Impact of Emergency Department Triage Sepsis Screening Algorithm and Treatment Order Sets: An Integrative Review

An Integrative Review

Submitted to the

Faculty of Liberty University

In partial fulfillment of

The requirements for the degree

Of Doctor of Nursing Practice

By

Danielle Marie Tester

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Lynchburg, VA

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Scholarly Project Chair Approval:

Dr. Vickie B. Moore, DNP, FNP Date

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Abstract

Sepsis is a life-threatening condition that can lead to tissue damage, end-organ damage, and death if left untreated. The Centers for Disease Control and Prevention defines sepsis as a severe response to an infection. Sepsis is prominent health concerns worldwide, as it continues to be a leading cause of mortality despite having access to health care. This has impelled many health care organizations to improve sepsis-related care and sepsis outcomes by formulating core measures to improve patient care. The purpose of this integrative review is to discuss if initiation of an emergency department triage sepsis screening algorithm and treatment order sets can improve patient outcomes and reduce mortality as well as to determine if early identification of systemic inflammatory response syndrome criteria will improve sepsis mortality. An extensive literature search was completed to find best practice regarding care of sepsis patients. Recommended care included identifying sepsis during triage through use of a screening tool and using standardized treatment order sets for positive triage screening. Use of systemic inflammatory response syndrome criteria also improves sepsis outcomes.

Keywords: sepsis treatment order sets, sepsis alert, sepsis mortality

Dedication

I have been blessed to have the support of so many throughout the completion of my Doctor of Nursing Practice program and integrative review. To my husband, Mike, thank you for loving me and supporting me through all the good and bad times over the last three years; these truly have been some of the most challenging and difficult times of my life. Your love, support, and encouragement made me want to chase my dreams and make them a reality. You have not only helped me through this journey, but you have been my saving grace during my recent cancer diagnosis and treatments. Thank you for working so diligently and effortlessly while picking up some of my responsibilities these last three years. I truly have the most supportive and patient husband and am blessed to be your wife, and Lucy is blessed to have the best daddy.

To my sweet, precious daughter, Lucy, thank you for being such a kind and sweet soul. You have watched me go through this journey and have done so with grace, compassion, and understanding when I had study, go to clinicals, or work on my project. Thank you for being the one constant that shows tremendous amounts of love and laughter.

To my grandma and papa who passed away during this journey, thank you for being two of my biggest supporters. Losing both of you has been one of the most difficult and heartbreaking things I have faced, all while trying to finish school because I knew how proud you would be of me. Papa, I am finally going to be your “Dr. D.”

I would also like to thank my family and friends for being so patient and understanding. Without all the love and support from each and every one of you, I would not have been able to obtain my DNP.

Lastly, I want to thank God for all the blessings He has bestowed upon me. During this time, your grace, mercy, love, compassion, and understanding have been evident and sufficient in my life. “I will give thanks to you, Lord, with all my heart; I will tell of all your wonderful deeds” (Psalm 9:1).

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I would like to acknowledge the Doctor of Nursing Practice faculty for the support and encouragement over these last three years. Liberty University has truly blessed me and exemplifies the body of Christ, and it is evident through their work.

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List of Abbreviations

Centers for Disease Control and Prevention (CDC)

Emergency department (ED)

Intensive care unit (ICU)

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

Systemic Inflammatory Response Syndrome (SIRS)

Sequential Organ Failure Assessment (SOFA)

World Health Organization (WHO)

Impact of Emergency Department Triage Sepsis Screening Algorithm and Treatment Order Sets: An Integrative Review

The Center for Disease Control and Prevention (CDC) defines sepsis as the body's severe response to an infection. Sepsis is a life-threatening condition that can lead to tissue damage, end-organ damage, and death if left untreated (CDC, 2021).

Sepsis is a burdensome illness that affects over 49 million people across the globe every year. It is estimated that over 11 million deaths are directly related to sepsis, and sepsis accounts for over 19% of all deaths worldwide (Jarczak et al., 2021). Mortality rates of sepsis are high, and one in three patients with sepsis in the hospital will die (CDC, 2021). Over half of the patients in the intensive care unit (ICU) will develop nosocomial sepsis, which has an in-hospital mortality rate of over 60% (Chriscaden, 2020). Those at high risk for sepsis include infants, individuals over the age of 65, immunocompromised individuals, and people with chronic medical conditions. Hospitalized at-risk patients have an even greater chance of developing severe sepsis and death (CDC, 2021).

In the United States, over 970,000 patients are admitted to the hospital with sepsis every year, a number that increases by 8.7% every year. Sepsis accounts for over 50% of hospital-related deaths, and mortality increases with the severity of sepsis. Approximately 10%–20% of patients with mild sepsis, 20%–40% of patients with severe sepsis, and 40%–80% of patients with septic shock die (Paoli et al., 2018).

Sepsis-related costs in the US are the highest in hospital-related expenses, with over $24 billion being spent every year for sepsis-related care. Sepsis-related care costs $1,800 per day in the US, while septic shock costs over $3,000 per day (Paoli et al., 2018).

Background

In healthy individuals, the immune system is a protective mechanism that is designed to prevent and fight infection. However, when individuals develop a more severe infection and the immune response fails, sepsis results. Sepsis is a severe, life-threatening condition that is related to a dysregulation of the host response to an infection. If left untreated, the infection cascades into a hyperinflammatory response, leading to immunosuppression, cell death, and end-organ

damage. Sepsis-induced immunosuppression and inflammation lead to uninhibited apoptotic immune cell destruction (Cao et al., 2019).

Immune cell destruction is clinically related to the severity of sepsis, and the aim of treatment is to stop the cell death process by targeting the immunosuppressive response to the infection and invading pathogen. In more severe forms of sepsis, immune cell destruction is significant. Immune cells include neutrophils, monocytes, macrophages, B cells, natural killer cells, and dendritic cells, all of which supply the ability to destroy the immunosuppressive phase of sepsis (Cao et al., 2019).

In 2001, three randomized control trials at large international hospitals did not show a significant difference in sepsis mortality with use of treatment order sets and early-goal directed therapy. However, since the World Health Organization (WHO) and World Health Assembly began recognizing sepsis as a global concern, new stratagems have been adopted to reduce sepsis mortality (Kim & Park, 2019).

Since 1992, the definition of sepsis has changed as new developments have arisen. Initial sepsis identifiers included the systemic inflammatory response syndrome (SIRS) criteria, positive predictors for sepsis. SIRS sepsis criteria include a temperature of > 100.4 or < 96.8 degrees, a heart rate of > 90 beats per minute, a white blood cell count of < 4 or > 12, and a respiratory rate (RR) of > 20 breaths per minute. Patients meeting two or more of these criteria were determined to be septic (Kim & Park, 2019). However, in 2016, the Society of Critical Care Medicine and the European Society of Intensive Care Medicine added end-organ dysfunction as a predictor of sepsis using the Sequential Organ Failure Assessment (SOFA) score. A SOFA score of >2 indicates the patient has end-organ dysfunction. Patients receive one point for each criterion they met, which included a respiratory rate of > 22 breaths/minute, altered mental status, and systolic blood pressure < 100 mm Hg (Prasad et al., 2020). Patients with a score of > 2 on the SOFA are considered to be septic, and patients with a score of > 2 with hypercalcemia and hypotension that require vasopressors and fluid resuscitation are considered to be in septic shock (Kim & Park, 2019).

The use of SOFA criteria has been successful in non-ICU settings, as it is readily available and has reformed how order sets are utilized in the emergency department (ED).

However, some argue that using the SOFA score and SIRS criteria alone for initial triage is sufficient, while others argue the SOFA criteria is sufficient. So, a task force restructured the criteria to develop the qSOFA for sepsis screening. The qSOFA is a combination of the SIRS criteria and SOFA criteria and states that sepsis can be determined if patients meet > 2 SIRS criteria and > 2 SOFA criteria as well as that if end-organ damage is present, then patients are likely in septic shock (Kim & Park, 2019).

Defining Concepts and Variables

The variables essential to this integrative review include defining sepsis and determining if a triage sepsis screening algorithm and treatment order sets can reduce sepsis mortality or the number of patients who present to the ED for initial treatment. Sepsis is defined as a dysregulated host response to an infection and can be life-threatening if not identified early. If sepsis is left untreated, it cascades and leads to cell death and end-organ damage (Cao et al., 2019). Specific diagnostic criteria for sepsis as defined by the WHO include a temperature of > 100.4 or < 96.8, a heart rate of > 90 beats per minute, a white blood cell count of < 4 or > 12, and a respiratory rate of > 20 breaths per minute (Kim & Park, 2019). Patients who present to the ED with the above diagnostic criteria often need immediate life-saving treatment. This review includes a variety of peer-reviewed studies completed in the ED on patients who are diagnosed with sepsis and discusses if using a triage sepsis screening algorithm and treatment order sets can reduce mortality.

Triage sepsis screening algorithms are used during the triage process upon a patient's presentation to the ED. The triage nurse is responsible for determining if there is a suspected infection and uses a nurse-driven screening tool. If infection is suspected and two or more SIRS criteria are met, then the patient has a positive screen for sepsis (Gyang et al., 2015). The triage nurse is then responsible for notifying the ED physician, and a sepsis treatment order set is then initiated. Sepsis treatment order sets are standing orders for patients that are triggered by a positive sepsis screen. The orders include placing the patient on the cardiac monitor, obtaining a blood pressure, respiratory rate, heart rate, and mean arterial pressure every 15 minutes until stable, using continuous pulse oximetry, providing oxygen as needed to maintain oxygen

saturation > 90%, and placing two large bore intravenous lines. Laboratory orders include two site blood cultures, urinalysis, CBC, and lactic acid level (Sepsis Algorithm, 2020).

List of Terms

Blood culture: Serum lab test that helps identify the type of bacteria that is present in the blood stream. Identifying the type of bacteria is imperative to allow the appropriate antibiotics to be administered (Kim & Park, 2019).

Hypotension: Systolic blood pressure < 90 mm Hg or mean arterial pressure < 60 mm Hg (A Train Education, 2020).

Infection: The presence of microorganisms that cause an inflammatory response to help trigger the immune system to fight off the infection (A Train Education, 2020).

Sepsis: An uncontrolled response to harmful bacteria that has manifested in the blood stream. The body then develops an uncontrolled response that leads to further damage, organ failure, shock, and death (A Train Education, 2020).

Septic shock: The presence of severe sepsis with progressive end-organ damage, hypotension with need for vasopressors to keep mean arterial pressure > 65, and a lactic acid level of > 2 (Caraballo & Jaimes, 2019).

Severe sepsis: The presence of an infection with two or more of the following: signs of end-organ damage, hypotension (systolic blood pressure < 90), and a lactic acid level > 4 (A Train Education, 2020).

Systemic inflammatory response syndrome (SIRS): An inflammatory reaction related to a bacterial infection. SIRS will produce two of the following: temperature > 100.4 or < 96.8 degrees, heart rate > 90 beats per minute, white blood cell count < 4 or > 12, and respiratory rate > 20 breaths per minute (Kim & Park, 2019).

Rationale for Conducting the Review

To reduce the morbidity and mortality of sepsis, the WHO and the CDC recommend establishing measures for early identification and treatment of sepsis (Chriscaden, 2020). However, sepsis is difficult to identify in the early stages, often due to patient comorbidities, lack of effective screening tools, and disease severity (McDonald et al., 2018). In 2017, the 70th World Health Assembly adopted a proposal to improve, prevent, diagnose, and manage sepsis.

Through “early diagnosis, timely and appropriate treatment, and effective infection prevention and control measures” (WHO, 2020, p. 5), sepsis mortality can be significantly reduced.

Purpose of the Integrative Review

Early identification and timely treatment are pivotal to reducing the severity, morbidity, and mortality of sepsis. The ED is an obvious setting for the development and implementation of early sepsis identification strategies, as it is a significant entry point for patients who are seeking care for sepsis and sepsis-related complications. The purpose of this integrative review is to discuss if initiation of an ED triage sepsis screening algorithm and treatment order sets can improve patient outcomes and reduce mortality as well as to determine if early identification of SIRS will improve sepsis mortality. One of several studies that has been completed showed that through early identification of sepsis and initiation of sepsis order sets, in-hospital mortality was decreased from 30.3% to 18.0% ($p = 0.054$; Umemura et al., 2022).

Review Question

What is the impact of the initiation of an ED triage sepsis screening algorithm and treatment order set on improving patient outcomes?

Goals

1. Explore the literature for evidence to assess if there is a decrease in time to diagnosis and time to antibiotics by utilizing a sepsis screening algorithm and treatment order set in the ED and determine if mortality is decreased.
2. Investigate if a screening algorithm helps increase the number of blood cultures obtained prior to the initiation of antibiotic administration and the amount of fluid resuscitation.
3. Determine if early identification of SIRS criteria improves sepsis outcomes.

Formulate Inclusion and Exclusion Criteria

Inclusion criteria for this integrative review included articles focused on patients who are of adult age, male and female, presenting in the ED, and meeting sepsis criteria. Keywords searched included *sepsis in the ED, triage sepsis order sets, sepsis algorithms,* and *sepsis mortality in the ED*. Other inclusion criteria include articles published in the English language

and published within the last five years. Exclusion criteria consisted of articles focused on patients under age 18.

Conceptual Framework

An integrative review is a precise method to review the literature and provide an understanding of the proposed health care problem. If the literature review is thorough, it can possibly be used to contribute to practice and policy change (Whittemore & Knafl, 2005).

The conceptual framework that best fits this integrative review was developed by Whittemore and Knafl (2005). This framework provides step-by-step guidance on how to evaluate research. The first step is problem identification. Identifying the health care problem provides a clear understanding of what the review is addressing and what its purpose is. The second step is performing a literature search. The third and fourth steps are to evaluate and analyze data. The fifth and final step is the presentation of the conclusion that was reached from the integrative review (Whittemore & Knafl, 2005). The five steps allow the reviewer to read, evaluate, and critique research to formulate a conclusion related to the identified health care problem. Perspicuous details are included in the review to support the evidence, which allows readers to formulate that the conclusion is appropriate, and the review did not exceed the available evidence (Duquesne University, 2021).

Section Two: Comprehensive and Systematic Search

As an entry point to a majority of patients with sepsis, the ED is vital to reducing the morbidity and mortality of sepsis through rapid identification and initiation of antimicrobial therapy. The first point of contact with patients in the ED is the triage nurse, who plays a fundamental role in the early identification of sepsis criteria (Fargo et al., 2018). Once sepsis criteria have been identified, the standards of care for rapid implementation of treatment should be applied.

Studies show that after triage, if sepsis criteria have been identified, then initiation of a triage sepsis algorithm and treatment order sets can improve patient care outcomes. By utilizing an algorithm and treatment order sets, the time to diagnosis, time to antibiotics, and time to fluid resuscitation can be reduced (Goldszer et al., 2017).

Search Strategy

In order to obtain validated evidence that supports triage algorithms and treatment order sets, a systematic and comprehensive literature review and search was completed. An extensive literature review was conducted using the online Jerry Falwell Library at Liberty University. The library databases used to perform the literature search were: (a) the Cochrane Library, (b) Cumulative Index to Nursing and Allied Health Literature (CINAHL), (c) EBSCO, and (d) PubMed. The keywords used in the search included: *sepsis in the ED, triage sepsis order sets, sepsis algorithms,* and *sepsis mortality in the ED*. Keywords were used separately and in combination to yield appropriate search results. Parameters for the search included studies published within the last five years (2016–2021), peer-reviewed resources, and articles published in the English language. Melnyk's levels of evidence were used to determine the quality of evidence.

Quality Appraisal

After the inclusion and exclusion criteria were determined, the literature was obtained and critically appraised for its applicability to the clinical question. Articles were appraised for their purpose, population sample size, study method, level of evidence, study limitations, and design of the study. Various results were obtained; however, the appraisal process allowed the elimination of irrelevant articles. Melnyk's level of evidence table was used to assess the quality of research (see Appendix A).

The level of evidence table allows literature to be ranked based on its level of evidence. The highest level of evidence is Level I, which consists of meta-analyses and systematic reviews. The lowest level of evidence is Level VII, which consists of expert opinions. Using the highest level of evidence available provides a solid basis for evidence-based practice changes in health care (University of Michigan Library Research Guides, 2021). Of the 12 articles used in this integrative review, 13 of the articles were Level III, and one article was Level II. Most of the articles had a moderate amount of evidence; however, randomized control studies and higher levels of evidence would be difficult to accomplish considering the unethical practices of research on live subjects.

PRISMA

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement was utilized to improve the literature search and ensure the inclusion of appropriate studies to complete this integrative review. The PRISMA consists of a 27-item checklist and four-phase flow diagram. The four-phase flow diagram includes identification, screening, eligibility, and included articles. The PRISMA is used to find evidence-based systematic reviews and meta-analyses to include in the integrative review (PRISMA, 2020). The PRISMA for this integrative review is included in Appendix C.

Synthesis

The review of the evidence available revealed that utilizing an ED triage sepsis screening algorithm and treatment order set can improve patient outcomes. Furthermore, there was a notable decrease in time to diagnosis and time to antibiotics when a triage screening and order set was used, as well as a decrease in the number of patients who received adequate fluid resuscitation. In-hospital mortality was also noted to decrease significantly with the use of a sepsis triage algorithm and treatment order sets.

Summary

The literature review provided solid evidence that use of an ED triage sepsis screening algorithm and treatment order sets does improve patient outcomes and a notable decrease in time to diagnosis and time to antibiotic administration. Furthermore, the review concluded early identification of SIRS criteria could improve outcomes of patients with sepsis.

Section Three: Results

A robust and precise search strategy was used to enhance the study and find all supporting evidence to complete this integrative review, as well as to avoid any bias and inaccurate results. Included in the review were 14 Level III controlled trials and one Level II randomized controlled trial. Once the available material was collected and analyzed, a summary was developed that answered the clinical question.

Thematic Data Evaluation

The impact of the initiation of an ER triage sepsis screening algorithm and treatment order sets on patient outcomes was analyzed in this review. In addition, the goals for this review

were: 1) Assess if there is a decrease in time to diagnosis and time to antibiotics by utilizing a sepsis screening algorithm and treatment order set and determine if mortality is decreased. 2) Investigate if a screening algorithm helps increase the number of blood cultures obtained prior to the initiation of antibiotic administration and the amount of fluid resuscitation. 3) Determine if early identification of SIRS criteria improves sepsis outcomes.

The review of the literature identified three recurring themes: sepsis screening algorithm and treatment order sets, screening and time to antibiotics and fluid retention, and improved patient care outcomes.

Sepsis Screening Algorithm and Treatment Order Sets

Sepsis is the sixth leading cause of death in hospitalized patients, and those diagnosed with sepsis have a mortality rate of over 30%. Early identification of sepsis is key to decreasing morbidity and mortality. Several studies reviewed indicated that sepsis screening algorithms and treatment order sets were beneficial when evaluating patients for sepsis in the ED (Goldszer et al., 2017; Gyang et al., 2015; Rajan & Rodzevik, 2021).

Gyang et al. (2015) suggested that a simple screening tool be devised explicitly for identifying sepsis, as prompt identification is crucial to patient survival. A study showed that out of 54 patients who presented with infection, only 32 were identified as being septic. Most often missed reasons included lack of blood pressure documentation or a higher than expected blood pressure ($p < 0.05$), suggesting additional measures like a triage screening algorithm would be beneficial (Morr et al., 2017). Evidence also indicates those who are diagnosed with severe sepsis in a non-ICU setting are twice as likely to die when compared to those identified as having sepsis in the ED, suggesting the use of sepsis screening tools is valuable in non-ICU settings, the ED, and the ICU (Gyang et al., 2015).

A retrospective chart review completed by Goldszer et al. (2017) indicated that the use of sepsis order sets improves morbidity and mortality as well as decreases the length of hospital stays. Additionally, the review demonstrated that patient mortality decreased from 25% to 19.4% ($p = .005$) with the use of sepsis order sets. The use of order set mortality rate was 11.57%, and the mortality rate without the use of order sets was 18.19% ($p = 0.015$). The average patient length of stay decreased by 1.63% with use of order sets (Goldszer et al., 2017).

An additional study (Shimabukuro et al., 2017) demonstrated the use of treatment order sets resulted in a statically significant decrease in mortality, which resulted in the length of stay declining by 2.7 days compared to lack of use of order sets. The 2.7-day reduction was statically significant with a confidence interval of 95%. Furthermore, in-hospital mortality decreased by 12.4% for those with whom treatment order sets were used, suggesting algorithms lead to improved patient outcomes (Shimabukuro et al., 2017). Moreover, education regarding sepsis screening order sets and triage screening should also be employed, as a retrospective chart review suggested the mean time to identify sepsis was decreased by 33 minutes through the use of order sets and triage screening (Rajan & Rodzevik, 2021).

To continue to keep sepsis mortality at a minimum, it is imperative that education be implemented (Society of Critical Care Medicine, 2021). Nurse leaders must provide continuing education regarding sepsis through the assistance of the Surviving Sepsis Campaign. The Surviving Sepsis Campaign provides a set of global sepsis guidelines that can be used to improve care of sepsis patients.

Screening and Time to Antibiotics and Fluid Resuscitation

Several studies suggest that screening and treatment order sets decrease the time to antibiotics and fluid resuscitation. Umemura et al. (2022) suggested that adherence to treatment order sets significantly decreases hospital mortality among patients who are identified as being septic. The hospital mortality rate of patients whose providers adhered to the order sets in this study decreased from 30.3% to 18.0% ($p = 0.054$). The researchers concluded that not obtaining blood cultures and delaying fluid resuscitation and antibiotic administration increased mortality significantly (Umemura et al., 2022). Utilizing the Surviving Sepsis Campaign guidelines for using treatment order sets decreases the time to sepsis identification, thus decreasing the time to antibiotics and fluid resuscitation as well as reducing in-hospital mortality (Umemura et al., 2022).

Another study completed by Bader et al. (2020) demonstrated that the initiation of antimicrobial therapy as soon as sepsis is identified increases survival rates of hospitalized patients. In this study, patients who presented to the ED were triaged using the SOFA guidelines, and if sepsis was identified, the treatment order set was initiated. After staff were educated

regarding the importance of time to antibiotics, the postintervention group demonstrated a statically significant difference in time to antibiotics and fluid administration. Over 89% of the postintervention group received antibiotics within one hour of sepsis identification. The time to initial antibiotics and fluid administration decreased from 95 minutes to 45 minutes, and in-hospital mortality decreased by 11.7% after the sepsis protocol was employed (Bader et al., 2020).

An additional study completed by Kim and Park (2019) determined that suspicion of sepsis in any patient should be treated as a medical emergency, because the earlier sepsis can be identified, the more the patient's probability of survival increases. Applying order sets and sepsis protocol to patients who have sepsis can reduce the likelihood of multi-organ failure and in-hospital mortality. Further, the application of treatment order sets can decrease the time to antibiotics and fluid administration.

Another study demonstrated the importance of time to antibiotics and fluid resuscitation once sepsis is identified. The mean time to antibiotics was 60 minutes ($p = 0.003$). The portion of septic patients receiving fluid resuscitation improved from 67.4% to 94.4% ($p = 0.001$). Following hospital admission in this study, the ICU length of stay decreased from average of five days to two days (McDonald et al., 2018).

Finally, Prasad et al. (2020) identified severe sepsis as life-threatening organ dysfunction through use of the SIRS criteria. After a retrospective chart review, it was determined that with the use of sepsis alerts and treatment order sets, sepsis can be identified early so antibiotics can be initiated in a timely manner. However, a delay in antibiotic administration of even one hour increases the mortality rate by 0.35%–1.8% (Prasad et al., 2020).

Improved Patient Care Outcomes

Sepsis can be difficult to recognize; however, by identifying sepsis early, in-hospital mortality can be significantly reduced. By improving patient care outcomes through the use of treatment order sets and early goal-directed therapy, the morbidity and mortality caused by sepsis can be even further reduced (Gatewood et al., 2015). Additionally, early goal-directed therapy, including improved time to antibiotics and fluid resuscitation, can even further reduce sepsis-related mortality and improve patient care outcomes (Hayden et al., 2016). For each hour delay

in identifying sepsis, mortality increases significantly. By utilizing the Surviving Sepsis Campaign guidelines, patient care outcomes can be improved, and patient mortality can be further reduced (Fargo et al., 2018).

Conducting randomized control trials to investigate patient care outcomes is controversial. However, a retrospective chart review identified improved patient care outcomes through the use of evidence-based care treatment order sets. By identifying sepsis early, there was a 14.1% reduction in mortality for patients with septic shock, a 24.9% reduction in patient mortality for patients whose providers used an order set, and a 4% reduction in length of stay for ICU patients when severe sepsis was identified in the ED (Health Catalyst, 2018).

Synthesis of Results

The literature reviewed demonstrated that the initiation of an ED triage sepsis screening algorithm and treatment order sets improve patient outcomes significantly, especially when blood cultures, fluid resuscitation, and antibiotic administration is completed in a timely manner. One study did not demonstrate a significant improvement for patients who received early administration of antibiotics when compared to patients who had delayed administration; however, the author noted the study was limited due to a small sample size and suggested that additional studies were needed before a valid conclusion could be made (Althunayyan et al., 2021)

Ethical Considerations

This project is an integrative review and does not involve human subjects or research. Additionally, no identifying personal information was collected or used. The integrative review complies with the standards of Liberty University's Institutional Review Board. A copy of the Institutional Review Board approval and Collaborative Institutional Training Initiative certificate are provided in Appendices B and C for review.

Timeline

This integrative review was completed according to the timeline below:

- Section One: November 8, 2021
- Section Two: November 20, 2022
- Section Three: March 8, 2022

- Section Four: April 10, 2022
- First defense: April 20, 2022
- Final draft: June 28, 2022
- Submission to chair: June 28, 2022
- Final draft sent to editor: July 9, 2022
- Final defense: July 25, 2022

Section Four: Discussion

Summary of Evidence

The literature review and information obtained for this integrative review revealed that there was a decrease in time to diagnosis and time to antibiotics when using a sepsis screening algorithm and treatment order set in the ED, resulting in improved patient care outcomes. Additionally, the literature reviewed demonstrated that improved time to antibiotics and fluid administration did in fact decrease patient mortality and morbidity the Surviving Sepsis Campaign evidence-based practice guidelines were followed, and SIRS criteria were used when sepsis was identified. There is a continued need for studies on how treatment order sets and algorithms can continue to decrease morbidity and mortality. Increasing awareness of, education on, and use of these standards of care will only continue to improve patient care outcomes, as will adherence to evidence-based practice guidelines.

The overall literature review meets the criteria for Level III evidence on the Melnyk pyramid. It would be difficult to obtain a higher level of evidence, as randomized control trials for septic patients would be controversial and unethical. Although sepsis can be difficult to identify, it is imperative that screening tools be utilized to help decrease delay in identification of sepsis. However, many of the studies provided evidence of improved patient care outcomes related to the use of treatment order sets and algorithms as well as decreased time to antibiotics and fluid administration. Using such methods can decrease sepsis mortality by 14.1% (Health Catalyst, 2018).

The goals of this integrative review were as follows. First, this integrative review sought to determine if there is a decrease in time to diagnosis and time to antibiotics when a sepsis

screening algorithm and treatment order sets are utilized in the ED to determine if mortality is decreased. A second goal of this review was to determine if screening algorithms help increase the number of blood cultures obtained prior to the initiation of antibiotic administration and fluid resuscitation. Finally, this integrative review sought to determine if use of SIRS criteria improves sepsis outcomes. Utilizing a sepsis screening algorithm and treatment order sets reduced in-hospital mortality by 12.4%, suggesting screening algorithms and treatment order sets are valuable (Shimabukuro et al., 2017). Obtaining blood cultures prior to antibiotic administration is important to complete, as a delay of only one hour can increase mortality by up to 1.8% (Prasad et al., 2020). The goals of this integrative review were met, and the use of a sepsis screening algorithm and treatment order sets were shown to improve patient care outcomes and decrease mortality.

Implications for Practice/Future Research

The goal of this integrative review was to provide solid evidence regarding sepsis to help educate and assist providers and nurses in identifying sepsis. Current standards of practice advise using sepsis treatment order sets and algorithms in EDs. Following order sets and using algorithms can drastically improve sepsis care. Current standards in EDs often include a triage screening algorithm; however, treatment order sets are not always used. By making treatment order sets a standard of care, improvements in patient care can be seen.

By following the Surviving Sepsis Campaign evidence-based practice recommendations, providers can continue to achieve improved patient care outcomes. As more information becomes available and more studies are completed, it will become more evident that early identification is a crucial step in improving patient care outcomes. Future studies may find improved statistics regarding morbidity and mortality of sepsis in the ED as well as determine the best plan of care.

Limitations

This integrative review had limitations. The initial literature search resulted in a broad range of results. To minimize articles that were irrelevant to this review, keywords were used in the search criteria. To further enhance the number of relevant articles, inclusion and exclusion criteria were set.

Lastly, 12 articles were used in this integrative review that were published within the last five years, narrowing the search criteria. Several articles were at risk for bias, as they were completed within one health care organization using a small sample size.

Dissemination

The purpose of this integrative review was to evaluate whether treatment order sets and decreased time to antibiotics and fluid resuscitation improved outcomes for septic patients if utilized in the ED. The findings will assist and encourage providers in conducting their own research regarding sepsis-related care in the ED. The author plans on disseminating results to providers and nurses in the ED through a poster presentation.

Summary

With over 970,000 patients admitted to hospitals for sepsis each year, it is important to identify sepsis as soon as possible. Sepsis continues to be a significant cause of mortality in hospitalized patients. Over 50% of hospital-related deaths are related to sepsis, and 40%–80% of patients with septic shock will die (Paoli et al., 2018). However, by identifying sepsis early using treatment order sets and initiating care early, sepsis mortality can be reduced by 14.1% (Health Catalyst, 2018). These findings answer the review question by showing that use of treatment order sets and a screening algorithm decreases mortality as well as the time to antibiotic and fluid administration.

Findings from this integrative review determined that using treatment order sets and algorithms allows for decreased mortality from sepsis as well as decreases the time to diagnosis and time to antibiotic and fluid administration once sepsis is identified. Thus, using treatment order sets and algorithms should be a standard of care in EDs.

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Appendix A

Evidence Table

Name: Danielle Tester

Clinical Question: Does the use of a triage sepsis screening algorithm and treatment order set improve patient care outcomes?

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
Althunayyan, S. M., Aljanoubi, M. A., Alghadeer, S. M., Alharthi, M. Z., Alotaibi, R. N., Mubarak, A. M., & Almutary, A. M. (2021). The impact of emergency antibiotic administration time on patients with sepsis. *Saudi Medial Journal*, *42*(9), 1002–1008. https://doi.org/10.15537/smj.2021.42.9.20210447	Assess the mortality of timely antibiotic treatment of adults who present to the emergency department with sepsis and compare the one-hour and three-hour administration of antibiotics.	*N* = 495	Retrospective chart review	Overall, in-hospital mortality was 31.8%. Early antibiotic mortality was 31.6% while immediate antibiotic administration was 33.3%. *p* value 0.823	Level III	Small sample size. Findings not statistically significant. Single center study with small participant size and only one comparison group. Retrospective chart review limited due to documentation and the ability to miss some	No. Small sample size. More information needed to make a definitive conclusion.

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
						important information.	
Bader, M. Z., Obaid, A. T., Al-Khateb, H. M., Eldos, Y. T., & Elaya, M. M. (2020). Developing adult sepsis protocol to reduce the time to initial antibiotic dose and improve outcomes among patients with cancer in the emergency department. *Asia-Pacific Journal of Oncology Nursing*, *7*(4), 355–360. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7529030/	Develop a sepsis protocol for adult oncology patients to decrease the time needed to receive the initial dose of antibiotics in and ED, improve early recognition of sepsis, and decrease in-hospital mortality	*N* = 168	Retrospective chart review	Initial antibiotic dose decreased from 95 minutes to 45 minutes. Decrease in hospital mortality by 11.7%.	Level III	Retrospective chart review. Small sample size.	Yes, although a small sample size was used there was a significant decrease in times to antibiotics and mortality.
Fargo, E. L., D'Amico, F., Pickering, A., Fowler, K., Campbell, R., & Baumgartner, M. (2018). Impact of electronic physician order-set on antibiotic	Determine if the use of order-sets used by physicians in the ED will decrease time to antibiotics for sepsis patients.	*N* = 123	Retrospective chart review	Antibiotic administration time decreased by 20 minutes (99% CI); however, was not	Level III	Small sample size. Findings not statistically significant.	Antibiotic administration times decreased; however, findings were not statistically

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
ordering time in septic patients in the emergency department. *Applied Clinical Informatics*, *9*(4), 869–874. https://doi.org/10.1055/s-0038-1676040				statistically significant. $p > 0.05$			significant. Electronic order-sets prove to be effective; however, stronger sample sizes are needed to be conclusive.
Goldszer, R. C., Ratzan, K., Csete, M., Nanes, N., Love, C., Cubeddu, L. X., Farcy, D., Shrestha, A., & Gillette, T. (2017). Impact of order set use on outcome of patients with sepsis. *Applied Informatics*, *4,* Article 2. https://doi.org/10.1186/s40535-016-0033-y	Identifying the impact of computerized physician order entry for patients with sepsis and using best practice alerts to remind physicians to use order-sets.	$n = 183$ ED $n = 592$ Inpatient	Retrospective chart review	Patient mortality decreased from 25% to 19.4% ($p = 0.005$). Use of order-set mortality was 11.57%. No use of order-set mortality was 18.19% ($p = 0.015$). Length of stay decreased by 1.63% with use of order-	Level III	Small sample size with chart review for data collection.	Yes. This study provided improved mortality rates and decreased length of stay for identified sepsis patients. Recommendations to use sepsis order sets will improve mortality and morbidity as well as

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
				sets			decrease length of stay.
Gyang, E., Shieh, L., Forsey, L., & Maggio, P. (2015). A nurse-driven screening tool for the early identification of sepsis in an intermediate care setting. *Journal of Hospital Medicine*, *10*(2), 97–103. https://pubmed.ncbi.nlm.nih.gov/25425449/	Evaluate a pilot study to determine if a nurse driven screening tool can help identify sepsis early in an intermediate care unit setting.	*N* = 245	Pilot study Retrospective chart review	A simple screening tool by nurses can be useful in identifying sepsis in medical and surgical patients	Level III	Pilot study Small sample size Retrospective review	Additional information would be needed to formulate a conclusion. However, they did show a positive correlation between a nurse driven screening tool and early identification of sepsis.
Hayden, G. E., Turri, R. E., Scott, R., Losek, J. D., Blackshaw, A. M., Schoenling, A. J., Nietert, P. J., & Hall, G. A. (2016). Triage sepsis alert and sepsis protocol lower times to fluids and antibiotics in the ED.	Measure effect of sepsis workup and treatment protocol (SWAT) for a triage-based sepsis alert system in the ED.	*N* = 130 Urban ED with annual census 48,000	Retrospective quasi experimental study	Door to antibiotic time was 67.8 minutes less in post-SWAT groups. Time to initial fluid bolus decreased in post-SWAT	Level III	Small study sample. Study was retrospective and was used at a single organization. The post-SWAT groups were more severely	While the validity was questioned, the information showed improvement and would support change in practice by

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
The American Journal of Emergency Medicine, *34*(1), 1–9. https://doi.org/10.1016/j.ajem.2015.08.039				groups by 59 minutes. 27% increase in lactates being completed 95% CI $p < 0.01$ No significant change in mortality rates.		ill resulting in questionable validity.	utilizing a triage sepsis alert and order-sets; however, a larger sample size and inclusion and exclusion criteria should be established before the study begins to avoid selection bias and validity of the study.
McDonald, C., West, S., Dushenski, D., Lapinsky, S. E., Soong, C., Broek, K., Ashby, M., Wilde-Friel, G., Kan, C., Mcintyre, M., & Morris, A. (2018). Sepsis now a priority: A quality improvement initiative for early	Develop a triage-based screening algorithm and treatment order-set to improve care for patients presenting in the ED.	$N = 346$ preintervention and 270 patients' post-intervention. Large teaching hospital with 35-	Retrospective cohort study	Time to antibiotic time decreased by 60 minutes ($p = 0.003$). Patients receiving fluid resuscitation increased by 30% ($p = <$	Level III	No significant difference in number of admitted patients to the ICU. No significant difference in blood culture positivity. ICD codes used to select	Yes. This can be used to support practice change. A triage based sepsis screening tool and order-sets can expedite care and improve

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
sepsis recognition and care. *International Journal for Quality in Health Care*, *30*(10), 802–809. https://doi.org/10.1093/intqhc/mzy121		bed ED.		0.001). Median ICU length of stay decreased by two days (p = 0.04)		criteria which may have omitted sepsis cases. Sepsis order-sets were not discontinued for patients who did not meet final criteria.	outcomes in patients presenting with sepsis.
Morr, M., Alexander, L., Rubig, R., Pavenstadt, H., & Kumpers, P. (2017). Sepsis recognition in the emergency department – Impact on quality of care and outcome? *BMC Emergency Medicine*, *17,* Article 11. https://doi.org/10.1186/s12873-017-0122-9	To identify sepsis patients early to establish goal-directed therapy bundles.	N = 487 University hospital over a four-week period.	Retrospective cohort study	Of 487,110 patients presented because of infection. 54 matched sepsis criteria. Sepsis was not identified in 32 of 54 cases. Lack of blood pressure documentation and higher than suspected blood	Level III	Small single study that was completed in retrospect. Unable to determine misrecognition vs. misdocumentation.	No. Recognition of sepsis in the ED did not have a direct impact on initial treatment.

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
				pressure caused missed sepsis ($p <$ 0.05).			
Prasad, P. A., Fang, M. C., Abe-Jones, Y., Calfee, C. S., Matthay, M. A., & Kangelaris, K. N. (2020). Time to recognition of sepsis in the emergency department using electronic health record data: A comparative analysis of systemic inflammatory response syndrome, sequential organ failure assessment, and quick sequential organ failure assessment. *Critical Care Medicine*, *48*(2), 200–209. https://doi.org/10.1097/CCM.0000000000004132	Improve sepsis outcomes by early identification of SIRS	*N* = 16,612 9,087 met SIRS criteria	Retrospective, observational study	Using SIRS criteria helped identify sepsis earlier in over 50% of patients using the electronic health record. However, a combination of SIRS and Sequential Organ Failure Assessment together will even further enhance sepsis identification	Level III	Single retrospective study: however, it includes a large and diverse population. Information relies on HER timestamped data and can affect validity.	Yes. Study was completed over several years and had a diverse population. SIRS was shown to provide the earliest indicators of sepsis (57.4%) for patients presenting to ED. Additional research is needed but it can be used to further develop research.

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
Rajan, J. J., & Rodzevik, T. (2021). Sepsis awareness to enhance early identification of sepsis in emergency departments. *The Journal of Continuing Education in Nursing*, *52*(1), 39–42. https://doi.org/10.3928/00220124-20201215-10	Early identification of sepsis is challenging. Identifying the gaps in policies and identification is needed to provide structure and early interventions.	*N* = 22 Full-time ED nurses. 11 nurses attending the staff educational sessions. 11 nurses who did not attend were identified as the control group	Quantitative descriptive design	Educational opportunities decreased sepsis identification by 33 minutes.	Level III	Data collection was limited over two months in a single department with a small sample size.	Yes. Why this information may not be enough to change practice, it is relative for nurse educators and leaders to notice the benefit of early sepsis identification.
Shimabukuro, D. W., Barton, C. W., Feldman, M. D., Mataraso, S. J., & Das, R. (2017). Effect of a machine learning-based severe sepsis prediction algorithm on patient survival and hospital length of	Evaluate the primary outcome and average length of stay and in-hospital mortality for septic patients using a severe sepsis	*N* = 142 75 control group 67 experimental group	Randomized clinical trial in two med/surg ICUs.	Average length of stay decreased from 13 days to 10.3 days in the control group (p = 0.042). In-hospital mortality	Level II	Single center randomized control trial. Fairly diverse population: however, patients had similar demographics and	No. The information was beneficial to determine outcomes; however, further studies would need to be completed in the ED to

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
stay: A randomised clinical trial. *BMJ Open Respiratory Research*, *4*(1), Article e000234. https://doi.org/10.1136/bmjresp-2017-000234	algorithm.			decreased by 12.4% (p= 0.018). No adverse events were reported.		comorbidities . Algorithm was used in the ICU and may differ in the ED with different outcomes. Small sample size.	determine validity.
Umemura, Y., Abe, T., Ogura, H., Fujishima, S., Kushimoto, S., Shiraishi, A., Saitoh, D., Mayumi, T., Otomo, Y., Hifumi, T., Hagiwara, A., Takuma, K., Yamakawa, K., Shiino, Y., Nakada, T., Tarui, T., Okamoto, K., Kotani, J., Sakomoto, Y., . . . Gando, S. (2022). Hour-1 bundle adherence was associated with	Evaluate the impact of hour-1 bundle completion on clinical outcomes in sepsis patients	*N* = 178	Retrospective, observational cohort study	Of those who received bundle adherent care mortality decreased from 30.3% to 18.0% compared to those who did not receive bundle adherent care. Non-adhering to collection of blood cultures and administering	Level III	Single retrospective study, mortality was estimated using multivariable logistic regression analysis.	Yes. Although the study was small, the in-hospital mortality was associated with a decrease when using sepsis algorithms and bundle care. criteria for sepsis.

Article	Study Purpose	Sample	Methods	Study Results	Level of Evidence	Study Limitations	Would Use as Evidence to Support a Change
reduction of in-hospital mortality among patients with sepsis in Japan. *PLOS One*, *17*(2), 1–12. https://doi.org/10.1371/journal.pone.0263936				broad-spectrum antibiotics within one hour also was related to higher in-hospital mortality			

Appendix B

Collaborative Institutional Training Initiative Training Certification

CITI PROGRAM

Completion Date 09-Jan-2022
Expiration Date 08-Jan-2025
Record ID 46472640

This is to certify that:

Danielle Tester

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Biomedical Research - Basic/Refresher
(Curriculum Group)
Biomedical & Health Science Researchers
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

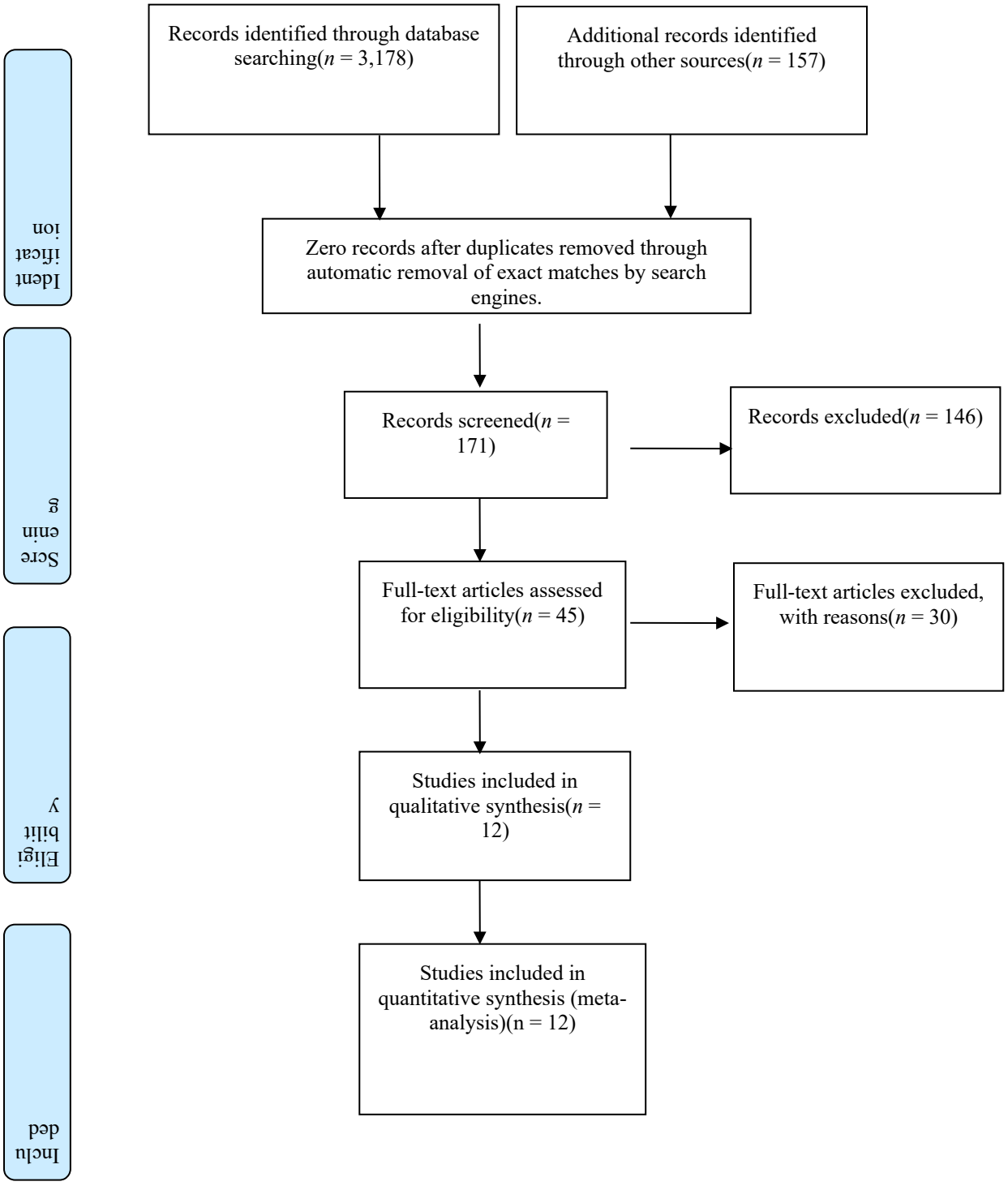
Liberty University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wdcdcb874-128f-4410-8891-5af1b4167473-46472640

Appendix C

PRISMA Diagram



Appendix D

Institutional Review Board Approval Letter

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

May 23, 2022

Danielle Tester
Vickie Moore

Re: IRB Application - IRB-FY21-22-974 Impact of Emergency Department Triage Sepsis Screening Algorithm and Treatment Order Sets: An Integrative Review

Dear Danielle Tester and Vickie Moore,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your project with the data safeguarding methods mentioned in your IRB application.

Decision: No Human Subjects Research

Explanation: Your study is not considered human subjects research for the following reason:

It will not involve the collection of identifiable, private information from or about living individuals (45 CFR 46.102).

Please note that this decision only applies to your current application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued non-human subjects research status. You may report these changes by completing a modification submission through your Cayuse IRB account.

Also, although you are welcome to use our recruitment and consent templates, you are not required to do so. **If you choose to use our documents, please replace the word *research* with the word *project* throughout both documents.**

If you have any questions about this determination or need assistance in determining whether possible modifications to your protocol would change your application's status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office