, figures, references) with no more than a total of eight tables and/or figures and no more than 50 references.

Original Research Contribution. These manuscripts include intervention studies, cohort studies, observational studies, pilot studies, survey research, cost-effectiveness analyses, and decision analyses. Each manuscript should clearly state aim(s)/objective(s), hypothesis(ses), setting and sample, design and methods, the intervention, outcome measures, results, limitations, discussion, and conclusions. For reporting randomized, controlled trials, authors are strongly encouraged to use the CONSORT 2010 Statement (Ann Intern Med 2010;152(11):726-732). Maximum length of manuscript: 3,000 words (not including abstract, tables, figures, references) with no more than a total of eight tables and/or figures.

Authors may direct general inquiries to: Kristine Kulage, Managing Editor, *Journal of Doctoral Nursing Practice*, Columbia University School of Nursing, 630 West 168th Street, Box 6, New York, NY 10032. E-mail: kk729@columbia.edu.

DRAFT MANUSCRIPT

Implementation of a Sepsis Alert to Improve Timely Sepsis Care:

A Quality Improvement Project

Abstract

Background: Sepsis is a leading cause of mortality in the hospital setting and early recognition and treatment is essential.

Objective: The goal of this quality improvement project was to implement an interdisciplinary designed sepsis alert protocol and guideline flowsheet to promote early recognition of sepsis, increase compliance with CMS bundle guidelines, and decrease mortality and length of stay.

Methods: A retrospective chart review was performed on emergency department patients who were diagnosed with severe sepsis or septic shock during a 3 month pre- and post-alert time period. Evaluation included time to interventions, completion of CMS bundle components, mortality rates and length of stay.

Results: The CMS bundle compliance improved from 33.3% in the pre-alert group to 45.5% in the post-alert group, closer to the national average of 51% at the time of this project. There was no significant change in mortality for this cohort, but there was a decrease in mean length of stay.

Conclusions: There was improvement with CMS bundle compliance, demonstrating that quality improvement initiatives can improve patient outcomes. There is still further work to be done to continue to improve sepsis care and ongoing evaluation is needed.

Implications for Nursing: In the emergency department, nurses are often the first member of the healthcare team to evaluate these patients and must be able to recognize potential infection and concern for sepsis.

Keywords: Sepsis Alert; Emergency Department; CMS bundle; Mortality

Implementation of a Sepsis Alert to Improve Timely Sepsis Care

Sepsis is a life-threatening emergency that can be attributed to one in three deaths in hospitalized patients and is responsible for over a quarter of a million American deaths each year (Centers for Disease Control [CDC], 2019). It is the body's response to an infectious process that can occur from a number of sources including but not limited to the lungs, abdomen, urinary tract or skin. This response to an infection causes a chain reaction in the body, which can have dire consequences leading to organ dysfunction, tissue damage or untimely death (Mayr, Yende, & Angus, 2014). Sepsis has become a costly burden on the healthcare system due to rising incidence and poor outcomes. Therefore, guidelines have been developed to assist in early recognition and treatment of sepsis (Dellinger et al., 2008).

In 2002, the Surviving Sepsis Campaign (SSC) was a joint collaboration established by the Society of Critical Care Medicine (SCCM), the European Society of Intensive Care Medicine (ESICM) and the International Sepsis Forum to develop treatment guidelines for sepsis care (Society of Critical Care Medicine, 2018). Initially, the SSC evaluated multiple studies referencing sepsis care and preceded to evaluate the evidence and formulate recommendations (Dellinger et al., 2004). The SSC continually updates their recommendations and published the fourth edition of the guidelines to manage sepsis and septic shock in 2016 (Rhodes et al., 2017). However, in 2018, a revision was proposed to include obtaining an initial lactic acid and blood cultures, and administering broad-spectrum antibiotics and intravenous fluids within one hour as opposed to three hours (Society of Critical Care Medicine, 2018). As new guidelines continue to transpire, the challenge is for healthcare teams to stay apprised and implement these new evidence-based practice recommendations.

Problem Description

The early recognition and timely treatment of sepsis is imperative, because sepsis is both costly and deadly. Sepsis is estimated to cost more than $20 billion annually (Jorgenson, 2019) and the calculated mortality rate for septic shock is approaching 50% (Mayr et al., 2014). Thereby, CMS established sepsis care as a reportable quality measure with plans for it to be a pay-for-performance incentive for hospitals in the future (Jorgenson, 2019).

In April 2019, a community hospital in the Mid-Atlantic region showed that only one-quarter (26%) of patients were treated with the recommended sepsis CMS guidelines compared to the national average of 51% (CMS, 2019). Therefore, an interdisciplinary team was created to evaluate and address sepsis care in the ED of this community hospital.

Available Knowledge

There have been many articles published about care of the septic patient, but few focus on care in the emergency department with the aim to improve mortality, length of stay (LOS) and compliance with the CMS bundle. The current SSC recommendations have removed the term “SIRS” and “severe sepsis” however they were included for the purpose of this project because the current CMS bundle guidelines continue to utilize them. Ferguson, Coates, Osborn, Blackmore, and Williams (2019), Arabi et al. (2017), Grek et al. (2017) and Rosenqvist, Fagerstrand, Lanbeck, Melander, and Akersson (2017) developed a sepsis response team. The team would be alerted if a patient with sepsis was in the emergency department (ED) and would provide quick assessment of the patient by a provider while the team would ensure compliance with the bundle components. The studies all demonstrated improvement with compliance measures of lactic acid and blood culture collection, and antibiotic administration. Rosenqvist et al. (2017) specifically focused on a decrease in time to antibiotics. Both Arabi et al. (2017) and

Rosenqvist et al. (2017) showed a decrease in the LOS for patients. Ferguson et al. (2019), Arabi et al. (2017) and Grek et al. (2017) all showed a statistically significant decrease in mortality.

Rationale

Improvement of sepsis care is paramount to decreasing the high mortality rate associated with this syndrome. A quality improvement project was undertaken utilizing Donabedian's model to evaluate the quality of health care. The model encompasses three different components: structure, process and outcome (Donabedian, 1988). The structure is the setting is the emergency department that is staffed by licensed physicians, nurse practitioners, physician assistants, nurses and patient care technicians who work together to provide for the patient. The process is the timely and effective care of patients with sepsis, which can be impacted by the knowledge of nurses and providers, bed availability in the ED, patient acuity and the electronic medical record. By utilizing protocols and evidence-based processes, quality, effective and timely care can be provided. The outcome is measurement of SEP-1 bundle compliance as set by a CMS core measure as well as mortality and length of stay which is a direct reflection of patient outcome. This quality improvement project used the SQUIRE 2.0 publishing guidelines to report results (Ogrinic, Davis, Goodman, Batalden, Davendoff & Stevens, 2015).

Specific Aims

The foundation of this quality improvement project was built from an enterprise-wide project aimed at improving sepsis care, specifically focused on decreasing in-hospital sepsis mortality. A sub-committee of the hospital-wide sepsis committee implemented a sepsis alert and guideline flowsheet in the ED. The primary purpose of this project was to improve CMS bundle compliance utilizing the new sepsis alert when compared to the previous standard of practice

within the institution. The secondary goals of the project were to decrease in-hospital sepsis mortality and hospital length of stay.

Methods

The program evaluation was a retrospective cohort review to determine the effect of implementation of a sepsis alert in the ED on SEP-1 bundle compliance, mortality and LOS. A review of charts for those patients identified with severe sepsis or septic shock occurred both pre- and post-implementation of the sepsis alert. The alert officially was implemented July 1, 2019 in the emergency department. The measurement period included the months August 1st through October 31st in 2018 and 2019.

Context

The emergency department is part of a 176-bed not-for-profit community hospital in the Mid-Atlantic Region that is part of a larger organization that has 12 acute care hospitals and over 300 sites of care. The ED has 24 beds and sees approximately 50,000 patients a year. Every month an outside vender randomly selects a certain percentage of septic patient to be audited for compliance on the sepsis bundle as required by CMS. Therefore, this evaluation utilized the patients identified by the vendor as well as used the current exclusion criteria set forth by CMS. For the purpose of this project, patients were excluded if they developed sepsis after hospital admission.

Interventions

As sepsis care has increasingly become a health priority, the larger enterprise established multiple interdisciplinary committees to promote early recognition and treatment of sepsis in the individual facility as well as committees composed of multiple sites. The individual hospital sepsis committee focused on outcomes set forth by the enterprise to improve in-hospital

mortality rates and decrease expenses between July 1, 2019 and November 30, 2019. Each hospital committee was further divided into sub-committees, and one of them pertained specifically to creating a sepsis alert in the emergency department. The sub-committee met over five months in weekly and bi-weekly meetings and developed a sepsis alert process. In addition to the sepsis alert protocol, a worksheet comprised of CMS guidelines was created identifying the alert triggers and listed evidence-based guidelines and interventions for care of the septic patient. The protocol developed a sepsis alert that was trigged by the ED physician prompting a call to the operator who notified the ED charge nurse, bedside nurse, ED technician, laboratory department, radiology department, respiratory therapist, nursing supervisor, and quality improvement coordinator. The ED nurses were educated on the new protocol during a mandatory nursing education day two weeks prior to implementation by the two nursing educators who were members of the sub-committee. The ED physicians were educated by the ED physician team member during a monthly staff meeting. There was an initial provisional period between June 3 and June 30, 2019 in which the first version of the sepsis worksheet was printed and posted throughout the ED. The sub-committee reconvened and updated the sepsis worksheet based on feedback from the staff prior to official go-live date. The official measurement period for the hospital wide initiatives started on July 1, 2019 and therefore this became the official start date of the sepsis alert protocol as well.

Study of Interventions

A retrospective chart review was performed utilizing the sample of septic patients identified by the research database vendor for the measurement period identified above. The rate of compliance with the CMS bundle, in-hospital mortality rate and the average length of stay in the hospital was entered into a database. The time from arrival to the emergency department to

initial lactic acid, blood cultures and antibiotics was also measured. A comparison between pre-alert and post-alert data was evaluated to identify any significant change or correlation among the primary and secondary outcomes.

Measures

The electronic medical record was reviewed for demographics, bundle components, mortality and length of stay. The demographic information included age, race and gender to determine the homogeneity of the pre- and post-alert groups. The first set of measurements identified the completion of the bundle elements including lactic acid, blood cultures and broad-spectrum antibiotics within the first three hours of presentation. The remaining bundle elements measured depended upon results of the initial interventions including a repeat lactic acid if the first lactic acid was greater than 2 mmol/L, resuscitation with crystalloid fluids if the initial lactate was greater than or equal to 4 mmol/L or the patient was persistently hypotension, initiation of vasopressors if persistently hypotensive, and evaluation of volume status and tissue perfusion after infusion of crystalloid fluids. The completion of the first three interventions were measured (SEP3T bundle), as well as if the remaining requirements were met, completing the entire bundle (SEP-1). The time from arrival to the emergency department to the time of the completion of the first three tasks was also measured. In the second measurement period, the post-implementation phase, whether a sepsis alert was called was also documented. The last two measures evaluated included the secondary outcomes, in-hospital sepsis mortality and length of stay.

Analysis

The data was entered in SPSS (v. 26) and the pre-alert group (2018) was compared to the post-alert group (2019). The age of the patient, time to completion, and length of stay are

continuous variables and were evaluated using the Mann Whitney *U* test. The time measures did not meet normality assumptions based on Fisher's measures of skewness and kurtosis and the Q-Q plot and histogram did not demonstrate normality. The rest of the data including race, gender, bundle element completion, overall bundle compliance, and in-hospital mortality are categorical variables and were evaluated using the chi-square test or Fisher's exact test depending on the sample size.

Ethical Considerations

This DNP project was approved by academic faculty for degree requirements and subsequently approved by the institution's Nursing Research Coordinator and IMPACT manager per the community hospital's protocol as a quality improvement project and Institutional Review Board approval was not required. The potential breach of patient confidentiality was the most significant threat and therefore only essential data elements were collected and stored on a password protected device approved by the institution.

Results

In 2018, there were a total of 24 patients that were randomly chosen by the outside vendor to be evaluated for compliance with the SEP-1 bundle. Three patients were excluded from the pre-alert period, because two did not meet CMS criteria for severe sepsis or septic shock and one met sepsis criteria after being admitted to the hospital, leaving 21 patients for further evaluation. In 2019, there were 33 patients chosen by the outside vendor and 11 patients were excluded. Based on CMS exclusion criteria, two were excluded because they received antibiotics prior to arrival to the ED, one patient was excluded because they arrived from an outside hospital and two were excluded due to not meeting severe sepsis or septic shock criteria. In addition to CMS exclusion criteria, six more were excluded because five of the patients

included in the sample developed sepsis after admission to the hospital and one patient was excluded because they were admitted prior to the go-live date of the sepsis alert.

Demographics

As demonstrated in Table 1, the mean age of the pre-alert group was 66.86 years (*SD* = 18.05) which was not statistically different from the post-alert group at 72.45 years (*SD* = 17.41), *U* = 187.5, *p* = 0.29. There were more males in the post-alert group (72.73%) compared to the pre-alert group (47.62%), χ^2 (1) = 1.88, *p* = .17, two-tailed. The race of the pre-alert group was composed only of white patients (100%) and the post-alert group was composed of six non-white patients (27.27%), which did demonstrate a difference in the homogeneity of the groups, χ^2 (1) = 6.66, *p* = .021, two-tailed.

Bundle Compliance

There were ten separate components measured in terms of sepsis interventions (Table 2). The first four were related to the SEP3T bundle compliance and included whether an initial lactic acid and blood cultures was drawn, whether the patient received a recommended antibiotic and whether blood cultures were drawn prior to receiving the antibiotic(s). The blood culture compliance increased to 90.91% (post-alert) from 80.95% (pre-alert), χ^2 (1) = .887, *p* = .412, two-tailed. These three measures were then evaluated to determine if they were completed in a timely fashion and in the correct order to meet compliance with the first three components of the sepsis bundle also known as the SEP3T bundle. The pre-alert group had 61.90% of patients meet the above requirements and the post-alert group had 68.18%, χ^2 (1) = .012, *p* = .911, two-tailed. The pre-alert group met all required SEP-1 bundle components 33.33% of the time and the post-alert group increased to 45.45% compliance, showing improvement, χ^2 (1) = .251, *p* = .617, two-tailed. There was no statistically significant change in any of the above interventions completed.

Secondary Outcomes

The mortality rates for the pre-alert group was 14.29% and for the post-alert group was 18.18%, χ^2 (1) = .120, p = 1.00, two-tailed. There was a decrease between pre-alert (6.68 $\pm$ 5.13 days) and post-alert (5.74 $\pm$ 3.54 days) length of stay, U = 213.00, p = .662, two-tailed. There were 22 patients included in the post-alert period and only 4 patients (18.18%) had a sepsis alert triggered. There was no statistical significance found in mortality or length of stay (Table 1).

Discussion

Summary

The goal of this project was to implement a sepsis alert and guideline flowsheet with the overall goal of improving CMS bundle compliance and ultimately sepsis care in the ED. The project did demonstrate an increase in the overall compliance with the CMS bundle, however fell short of aligning or surpassing the national average of 51% during that timeframe (CMS, 2019). The mortality rate for the selected CMS cases increased slightly from the pre-alert group to post-alert group, although this was not found to be statistically significant. However, the overall sepsis mortality during this timeframe was evaluated by the hospital-wide committee and the overall mortality rate decreased. The median and mean of LOS was calculated due to a significant outlier in the pre-alert group, while the mean of the LOS decreased, the median stayed the same.

Interpretation

The project showed an increase in compliance of the CMS bundle, demonstrating clinical improvement in rapid recognition of sepsis and initiation of recommended interventions. In the post-alert group, there were significant outliers in regard to time to lactic acid collection and antibiotic administration. In Figure 1, the boxplot shows a decrease in the time of antibiotics

and Table 3 shows a decrease in the median time to antibiotics by taking into account the significant outlier. During the initiative, the pharmacy implemented intravenous push antibiotics as opposed to intravenous piggyback thereby decreasing the time it took to receive the antibiotics, making it a less time-consuming task for the bedside nurse. Rosenqvist et al. (2017) created a sepsis response team comprised of a physician and a team to ensure completion of the CMS bundle, their study also showed a decrease in time to antibiotic treatment but no change in mortality, similar to this project.

In terms of completion of the CMS bundle, in Figure 3, the bar graph shows an increase in bundle compliance in the post-alert group compared to the pre-alert group. In terms of evaluating efficacy of sepsis alerts, there was less than 20% compliance in sepsis alerts being triggered therefore true analysis of the implemented sepsis alert was not obtained. Of the four patients that had a sepsis alert called, only one of them met bundle compliance. Therefore, even with the multiple initiatives surrounding sepsis care during this time, there are further evaluation and adjustments that need to be made to patient care as this is an ongoing process.

Limitations

During the measurement period for evaluation of the sepsis alert, there were other enterprise wide initiatives occurring which is likely the largest limitation to this evaluation potentially confounding the results. Another limitation of this project was only the patients selected by the outside vendor for CMS report were evaluated and that was only 10% of septic patients during that time frame. There would be added benefit in evaluation of the other septic patients as well as reviewing the patients that had a sepsis alert trigged to determine improvement in compliance with the CMS bundle. Lastly, the timeframe of the project was a

limitation as it was only a three-month measurement period, even though the same three months were utilized in attempt to minimize bias from seasonal variation.

Conclusions

There were many practice implications for the advancement of nursing care in regard to sepsis care stemming from this project. The education provided to the ED nurses assisted with improved sepsis screening for patients in which infection was a potential concern. Secondly, with improved identification skills and sepsis alert triggers, the implication to provide expedited care of the septic patient promoted improved patient outcomes. The knowledge gained by development of the guideline flowsheet and alert can provide valuable information for development of appropriate interventions of sepsis care in patients that are already admitted to the hospital when sepsis occurs.

Currently, the emergency department is the only department in the hospital in which a sepsis alert is called. The sepsis alert was trigged on less than 20% of patients selected for CMS review, therefore further work by the sepsis committee is needed. There will be further evaluation as to the utilization of the alert in the ED as well as further training and education of the ED staff regarding effective and timely sepsis care. At this time, CMS is currently following the SSC guidelines from 2012, but with the updated one-hour bundle in 2016, this is subject to change in the future. Based on the time to antibiotics at this community hospital, although time was improved, there is further work needed to ensure antibiotics within an hour of diagnosis of sepsis.

Sepsis is a syndrome with a significant mortality rate, and nurses are in a position to improve patient outcomes by understanding and recognizing the signs and treatment algorithm for septic patients. Implementing system level process improvements to sepsis screening and

expedited care followed by studying the intervention outcomes can improve patient outcomes and increase CMS core measure compliance.

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Table 1

Characteristics and Outcomes of Pre- and Post-alert Groups Over Three-Month Period

	Pre-Alert (*N = 21*)				Post-Alert (*N = 22*)				
	n	%	Mean (*SD*)	Median	n	%	Mean (*SD*)	Median	*p*
Age	21		66.86 (18.05)		22		72.45 (17.41)		0.29[a]
Gender (Male)	10	47.62%			16	72.73%			0.17[b]
Race									
White	21	100%			16	72.73%			0.02[c]
Non-White					6	27.27%			
Mortality	3	14.29%			4	18.18%			1.00[c]
Length of Stay, days	21		6.68 (5.13)	4.85	22		5.74 (3.54)	4.75	0.236[a]
Sepsis Alert					4	18.18%			

Note. *SD* = standard deviation

[a]*p*-value calculated using Mann Whitney *U* test. [b]*p*-value calculated using chi-square test continuity correction. [c]*p*-value calculated using Fisher's Exact Test

Table 2

Sepsis Interventions Completed

	Pre-Intervention (*N* = 21)		Post-Intervention (*N* = 22)		
	n	%	n	%	*p*[a]
Initial Lactic Acid	20	95.24%	22	100.00%	0.49
Blood Cultures	17	80.95%	20	90.91%	0.41
Blood Cultures, prior to Antibiotics	17	80.95%	17	77.27%	1.00
Antibiotics	18	85.71%	20	90.91%	0.91
SEP3T bundle	13	61.90%	15	68.18%	0.92[b]
Repeat Lactic Acid (# required)	12 (14)	85.71%	13 (15)	86.67%	1.00
Fluid Bolus (# required)	3 (10)	30.00%	3 (7)	42.86%	0.64
Vasopressors (# required)	1 (1)	100.00%	4 (4)	100.00%	-
Fluid Status Reassessment (# required)	1 (10)	10.00%	2 (7)	28.57%	0.54
SEP-1 Bundle	7	33.33%	10	45.45%	0.62[b]

[a]*p*-value calculated using Fisher's Exact test. [b]*p*-value calculated using chi-square test, continuity correction

Table 3

Time to Sepsis Intervention from Emergency Department Arrival Time

	Pre-Intervention (*n* = 21)			Post-Intervention (*n* = 22)			
	n	Mean Time (*SD*)	Median Time	n	Mean Time (*SD*)	Median Time	p[a]
Lactic Acid	19	50 (30)	42	22	79 (86)	56	0.40
Blood Cultures	17	71 (71)	57	20	101 (108)	56	0.51
Antibiotics	20	165 (99)	128	22	186 (222)	105	0.24

Note. Mean and Median time are displayed in minutes. *SD* = standard deviation

[a]*p*-value calculated using Mann Whitney *U*

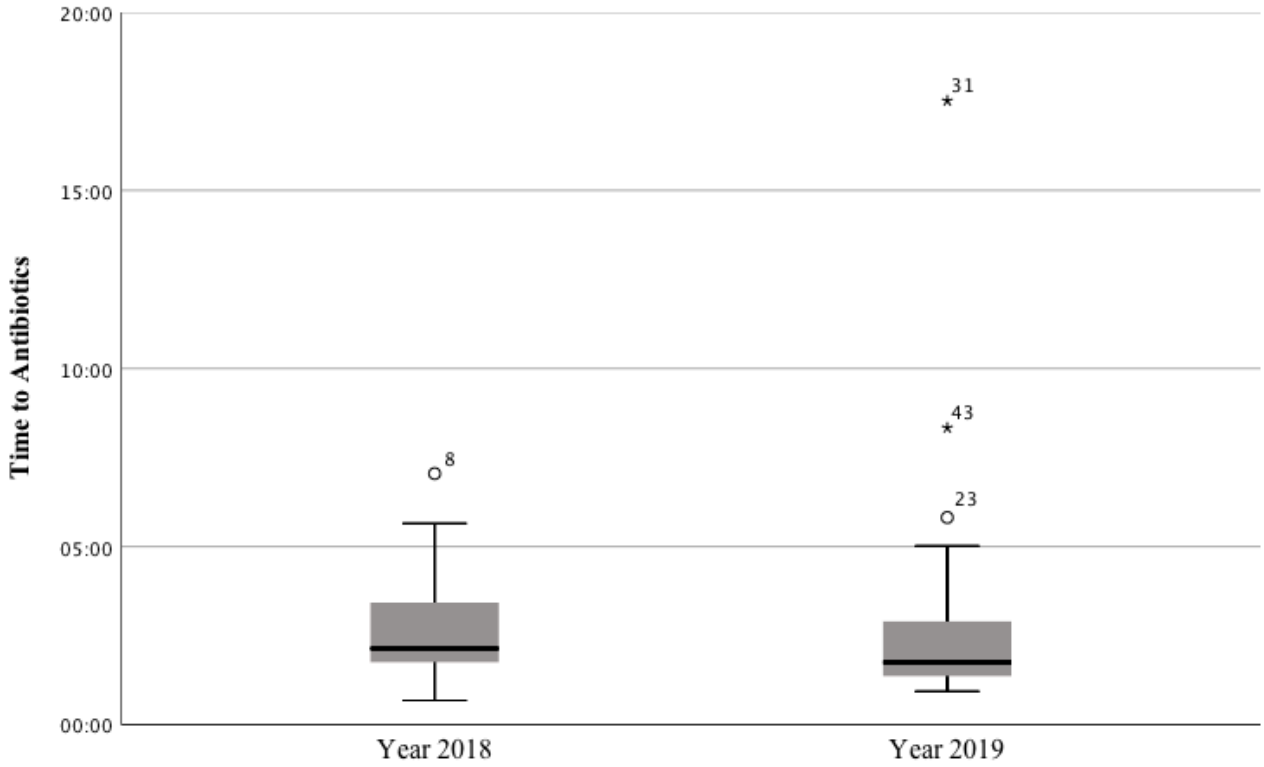

Figure 1. Comparison of the pre-alert group (2018) and the post-alert group (2019) in regard to time to antibiotics from the time of arrival. In the both groups, there were significant outliers, but the time to antibiotics is decreasing in the post-alert group when compared to the pre-alert group.

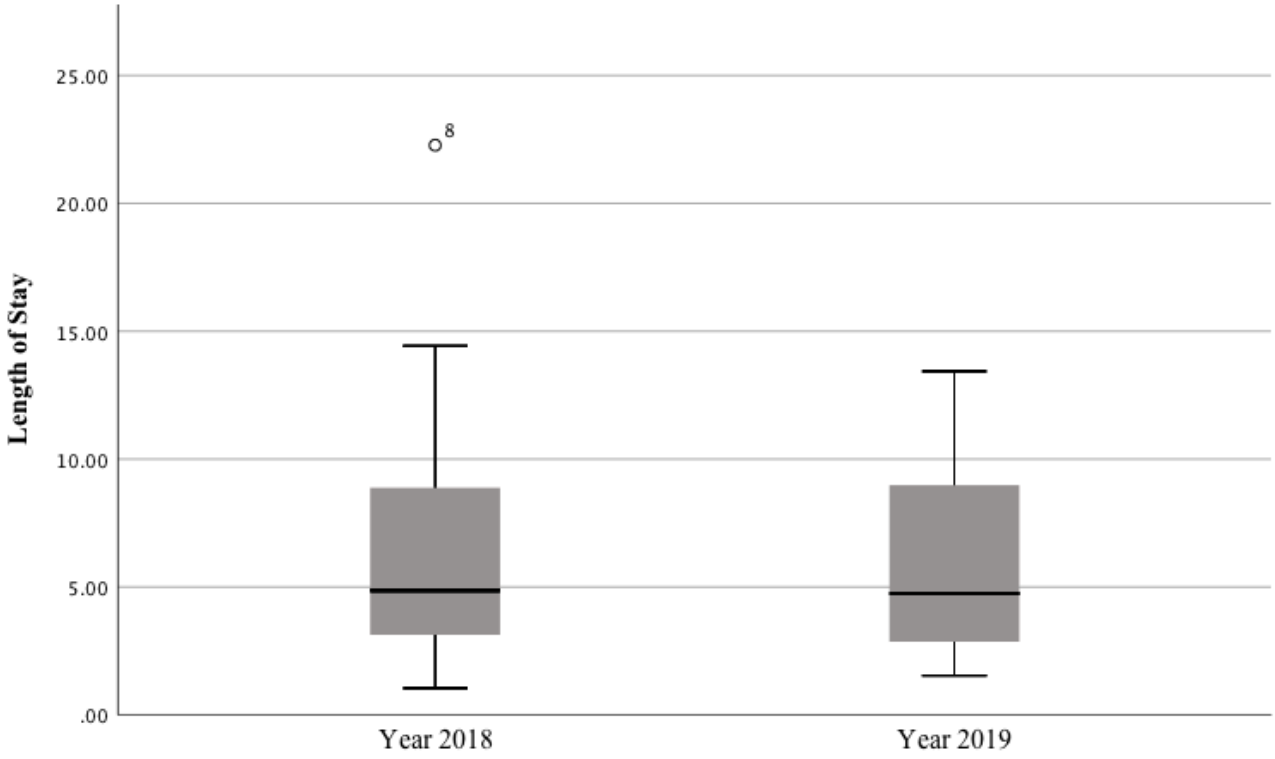

Figure 2. Comparison of the pre-alert group (2018) and the post-alert group (2019) in regard to time to blood cultures from the time of arrival. In the pre-alert group (2018), there is a significant outlier, and the post-alert (2019) group has a decreased range.

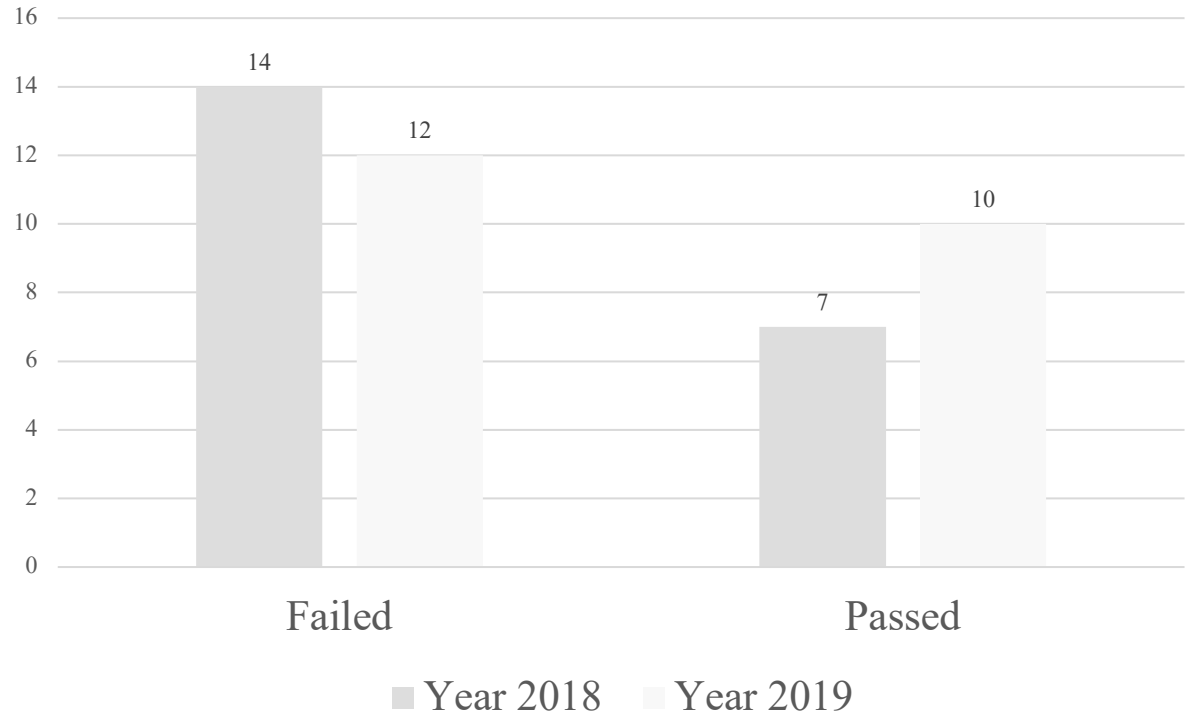

Figure 3. Overall CMS bundle compliance was measured for the pre-alert group (2018) and the post-alert group (2019). The dark gray bar shows the number of patients that met CMS bundle compliance and the light gray bar shows the number of patients that did not meet bundle compliance.