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# Nursing Perspectives and Opinions on Early or Delayed Sepsis Treatment: A Mixed Methods Approach

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## Abstract

Purpose. Each year at least 1.7 million adults in America develop sepsis. Sepsis can lead to life threatening organ dysfunction, severe hypotension, and death when severe sepsis or septic shock is involved. Sepsis is responsible for 50% of acute kidney injury (AKI), which is the most common form of organ dysfunction seen in critical care. Sepsis associated AKI results in loss of, or decreased renal function, is associated with adverse long-term outcomes, and carries a higher mortality rate than non-septic AKI, sepsis without AKI, or septic shock without AKI. Surviving sepsis guidelines suggests a 1-hour window from the time of sepsis diagnosis to initiating critical treatments. Nurses are vital in identifying early signs and symptoms of sepsis. Early sepsis treatment is essential to hinder preventable sepsis deaths. The purpose of this study was to gauge how critical care nurses who work in ED and ICU perceive factors that might affect early or delayed sepsis treatment. Methods. An exploratory sequential mixed methods approach was performed to describe the study findings. Qualitative data was collected and analyzed from 14 nurses, whereby themes were extracted and explained using a phenomenological method. Descriptive statistics were used to analyze the results of a self-completed survey for the quantitative portion of the study. Surveys were given out to and collected from 100 nurses. The quantitative data was utilized to strengthen the themes of the qualitative themes. Results. Themes from the quantitative study corroborated qualitative findings. Study participants ranked poor communication and coordination of care, knowledge deficit regarding appropriate management, and lab delays as the 1st, 2nd, and 3rd greatest cause of delays in sepsis treatment, respectively. Although self-knowledge of sepsis identification was high among participants, sepsis management was more difficult. Conclusion. Sepsis bundles assist nurses in facilitating early sepsis treatment. Edu- cation programs dedicated to ED and ICU nurses are needed. Yearly continuing education programs focusing on sepsis management should be implemented to keep nurses well informed on sepsis identification and management.



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This work is dedicated to my loving mother, Fannie Brown, who has shown grace and strength throughout my life. Her support has been beyond measure. To my wonderful father, James K. Brown, who guided my spiritual growth and who showed me what family is meant to be. Your memory will live in my heart forever. To my loving and adoring husband Lamar, who has always supported me in whatever journey has come my way. Thank you. To my family, my biggest cheerleaders, Thank You for your support, not just support for this educational journal but thank you for your support throughout life. I love you all.To Nurses and doctors everywhere, your empathy and passion to provide care for fellow human beings goes above and beyond any level of dedication. COVID taught us that. Your drive and commitment to service is immeasurable. Thank you!

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# Abstract

Pamela L. Harris

*Nursing Perspectives and Opinions on Early or Delayed Sepsis Treatment: A Mixed Methods Approach*

**Purpose.** Each year at least 1.7 million adults in America develop sepsis. Sepsis can lead to life threatening organ dysfunction, severe hypotension, and death when severe sepsis or septic shock is involved. Sepsis is responsible for 50% of acute kidney injury (AKI), which is the most common form of organ dysfunction seen in critical care. Sepsis associated AKI results in loss of, or decreased renal function, is associated with adverse long-term outcomes, and carries a higher mortality rate than non-septic AKI, sepsis without AKI, or septic shock without AKI. Surviving sepsis guidelines suggests a 1-hour window from the time of sepsis diagnosis to initiating critical treatments. Nurses are vital in identifying early signs and symptoms of sepsis. Early sepsis treatment is essential to hinder preventable sepsis deaths. The purpose of this study was to gauge how critical care nurses who work in ED and ICU perceive factors that might affect early or delayed sepsis treatment.

**Methods.** An exploratory sequential mixed methods approach was performed to describe the study findings. Qualitative data was collected and analyzed from 14 nurses, whereby themes were extracted and explained using a phenomenological method. Descriptive statistics were used to analyze the results of a self-completed survey for the quantitative portion of the study. Surveys were given out to and collected from 100 nurses. The quantitative data was utilized to strengthen the themes of the qualitative themes.

**Results.** Themes from the quantitative study corroborated qualitative findings. Study participants ranked poor communication and coordination of care, knowledge deficit regarding appropriate management, and lab delays as the 1st, 2nd, and 3rd greatest cause of delays in sepsis treatment, respectively. Although self-knowledge of sepsis identification was high among participants, sepsis management was more difficult.

**Conclusion.** Sepsis bundles assist nurses in facilitating early sepsis treatment. Education programs dedicated to ED and ICU nurses are needed. Yearly continuing education programs focusing on sepsis management should be implemented to keep nurses well informed on sepsis identification and management.

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# List of Abbreviations

| | |
|---|---|
| AKI | Acute Kidney Injury |
| APACHE II | Acute Physiology and Chronic Health Evaluation |
| CKD | Chronic Kidney Disease |
| COPD | Chronic Obstructive Pulmonary Disease |
| DNP | Doctorate in Nursing Practice |
| ED | Emergency Department |
| ESRD | End Stage Renal Disease |
| GFR | Glomerular Filtration Rate |
| ICU | Intensive Care Unit |
| KDIGO | Kidney Disease: Improving Global Outcomes |
| MEWS | Modified Early Warning Score |
| MSN | Master of Science in Nursing |
| NEWS | National Early Warning Score |
| QUAL | Qualitative |
| QUAN | Quantitative |
| RRT | Renal Replacement Therapy |
| SIRS | Systemic Inflammatory Response Syndrome |
| SOFA | Sequential Organ Failure Assessment Score |
| SSC | Surviving Sepsis Campaign |

# Chapter 1

# Introduction

## 1.1 Overview

According to the Centers for Disease Control and Prevention (CDC), each year at least 1.7 million adults in America develop sepsis. Nearly 270,000 Americans die as a result of sepsis and one in 3 patients who die in a hospital have sepsis (CDC, 2021). Sepsis is the 5th leading cause of death in the United Sates and a major cause of death worldwide (CDC, 2021). The elderly is affected by sepsis more than any other segment of society however, neonates, patients with significant co-morbidities, and those with immunocompromise are also affected by sepsis and commonly experience worse outcomes compared to other groups. Importantly, sepsis impacts African Americans disproportionately more than other races, with males more commonly affected than females (Esper et al., 2006; Jones et al., 2017).

Despite sepsis being a major cause of death, few people in the general public are aware of this disease state (Bellomo et al., 2017). If patients survive sepsis associated AKI, they can have a full recovery, or face health challenges including chronic kidney disease (CKD) or end stage renal disease (ESRD). There is growing realization that patients who survive sepsis frequently have long-term physical, psychological, and cognitive disabilities with substantial healthcare and social consequences (Ghimire et al., 2014), with most sepsis survivors suffering from extensive physical and psycho-social dysfunction as well as a lower health-associated quality of life (Schmidt et al., 2014). The long-term effects of sepsis associated AKI significantly increase the cost of healthcare while placing undue burden on patients and their caregivers.

AKI is a syndrome that affects many people globally. It has risen in incidence and causes increased morbidity and mortality worldwide. This syndrome does not discriminate when it comes to socioeconomic status and seems to affect the rich and poor at similar rates (Selby et al., 2016). Selby et al., 2016 also assert that AKI globally affects 13 million people per year. AKI is responsible for approximately 2 million deaths per year worldwide and survivors of AKI have a higher risk of progressing to CKD and ESRD (Chawla et al., 2017). AKI is more likely to be seen in the elderly and those with comorbidities (Chawla et al.,

2017). At least $5 billion in hospital expenses are associated with AKI in the United States (Silver & Chertow, 2017). Sepsis patients who already suffer from CKD may have a more complicated medical course when AKI presents itself.

The Surviving Sepsis Campaign (SSC) is the leading provider of guidelines in treating sepsis (Barrier, 2018). It is a joint initiative led by multidisciplinary, international experts dedicated to improving time to recognition and treatment of sepsis and septic shock (Barrier, 2018). Within these guidelines, providers have a 1-hour window from the time of sepsis diagnosis to initiating critical treatments. These treatments include collecting lactate levels and blood cultures, administering antimicrobials, rapid administration of crystalloid for hypotension or lactate level $\geq$ 4 millimoles per liter, and delivering vasopressors if the patient is hypotensive during or after fluid resuscitation to maintain mean arterial pressure $\geq$ 65 millimeters of mercury (Barrier, 2018). SSC bundle compliance is associated with a 25% reduction in the risk of death and overall cost. However, compliance can be difficult because it is challenging to identify sepsis (McVeigh, 2020). The Survive Sepsis organization is another provider of sepsis guidelines. It produced the Sepsis Six guidelines, which includes those recommendations used in the SSC in addition to high-flow oxygen and urine output measurement (Breen & Rees, 2018).

Early recognition of signs and symptoms of sepsis is extremely important in preserving organ function as well as preserving life. When antibiotics and fluid resuscitation are not implemented early, death rates rise by 7.6% for every hour that passes in the presence of septic shock (Borrelli et al., 2019). Health care facilities have implemented various types of sepsis alert systems to support early sepsis recognition. These sepsis alert systems facilitate early sepsis treatment.

Although there have been advances in medical technologies and medical treatments, AKI has continued to rise in incidence, especially in the presence of sepsis and has led to adverse renal outcomes. When patients present to a critical care unit (i.e., emergency department or intensive care unit), nurses play a major role in getting treatment started to preserve kidney function. They are in key positions to recognize signs and symptoms of sepsis. Nurses are on the front line in identifying signs of sepsis. The importance of early implementation of treatment is preservation of renal function and decreased mortality rates. Early recognition of sepsis is imperative to saving lives and organs. Early sepsis recognition and early treatment implementation are key factors in preserving kidney function and decreasing mortality rates (Bellomo et al., 2017). Timing is extremely important. The more time that passes without treatment, the more damage is done in relation to organ failure, specifically kidney failure. Quick implementation of treatment from the nurse's standpoint saves renal function and saves lives. They are instrumental in implementation of sepsis bundles which include fluid resuscitation and antibiotic therapy. The timing of these therapies is essential in preventing worsening and related sepsis sequela, including AKI. By ensuring that sepsis alert systems are acted on quickly and bundles and protocols are implemented early, nurses are contributing to the fight against sepsis. Early or delayed

treatment can be measured by when treatment was started by nurses in relation to when diagnosis was made and when sepsis alert systems activated an alarm.

Nurses should be aware of the benefits of early sepsis treatment and should be capable of reliably recognizing sepsis. Critical thinking, the ability to follow guidelines and protocols, the ability to identify and list systemic inflammatory response syndrome (SIRS) criteria, and the ability to recognize subtle changes are all important aspects of identifying sepsis. The greatest causes of treatment delays and delay in sepsis identification should be recognized and incorporated into sepsis training programs to generate awareness and education on the nurse's ability to influence patient outcomes.

Research has suggested that decreased compliance with the SSC and Sepsis Six pathway persists (Breen & Rees, 2018; Warstadt et al., 2022). Breen and Rees, 2018 conducted a study of a convenience sample of 108 doctors and nurses in an acute teaching hospital in the UK to identify perceived barriers to implementation of the Sepsis Six pathway. The study found that 77% stated that they were more likely to utilize the Sepsis Six pathway in patients with clinically identifiable signs of septic shock instead of biochemical indication of septic shock. Twenty six percent of doctors and 28% of nurses ranked lack or recognition during observation rounds as a significant cause of delay in sepsis treatment. Twenty-six percent of study participants also felt that it was not possible to deliver the sepsis six pathway within the required one-hour time-frame, mainly due to lack of adequate nursing staff. Previous research has shown nursing delays as the most common barrier to sepsis treatment (Amy Dzierba et al., 2011; Carlbom & Rubenfeld, 2007). This study also found that 64% of doctors and 52% of nurses considered further training in 'applying the sepsis pathway' to be the most important educational need while 50% of nurses also felt that the 'theory underpinning sepsis' needed improvement.

Overall, as skilled professionals, nurses are obligated to remain proficient on sepsis education, and employers must provide an atmosphere that encourages competent nursing practice (Association, 2014). Healthcare facilities should assess nurses' ability to follow SSC one-hour bundles and guidelines, and at that point identify and correct barriers that lead to delay in implementing bundles and guidelines within one hour. Other factors such as staffing, lack of equipment, effective communication during hand off, and effective facility training may all contribute to barriers that affect timely sepsis treatment. Based on nursing experience, knowledge, and sepsis training, patient outcomes can potentially be negatively or positively impacted. Because organ dysfunction is a main contributor to death in the presence of severe sepsis and septic shock, it is imperative that nurses understand the importance of early sepsis treatment.

### 1.1.1 Purpose of the Study

The longer sepsis goes untreated, the greater organ damage becomes. The kidneys are usually the organs that are negatively affected by sepsis first. Even a mild increase in creatinine (0.2997mg/dl) is associated with worse long-term outcomes and increased mortality.

Renal outcomes are largely dependent on time-based therapies, therefore understanding factors associated with timely implementation of sepsis treatment is essential. Nurses are in unique positions to recognize early sepsis symptoms because they spend more time with hospitalized patients than any other healthcare personnel. The purpose of these studies is to assess nurses' perspectives and opinions of factors that contribute to early or delayed sepsis treatment and to gauge their knowledge of how early treatment impacts renal outcomes. The long-term goal is to provide improved education on hospital units and in hospital educational programs that stress the importance of early sepsis recognition and implementation of yearly continuing education programs to keep nurses abreast of the latest trends and data on sepsis.

### 1.1.2 Specific Aims and Research Questions

The following specific aims and questions were developed to assess nurses' perspectives and opinions of factors that contribute to early or delayed sepsis treatment and to gauge their knowledge of sepsis identification and how that knowledge impacts renal outcomes.

#### Specific aim 1 and research question

To explore the factors that contribute to timing of (early or delayed) sepsis identification and treatment from perspectives of critical care nurses (i.e., emergency department (ED) and intensive care unit (ICU) nurses).

What are the qualitative themes related to the factors that contribute to early or delayed sepsis treatment?

#### Specific aim 2 and research questions

To determine current nursing practices related to sepsis identification in two local hospitals.

- What are the average prevention practice scores (primary or secondary) for critical care nurses?
- What is the self-reported level of knowledge towards early sepsis management?
- What is the self-reported level of knowledge towards delayed sepsis management?
- What are the self-reported attitude levels towards early and delayed sepsis management?
- What demographic difference exists between participants who have less nursing experience, but more experience related to sepsis identification?
- What demographic difference exists between participants who have less nursing experience, but more experience related to sepsis management?

**Specific aim 3 and research question**

To determine if quantitative data supports the qualitative themes on nurses' perspectives of sepsis identification and management

Do the quantitative results support the qualitative themes of critical care nurses' perspectives on early or delayed sepsis identification and management?

## 1.2 Conceptual and Theoretical Framework

Neuman Systems Model's Prevention as Intervention Theory is fitting for the line of research that will be evaluated. Factors influencing timely implementation of treatment for sepsis from the nurse's standpoint will be assessed. When diagnosis was made, when treatment was started and how these affected renal outcomes will be compared. Prevention as intervention is part of Neuman's System Model. Betty Neuman's basic philosophy for this model is "helping each other live" ((Fawcett & Desanto-Madeya, 2013) P.140). The primary aim of nursing in Neuman's system model is to decrease the effect of any possible harmful stressors and to increase those stressors that are beneficial which ultimately reinforces defense and resistance (Fawcett & Desanto-Madeya, 2013). Stressors are intrapersonal, interpersonal and extrapersonal. Intrapersonal stressors are inner biological influences that arise within the margin of the client system (acclimatized or autoimmune reaction in the patient). Interpersonal stressors are outer biological influences that arise outside the margins of the client system at proximal range (the nurse, involving role expectations or interaction plans). Extrapersonal stressors are outer biological communication influences that arise outside the margins of the client system at the distal range (involving social guidelines or fiscal matters).

Optimal client stability and Prevention are the concepts that are represented in this theory. Prevention as intervention is classified as a middle range theory because it requires actual intervention to be beneficial to patients. This Theory is suitable in practice because nursing actions directly affects outcomes for the client. Nursing is a concept in this model which uses prevention as intervention and focuses on people as holistic systems. Optimal client stability represents health for the system. Prevention falls into 3 categories: Primary, secondary, and tertiary. Primary prevention involves reduction of possible stressors to prevent possible adverse reactions. Secondary prevention involves identification of symptoms and intervention to reduce harmful effects. Tertiary prevention involves recovery and adjustment back to primary prevention (Fawcett & Desanto-Madeya, 2013). These categories are designed to retain, attain, or maintain optimal system stability or wellness. This theory directly correlates with factors influencing timely implementation of treatment for sepsis from the nurse's standpoint. In this case, nursing's timely implementation of treatment is a prevention intervention that could ultimately preserve renal function. **Figure** 1.1 represents a conceptual model of Neuman's Systems Model: Prevention as intervention.

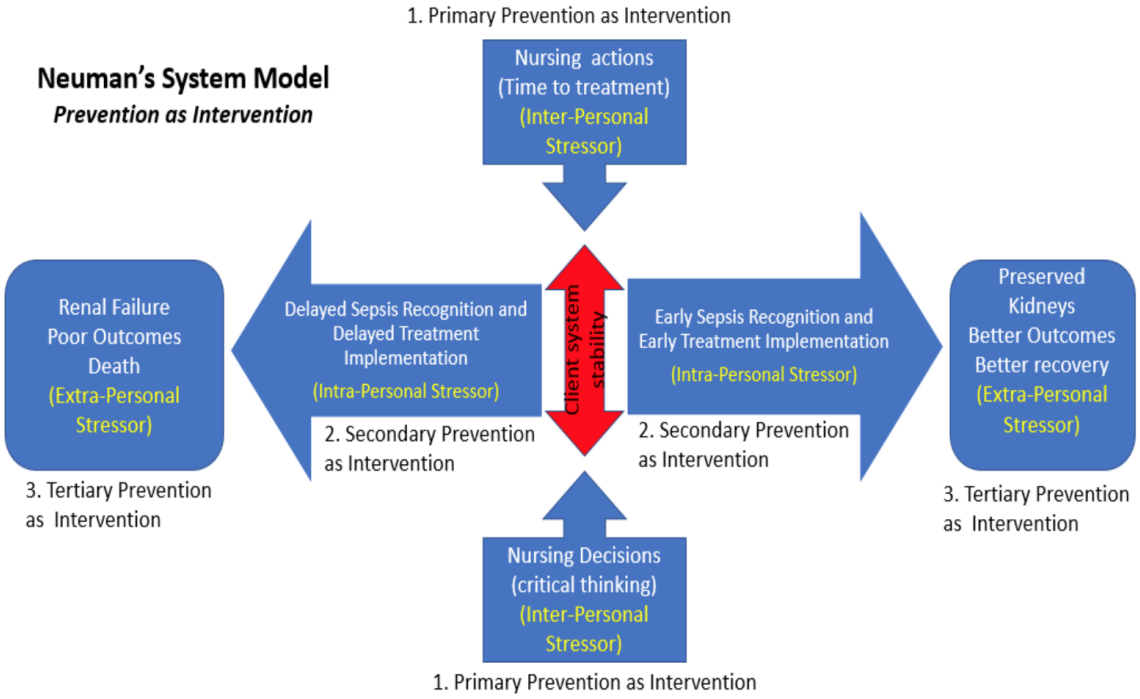


**Figure 1.1: Patient outcomes depending on how nurses react to initiating sepsis care.** Neuman, B., & Fawcett, J. (Eds.) (2011). The Neuman systems model (5th ed., p.13). Upper Saddle River, NJ: Pearson. Modified with the permission of Betty Neuman and Jacqueline Fawcett. Neuman, B. M., & Fawcett, J. (2011). The neuman systems model. https://www.neumansystemsmodel.org/neuman-fawcett-2011.

### 1.2.1 Metaparadigm

Neuman's system model is comprised of the 4 metaparadigm concepts of human beings, environment, health, and nursing (Fawcett & Desanto-Madeya, 2013). Examining these 4 concepts is essential in understanding how nursing actions are related to preventing a downward spiral of kidney function.

#### Human being

The metaparadigm concept of human beings is symbolized by client/client system. This can be broken down to represent the individual or a type of group (family, community, or a social issue). The client system is considered an exposed structure that associates with inner and outer surroundings. The basic structure or central core of the client system as an individual consists of basic survival factors. They are represented by preservation of normal temperature range, genetic response patterns, strength or weakness of body organs and cognitive ability (Fawcett & Desanto-Madeya, 2013).

#### Environment

The metaparadigm of environment is composed of internal and external environment, created environment and stressors (Fawcett & Desanto-Madeya, 2013). As previously stated, stressors are broken down even further into intrapersonal, interpersonal, and extra-personal. The internal environment is internal to the client system and includes intrapersonal stressors. The external environment is external to the client and includes interpersonal and extra-personal stressors. Created environment is composed of unconscious utilization of all system constructs, including psycho-sociocultural constructs. The created environment is instrumental in regulating the reply to a stressor. Stressors are tension generating entities that transpire within the boundaries of the internal and external environments of the client system. Intrapersonal stressors occur within the internal environment of the client system. Interpersonal stressors take place within the external environment, outside the client system (Fawcett & Desanto-Madeya, 2013). These could include role expectations or communication patterns. Extra-personal stressors take place within the external environment, outside the client system at a distal range. These could include social policies or financial interests.

#### Health

The metaparadigm of health is composed of health, wellness, and optimal client system stability. It is also composed of variance from wellness, illness, and reconstitution. Health is described as changing levels of normal which can rise or fall though out the life span due to basic structure factors and adequate or inadequate changes to environmental stressors. Health ranges from wellness, illness, severe illness, and death. Variance from wellness is ascertained by comparison of the normal health state with what is taking place at any given time. Illness is inadequacy that has unfulfilled disrupting requirements. Reconstitution

is the adjustment to stressors and the ideal use of resources for client system stability or wellness preservation (Fawcett & Desanto-Madeya, 2013).

#### Nursing

The Metaparadigm of nursing is composed of the three-part perception of prevention as intervention (Fawcett & Desanto-Madeya, 2013). Nursing itself is considered prevention as intervention. The three parts include Primary Prevention as Intervention, Secondary Prevention as Intervention and Tertiary Prevention as Intervention (Fawcett & Desanto-Madeya, 2013).

### 1.2.2 Theoretical Application

Neuman's Systems Model is based on a person's affiliation with stress, their reaction to stress and modification factors that are progressive after stress. The focus of this system is on the wellness of the client system as it relates to environmental stressors and reactions to stressors. In Neuman's system, nursing is mainly concerned with understanding suitable actions to stress related situations and understanding reactions of the client system. Within the Neuman's System Model the goal of nursing is to support the utmost wellness for the client by achieving or maintaining client system stability. One of the main objectives for nursing in this model is to decrease the effect of stressors and improve client resistance.

As with Neuman's Systems Model, nursing decisions and actions can reduce sepsis related stressors and thereby decrease long-term complications related to sepsis induced AKI. Early treatment from the nursing standpoint will alleviate continued or further stressors such as renal damage. It is important to patients that nurses make appropriate decisions and use critical thinking when providing care. This will contribute to the achievement or maintenance of client system stability. Nursing interventions specific to this study are critical thinking in knowing when true sepsis signs and symptoms are present, acting on sepsis alerts by effectively communicating nursing concerns with physicians and timely implementation and adherence to sepsis bundles, which includes timely administration of intravenous fluids and antibiotics.

## 1.3 Definitions of Major Concepts

### 1.3.1 Sepsis

Sepsis is generally defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection (Singer et al., 2016). This is the most recent definition of sepsis (known as Sepsis-3) which was previously known as "severe sepsis". Sepsis-3 has not been universally adopted as some hospital systems and literature may still be using the 1991 Consensus Conference definition (Bone et al., 1992). For example, sepsis is still identified as symptoms triggered by SIRS along with a known or suspected source of infection (Makic &

Bridges, 2018). SIRS is characterized by at least two of the following symptoms: temperature < 36°CM or >38°C, heart rate > 90bpm, respiratory rate >20bpm or $PaCO_2$ < 32mmHg, and WBC < 4,000$mm^3$ or >12,000$mm^3$ (Makic & Bridges, 2018).

### 1.3.2 The Surviving Sepsis Campaign (SSC)

The leading provider of guidelines in treating sepsis. It is a joint initiative led by multidisciplinary, international experts dedicated to improving time to recognition and treatment of sepsis and septic shock.

### 1.3.3 Sepsis Six Guidelines

A group of medical treatments intended to decrease mortality in patients with sepsis. Derived from international guidelines that arose from the Surviving Sepsis Campaign, the Sepsis Six was developed by The UK Sepsis Trust.

### 1.3.4 Sepsis Alert Systems

Electronic alert systems are designed to facilitate early recognition of the signs and symptoms of sepsis. These are institutional based systems that give nurses warnings when patients meet criteria for a diagnosis of sepsis.

### 1.3.5 Nursing Standpoint

The point at which nurses deliver care in the form of critical thinking, effective communication or carrying out patient treatments and medical orders.

### 1.3.6 Nursing Perspective

A way of thinking and understanding that is influenced by the nurse's professional healthcare beliefs and experiences.

### 1.3.7 Primary Prevention as Intervention

General knowledge that is applied in client assessment and intervention in identification and reduction or mitigation of possible or actual risk factors associated with environmental stressors to prevent possible reactions. The goal is to promote client wellness by stress prevention and reduction of risk factors and to reduce the possibility of stressor encounter or in some manner attempt to strengthen the client's flexible line of defense to decrease the possibility of reaction.

### 1.3.8 Secondary Prevention as Intervention

Secondary prevention relates to symptomatology following a reaction to stressors, appropriate ranking of intervention priorities and treatment to reduce their noxious effects. The goal

is to provide appropriate treatment of symptoms to attain optimal client system stability or wellness and energy conservation.

### 1.3.9 Tertiary Prevention as Intervention

The adjustive process taking place as reconstitution begins and maintenance factors move the client back in a circular manner toward primary prevention. The goal is to maintain an optimal wellness level by supporting existing strengths and conserving client system energy.

### 1.3.10 Organ Dysfunction

Organ dysfunction can be characterized by a rise in the Sequential [Sepsis-related] Organ Failure Assessment (SOFA) score of 2 points or more. An increased SOFA score is associated with a more than 10% in-hospital mortality rate (Singer et al., 2016). Septic shock is described as a subgroup of sepsis in which intense circulatory, cellular, and metabolic abnormalities are associated with a greater risk of mortality than with sepsis alone (Singer et al., 2016).

#### Acute kidney injury (AKI)

Conceptually, AKI can be defined as mild damage or impairment to the kidneys or kidney function which is seen in changes in urinary output and chemistry blood work. The physiological definition of AKI is an abrupt drop in glomerular filtration rate (GFR) and total renal function (Khwaja, 2012).

#### Chronic kidney disease (CKD)

According to the Kidney Disease: Improving global outcomes (KDIGO) guidelines, CKD is defined as abnormalities of kidney structure or function present for more than 3 months with consequences for health. CKD is classified based on cause, GFR category and albuminuria category (KDIGO, 2013).

## 1.4 Significance

This study is important because sepsis outcomes are largely dependent on time-based therapies. An understanding of factors associated with timely implementation of treatment is essential in preservation of organ function, specifically renal function and decreased mortality rates. Nurses play a significant role in starting treatment in a timely manner. This study will evaluate the impact of nurses' timing on early or delayed sepsis identification and treatment. The findings of this study will bring awareness to how nurses' decisions and actions influence sepsis management.

## 1.5 Assumptions

1. Timely implementation of sepsis treatment will reduce intrapersonal stressors thereby reducing the effects of sepsis induced AKI
2. Critical thinking and effective communication are interventions that prevent or reduce the cascade from health to critical illness in sepsis patients
3. Sepsis guidelines, bundles and alert systems facilitate early sepsis treatment
4. Early sepsis treatment promotes better patient outcomes

## 1.6 Potential Limitations

1. Lack of a control group for comparison or controls recruited by convenience sampling
2. Lack of generalizability due to sample size

# Chapter 2

# Long-Term Renal Outcomes in Adults with Sepsis-Induced Acute Kidney Injury: A Systematic Review [1]

## 2.1 Background

Sepsis-induced acute kidney injury (AKI) is a leading cause of death and poor renal outcomes and a growing concern worldwide. Nurses play a significant role in the timely implementation of AKI treatment and the long-term renal outcomes after sepsis-induced AKI. They are urged to 'think sepsis' when slight changes arise in patients with possible infection (Makic & Bridges, 2018). Early identification and assertive sepsis treatment are significant in improving patient outcomes and curbing the effects that sepsis may have on renal function (Makic & Bridges, 2018).

With increasing incidence and severity, sepsis affects a considerable number of people each year and is a major source of death and critical illness globally (Singer et al., 2016). The kidneys are often among the first organs to lose function, leading to AKI. After surviving an initial septic episode, renal function may improve, fluctuate, or fail to improve, with varying levels of dysfunction (S. J. Kim et al., 2020). If renal recovery is obtained by hospital discharge, septic AKI patients fare as well as patients who have AKI without sepsis; however, if patients do not have full renal recovery at hospital discharge, they suffer higher mortality rates (Fiorentino et al., 2018). In most cases, severity of AKI will determine if renal function will improve or if renal replacement therapy (RRT) is required. AKI can be life-changing, leading to a high burden of cost financially and physically. Chronic kidney disease (CKD) and dependence on RRT for survival can devastate both patients and their families.

The third international consensus conference for sepsis and septic shock (SEPSIS-3) defines sepsis as a "life-threatening organ dysfunction caused by a dysregulated host

[1] Reprinted from final submission with permission from Wolters Kluwer Health Inc. Harris, P. L., & Umberger, R. A. (2020). Long-term renal outcomes in adults with sepsis-induced acute kidney injury: A systematic review. *Dimensions of Critical Care Nursing*, *39*(5), 259–268. https://doi.org/10.1097/DCC.0000000000000432.

response to infection" ((Singer et al., 2016) p. 801). These authors described sepsis as a growing health concern that accounted for $20 billion (5.2%) of overall U.S. hospital expenses in 2011 and was responsible for 50% of all AKIs in hospitalized ICU patients (Kosaka et al., 2016). The authors further attributed the growing incidence of sepsis to the aging population that exhibits more comorbidities, better detection of sepsis, and even sepsis coding practices in some countries that may be more beneficial for compensation (Singer et al., 2016).

Early consensus criteria for sepsis have traditionally included clinical signs and symptoms in response to inflammation as a group of reactions called systemic inflammatory response syndrome (SIRS) (Bone et al., 1992). SIRS is characterized by the presence of at least two of the following: temperature < 38°C or >36°C; respirations greater than 20 or $PaCO_2$ less than 32mmHg; white blood cells > 12,000 or < 4,000 cells/($\mu$L); immature bands > 10%; or minimum heart rate > 90 (Singer et al., 2016). If infection is not treated in a timely manner, SIRS may lead to sepsis (which includes organ dysfunction), septic shock, and in some cases death (Guirgis et al., 2016). The Sequential Organ Failure Assessment (SOFA) is a tool that uses laboratory and clinical data to characterize the degree of organ failure. Sepsis experts have suggested using SOFA as an important measure of outcomes for clinical trials (Guirgis et al., 2016). In older adults, mental status change is an early sign of sepsis (Umberger & Brown, 2015). Sepsis and septic shock are prevalent in critically ill patients. Sepsis affects 13 million people per year globally and does not discriminate when it comes to socioeconomic status, as it afflicts people living in poverty and people living in affluence at similar rates (Selby et al., 2016).

If sepsis progresses to septic shock, then AKI, which is characterized by decreased renal perfusion, is a major risk factor. AKI is present in over 50% of septic shock cases (J. Kim et al., 2018). **Figure 2.1** illustrates the cascade from infection to AKI and its long-term complications. AKI is responsible for approximately 2 million deaths annually worldwide, and survivors of AKI have a higher risk of progressing to CKD and end-stage renal disease (ESRD) (Chawla et al., 2017).

The long-term renal outcomes of sepsis-induced AKI are commonly associated with the severity of the disease. Even a small rise in creatinine (26.5 µmol/L) is associated with poorer long-term outcomes and increased mortality (Suetrong et al., 2016). Early recognition of sepsis is a key factor in preventing AKI and reducing its negative consequences; therefore, more research should be conducted on reversing sepsis-induced AKI. The purpose of this state of the science review is to provide a critical assessment of the current literature regarding long-term renal outcomes after sepsis-induced AKI and long-term renal consequences.

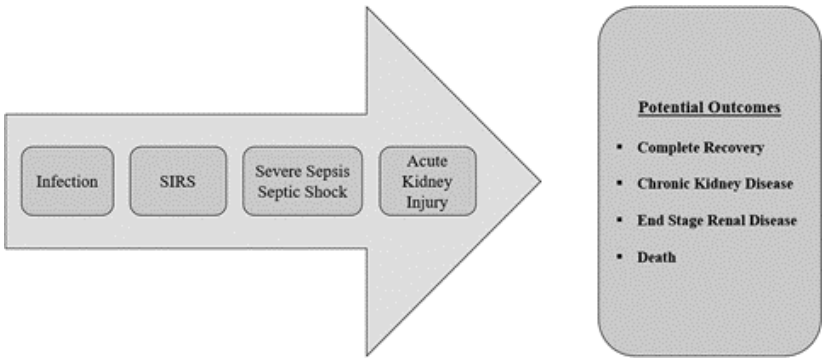


**Figure 2.1: Cascade from infection to acute kidney injury and potential associated outcomes**.

## 2.2 Methods

This review was designed to assess long-term outcomes of sepsis induced AKI in the adults. The first author searched PubMed and CINAHL databases in March 2019 and in March 2020 on long-term outcomes of patients with sepsis-induced AKI using the following search terms: septic AKI, long-term outcomes of patients with sepsis-induced AKI, long-term outcomes of patients with sepsis-related AKI, long-term outcomes of sepsis, and long-term outcomes of AKI. **Figure** 2.2 describes the article selection using PRISMA guidelines (Liberati et al., 2009). After a detailed review, 12 relevant articles dated within the laser 5 years met criteria (renal outcomes associated with sepsis-induced AKI) for continued analysis of long-term renal outcomes of sepsis-induced AKI. A 5 year limit was chosen by the first author to access the most updated literature being developed in the field. Results of the search were imported into the citation manager EndNote X9. The first author independently identified and removed duplicate articles and also extracted key data, including study objectives, study type, outcome measures, instruments, diagrames, and limitations. These articles were reviewed for common themes. Common themes were refined and agreed up on by the authors during data analysis.

## 2.3 Results

We identified four common themes among the selected articles: (1) AKI determination criteria, (2) severity of disease/prognosis-related factors, (3) time frame for long-term outcome measures, and (4) chronic kidney disease and renal-related exclusion criteria. **Table** 2.1 and **Table** 2.2 provides a brief synopsis of each selected article, highlighting the purpose, population, study design, AKI definitions used, primary study outcomes, timing of outcome, and long-term renal outcomes assessed in each study. In addition, the

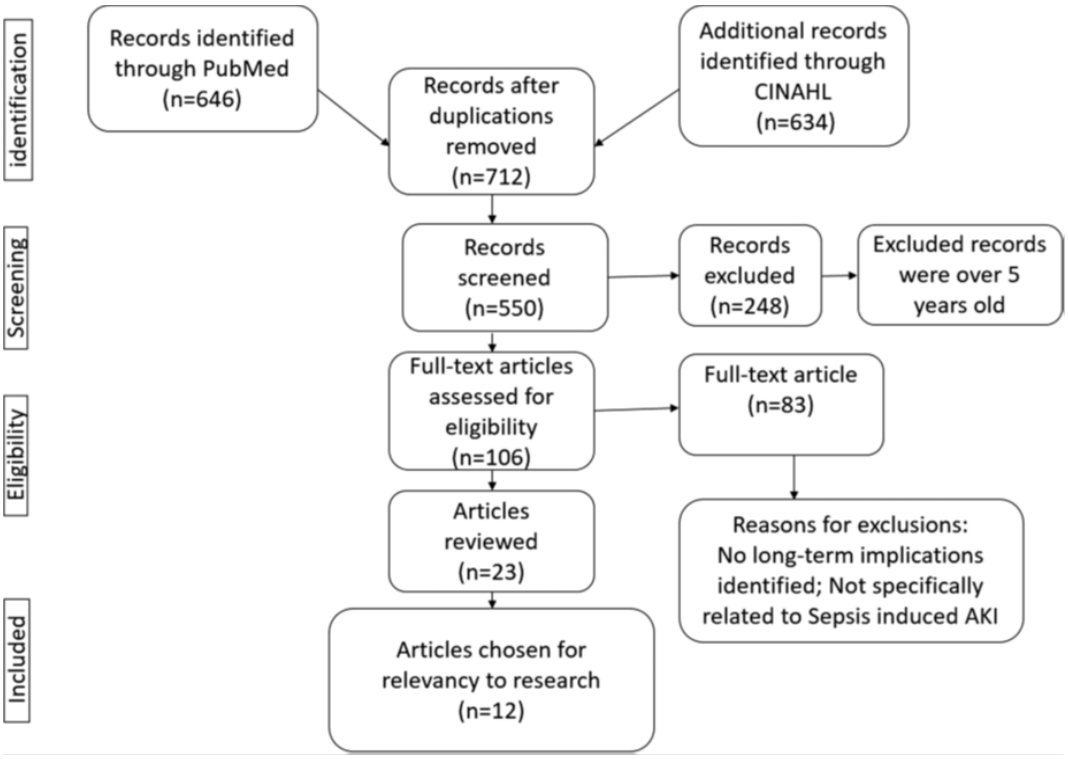


**Figure 2.2: Article selection using PRISMA guidelines**.

**Table 2.1: Summary of selected articles part 1.**

| First Author and Year | Purpose | N | Study Design | AKI Definition |
|---|---|---|---|---|
| (Baudry et al., 2019) | To describe both short and long-term outcomes and to evaluate factors predicting mortality | 149 | Retrospective cohort of critically ill patients with septic shock liver cirrhosis | Not given |
| (Cruz et al., 2014) | To describe and compare the characteristics and clinical outcomes of patients with septic and non-septic AKI | 117 | Retrospective cohort of critically ill patients with AKI admitted to the ICU | RIFLE criteria |
| (Fiorentino et al., 2018) | To assess the long-term survival of septic acute kidney injury patients after they have had renal recovery | 1742 | Prospective cohort | Stage 2-3 KDIGO criteria or initiation of renal replacement therapy |
| (Guirgis et al., 2016) | To characterize long-term organ dysfunction after sepsis who had received quantitative resuscitation | 110 | Secondary analysis of a prospective cohort | Renal dysfunction on admission: serum creatinine >2mg/dL or increased 0.5mg/dL from baseline, urine output <0.5mg/kg/hr; persistent or long-term renal dysfunction: serum creatinine >2mg/dL or creatinine increased 0.5mg/dL from pre-sepsis baseline, or on dialysis since sepsis |
| (J. Kellum et al., 2016) | To determine the role of structured resuscitation on AKI development or severity and outcome | 1,243 | Ancillary study to the Protocolized Care for Early Septic Shock (ProCESS) trial of alternative resuscitation strategies for septic shock | KDIGO criteria |
| (J. Kim et al., 2018) | To identify risk factors for the development of CKD in septic shock patients with AKI | 2208 | Single center retrospective cohort | KDIGO criteria |
| (Roveran Genga et al., 2017) | To investigate the association between HDL levels during sepsis and sepsis associated AKI | 180 | Observational cohort | KDIGO stage 1-3 |
| (Rubin et al., 2019) | To evaluate the long-term incidence of CKD after non-severe AKI in critically ill patients | 232 | Prospective 3-year observational study | KDGIO criteria |
| (Shum et al., 2016) | To examine 90 day mortality and clinical findings among Chinese patients with AKI and sepsis | 3687 | Retrospective single center cohort | KDIGO criteria |
| (Stoumpos et al., 2017) | To determine the long-term renal outcome of patients with AKI needing dialysis secondary to hypo-perfusion injury and/or sepsis who recovered to normal renal function | 396 | Single center population based cohort | AKI requiring dialysis |
| (Suetrong et al., 2016) | To evaluate the association of hyperchloremia and acute kidney injury in severe sepsis and septic shock patients | 240 | Retrospective cohort | KDIGO criteria measured within 3 months prior to enrollment. |
| (Thalji et al., 2017) | To examine the development of AKI after burn injury | 18,155 | Retrospective cohort | AKI was identified using ICD-9 codes |

**Table 2.2: Summary of results of selected articles part 2.**

| First Author and Year | Outcomes | Outcome Timing | Renal Outcomes |
|---|---|---|---|
| (Baudry et al., 2019) | Cirrhotic patients with septic shock who needed RRT had higher mortality rates | 1 year from time of admission to ICU | 1 year survival rate dramatically increased if RRT was needed while in ICU |
| (Cruz et al., 2014) | Sepsis was an independent predictor of death. Death was the main outcome and dialysis dependency and renal function recovery were secondary outcomes. | Duration of hospital stay, and total length of stay was not reported. | Renal outcomes were reported among patients with septic AKI (n=54) as recovery of renal function 5 (9.26%), need for dialysis 18 (33.3%), and death 35 (64.8%). It is unclear how many of the patients who died had received dialysis or if the groups reported are mutually exclusive. |
| (Fiorentino et al., 2018) | Incident ESRD after hospital discharge and variables associated with recovery | Up to 3 years from the date of hospitalization | Only 11 patients (0.63%) developed ESRD over the 1st year after hospitalization. These patients had a history of CKD. |
| (Guirgis et al., 2016) | Overall rates of organ dysfunction on sepsis admission were pulmonary 47%; renal 47%; coagulopathy 25%; cardiovascular 56%; hepatic 5%; and neurologic 54%. Inpatient mortality of those admitted with sepsis was 18%, leaving 90 sepsis survivors. Of those survivors, 12 died before the 28-day follow-up; at 28-90 days, 65% had available data on organ function, lost to follow-up was 35% | 28-90 days (persistent); >90 days (long-term) | Long-term renal dysfunction occurred in 7 of 40 (or 18%) of patients followed up to 90 days. |
| (J. Kellum et al., 2016) | In patients with septic shock, AKI is common and associated with adverse outcomes, but it is not influenced by protocolized resuscitation compared with usual care | 1 year | Death or dialysis at 1 year occurred in 38.9% of EGDT group, 37% of the PSC group and 38.6% of the usual care group. |
| (J. Kim et al., 2018) | 80% had full renal recovery, 20% progressed to CKD, and 2% were dependent on RRT. | 1 year | AKI stage determination was made according to KIDGO guidelines on day 1 of hospital admission. Of 117 stage 1 patients, 48(41%) recovered full kidney function and 12(20%) developed CKD within 1 year; of 337 stage 2 patients, 91(27%) recovered full kidney function and 21(6%) developed CKD; of 385 stage 3 patients, 90(23%) recovered full kidney function and 24(6%) developed CKD. |
| (Roveran Genga et al., 2017) | Higher APACHIE II scores, creatinine and WBC counts in patients with low HDL | 3 months to 2 years post hospital discharge | Decreased eGFR within the 3-month to 2-year observation period after sepsis was found in 35/115 patients (30.4%), 101(87%) of whom had prior AKI, 11(19.3%) were in higher HDL group, and 24 (41.4%) were in the lower HDL group. |
| (Rubin et al., 2019) | Sepsis was a major cause of AKI in severe and non-severe AKI patients | 3 Years | 22% of non-severe AKI patients and 44% of severe AKI patients had CKD at 3 year follow-up |
| (Shum et al., 2016) | AKI, especially septic AKI, is common in critically ill Chinese patients and is associated with poor patient outcome. Etiology of AKI has a significant impact on 90-day mortality and may affect outcome. | 90 days | Full renal recovery was achieved in 71.6% of AKI patients compared to non-septic AKI patients. Non-recovery of renal function occurred in 2.5% of patients with septic AKI compared to 6.4% of non-septic patients |
| (Stoumpos et al., 2017) | The primary outcome was timing to CKD based on eGFR (<60mL/min/ 1.73m2)from the time of initial dialysis after AKI. | Up to 1 year | Based on eGRF measures, 35(8.8%) of the patients developed CKD after a median 5.3 years from the first dialysis for AKI. Incidence rate of progression to CKD was1 per 100 person-years. |
| (Suetrong et al., 2016) | The primary outcome was the development of AKI by KDIGO criteria. The secondary outcomes were requirement of RRT and 28-day mortality. Hyperchloremia is common in severe sepsis and septic shock and independently associated with AKI. A moderate increase in serum chloride is associated with AKI even without hyperchloremia. | 28 days | AKI and RRT timing seemed to only be measured in the short term. Long-term outcomes focused on mortality |
| (Thalji et al., 2017) | Stage 3-5 CKD, dialysis, pneumonia, hospital readmission, mortality | 1 year | One year after burn injury, AKI was associated with development of CKD and conversion to chronic dialysis |

**Table 2.3:** Acute Kidney injury diagnosis guidelines

| **Criteria for all 3 Diagnosis Guidelines** | | | | **KDIGO**[c] | |
|---|---|---|---|---|---|
| **Stage** | **Urine Output** | **Rifle Criteria**[a] **(Class) Serum Creatinine** | **AKIN Staging**[b] **Serum Creatinine** | **Serum Creatinine** | GFR |
| 1 | <0.5ml/kg/h for 6 hr (6-12 hr in KDIGO) | sCr x 1.5 (Risk) | Increase of 0.3 mg/dL or increase of 150-200% from baseline | 1.5-1.9 x baseline or $\geq$ 0.3mg/dL increase | Decrease of >25% |
| 2 | <0.5ml/kg/hr for 12 hr | sCr x 2 (Injury) | Increase of >200-300% from baseline | 2-2.9 x baseline | Decrease of >50% |
| 3 | <0.3ml/kg/hr for $\geq$ 24hr or anuria $\geq$ 12hr | sCr x 3 or >4mgdL with an acute rise of >0.5mg/dL (Failure) | Increase of >300% from baseline or $\geq$ 4mg/dL with an acute increase of $\geq$ 0.5 mg/dL or on RRT | 3 x baseline or increase to $\geq$ 4mg/dL or initiation of RRT | Decrease of >75% |
| No # | | Persistant acute renal failure leading to complete loss of renal function (Loss) | | | |
| No # | | ESRD >3 months (ESRD) | | | |

Abbreviations: glomeruli filtration rate (GFR); serum creatinine (sCr), and end-stage renal disease (ESRD). a: Risk, Injury, Failure, Loss of kidney function, End-stage kidney disease (RIFLE) criteria as proposed in 2002. b: Acute Kidney Injury Network (AKIN) criteria as proposed in 2005. c: Kidney Disease Improving Global outcomes (KDIGO) criteria as developed in 2012.

strength and quality of the evidence was assessed (Dearheart & Dang, 2012). Each theme is described below.

### 2.3.1 AKI Determination Criteria

Researchers and practitioners within organizations have developed diagnostic tools to assist in classifying AKI. These tools are needed to standardize measures for AKI for both research and practice. **Table** 2.3 summarizes these tools to define AKI. RIFLE (Risk, Injury, Failure, Loss of kidney function, and End-stage kidney disease) classification for the AKI definition was developed through consensus conference held in May 2002. (Bellomo et al., 2004; Lopes & Jorge, 2013). In September 2005, RIFLE criteria were modified and became Acute Kidney Injury Network (AKIN) criteria for diagnosing AKI (Mehta et al., 2007). Based on AKIN criteria, AKI is only considered after reaching adequate levels of hydration and ruling out urinary obstruction. To build a consensus definition, in 2012 the Kidney Disease Improving Global Outcomes (KDIGO) workgroup merged the RIFLE and AKIN definitions to create one definition of AKI for practice, research, and public health (J. Kellum & Lameire, 2013). This definition has now become the gold standard of AKI measurement. In a majority of the articles, AKI was determined using KDIGO guidelines. With a standardized method of measuring AKI, clinicians can now diagnose and define AKI, which may lead to earlier detection and treatment of the syndrome, thereby reducing the incidence of secondary long-term kidney injury.

### 2.3.2 Severity of Disease/Prognosis-Related Factors

In all of the studies, prognosis was related to initial acuity and severity of AKI. If sepsis was treated in early stages, AKI did not present as severe as it did in severe sepsis or septic shock. Further, in 11 of the 12 articles reviewed, AKI was associated with adverse outcomes such as CKD, ESRD and RRT, or death (Cruz et al., 2014; Fiorentino et al., 2018; Guirgis et al., 2016; J. Kellum et al., 2016; J. Kim et al., 2018; Roveran Genga et al., 2017; Shum et al., 2016; Stoumpos et al., 2017; Thalji et al., 2017). In one study that evaluated septic shock in Cirrhotic liver patients, RRT was the only tool used to measure 1 year prognosis (Baudry et al., 2019). Patients with sepsis-induced AKI usually presented from the emergency room and had higher rates of in-hospital mortality. Sepsis was found to be an independent predictor of death (Cruz et al., 2014). Sepsis patients were more prone to higher APACHE II scores (score > 18.5). There was also a significant association between APACHE II score of >18.5 and mortality (Cruz et al., 2014). Sepsis patients also required dialysis. Patients with sepsis would likely fall into relapses (according to KDGIO diagnosis guidelines) after primary AKI reversal and community-acquired AKI (present on admission) was more common (Fiorentino et al., 2018). Biomarkers such as low baseline HDL (< 33.06mg/dL$^{-}$1) in early sepsis could increase risk of sepsis-associated AKI and/or long-term renal dysfunction after sepsis (Cruz et al., 2014). Hyperchloremia ($\leq \Delta[Cl^{-}] \geq$5 mmol/L) is often seen in severe sepsis and septic shock and is independently related to AKI (Suetrong et al., 2016). An increase in serum chloride was also associated with higher APACHIE II scores (Suetrong et al., 2016).

### 2.3.3 Time Frame for Long-Term Outcome Measures

Long-term renal outcomes were evaluated in each article, ranging from 28 days to 3 years, as summarized in Tables 2.1 and 2.2. The long-term outcomes ranged from dependence on RRT to complete renal recovery. Fiorentino et al., 2018 found that subjects who developed moderate to severe sepsis-induced AKI and obtained renal recovery by hospital discharge had similar 3-year survival rates as those who did not develop AKI; however, non-recovery at hospital discharge had a much higher mortality rate (Fiorentino et al., 2018). Rubin et al., 2019 found that 50% of patients who developed AKI had an admitting diagnosis of sepsis. Their study showed that at 3 years after ICU discharge 22% of non-severe AKI patients developed CKD and 44% of severe AKI patients developed CKD (Rubin et al., 2019). Other researchers measured kidney function over time at day 28, from 3-6 months, from 6-12 months, and from 1- 2 years after hospital admission (Roveran Genga et al., 2017). Other authors described 'long-term' as greater than 90 days (Guirgis et al., 2016). Eighteen percent of those who survived past 90 days had renal dysfunction (Guirgis et al., 2016).

J. Kellum et al., 2016 tested three alternative resuscitation strategies to treat septic shock patients with AKI, including early goal-directed therapy (EGDT), protocol-based standard care (PSC), and usual care. They found that at 1-year follow-up, death or dialysis occurred in 38.9% of the EGDT group, 37.0 % of the PSC group, and 38.6% of the usual care

group.There was no significant difference in the usual care group compared to the EGDT group and PSC groups (J. Kellum et al., 2016).

J. Kim et al., 2018 conducted a 1-year follow-up of septic shock patients with AKI. This study evaluated SCr and eGFR one year after discharge to assess progression to CKD and ESRD. Eighty percent of subjects in this study had full renal function recovery, while 20% progressed to CKD. CKD was determined by evaluating the highest sCr and the lowest GFR over one year. Two percent were on dialysis. All-cause mortality was 40% at 1 year.

Shum et al., 2016 evaluated 90-day survival rate after septic AKI and non-septic AKI and found that septic patients had better renal recovery than non-septic patients and septic patients had higher APACHE II scores. Stoumpos et al., 2017 followed patients 1 year after discharge and found that if AKI progressed to CKD, it did so within 3-6 months and 1-year follow-up may not be necessary. This study concluded that if patients survived 1-year post AKI requiring in-hospital dialysis and then returned to normal renal function, progression to CKD over the next 10 years was very low. Thalji et al., 2017 studied septic AKI in burn patients and found that early sepsis treatment influenced outcomes and decreased mortality. They concluded that sepsis is the leading cause of AKI in burn patients. One-year follow-up showed an increase in chronic dialysis, hospital readmission, and mortality.

Multiple studies have shown that severe sepsis and septic shock are associated with increased rates of mortality and poor renal outcomes, although early sepsis treatment has been shown to have minimal effects on kidney function. Suetrong et al., 2016 asserted that critically ill patients with severe sepsis and septic shock who acquire AKI with only a small rise in serum creatinine (26.5µmol/L) had higher mortality, longer ICU stays, a greater need for vasopressors and mechanical ventilators, and worse long-term outcomes. J. Kim et al., 2018 stated that AKI in the presence of septic shock is likely to lead to continuous or permanent kidney damage.

### 2.3.4 Chronic Kidney Disease and Renal-Related Exclusion Criteria

Common exclusions for most of the studies were related to some form of previous kidney damage or RRT. (Cruz et al., 2014; Fiorentino et al., 2018; J. Kellum et al., 2016; J. Kim et al., 2018; Roveran Genga et al., 2017; Shum et al., 2016; Stoumpos et al., 2017; Suetrong et al., 2016; Thalji et al., 2017). Age below 18 years was an exclusion criterion for all the studies. Other exclusions that were declared by the authors were as follows: pregnancy; ESRD; kidney transplant; liver transplant; brain damage within 24 hours of admission; incomplete outcome data and missing enrollment serum creatinine values; incarceration; emergency surgery; patients receiving non-invasive ventilation; admission for sepsis re-occurrence; and various forms of nephropathy such as glomerulonephritis, vasculitis with kidney involvement, hemolytic-uremic syndrome, polycystic kidney disease, and multiple myeloma. Because the purpose of a majority of these studies was to assess renal function after sepsis insult, patients with some form of CKD were excluded. Thus, little is known

still about the long-term impact of patients with CKD who have AKI (acute on chronic kidney injury).

## 2.4 Discussion

Overall, this review highlights how sepsis impacts a patient's life long after the initial syndrome is treated. Renal failure can be very traumatic for patients and their families. Sepsis must be recognized and treated early to stop the progression of AKI into full renal failure and dependence on RRT. Nurses are instrumental in starting early sepsis treatment. Currently early recognition of AKI in hospitalized patients provides the best opportunity to improve patient outcomes.

Nursing could make an impact on reducing the long-term complications of sepsis induced AKI by ensuring that sepsis protocols are implemented early. Nurses are front line fighters in combating sepsis. They spend more time with hospitalized patients than any other healthcare personnel, therefore they are in prime positions for early sepsis identification. Nurses should be educated on the importance of early recognition, signs and symptoms of sepsis and current screening protocols. The surviving sepsis campaign (SSC) suggests that resuscitation and management start immediately. (Schorr, 2018). Comparison between each article shows that delayed sepsis treatment contributes to long-term renal complications and higher mortality rates. If nurses are educated on the importance of early recognition and treatment, they can become instrumental in saving renal function as well as saving lives. It is also important that patients in the community seek care in a timely manner, particularly patients who already have some degree of compromised renal function. Once severe sepsis or septic shock is diagnosed, AKI, the most frequent organ failure, is a common risk factor (J. Kim et al., 2018). Because patients who are hospitalized in the ICU with severe sepsis or septic shock are at higher risk for AKI, nurses must be ready to implement treatment as soon as they arrive to the unit. Early treatment implementation at this stage may prevent long-term renal complications

The common themes identified in these articles were as follows: (1) AKI determination criteria, (2) severity of disease/prognosis-related factors, (3) time frame for long-term outcome measures, and (4) chronic kidney disease and renal related exclusion criteria. Sepsis-induced AKI is commonly found in patients with severe sepsis and septic shock. AKI in these patients is associated with adverse long-term renal outcomes. Renal recovery was dependent on sepsis severity. Long-term follow-up described in these articles gave insights into long-term renal outcomes after sepsis AKI. We did not find similar review articles focused on describing these long-term renal outcomes. Among septic and non-septic AKI, the septic patients required more RRT but had better renal recovery than the non-septic group (Shum et al., 2016). This may explain why the etiology of the source of AKI is important. Biomarkers such as chloride and HDL could be early indicators of AKI and sepsis (Cruz et al., 2014). Other biomarkers for early detection (e.g., cystatin-C (Powell

et al., 2015) and nephrocheck (Noto et al., 2019)) are also important but were not the focus in the articles reviewed.

Frequent hospital re-admissions for recurrent sepsis was associated with a high health care burden. A review by Doyle and Forni, 2016 showed that long-term outcomes of sepsis-induced AKI were associated with significant morbidity and mortality. These findings are consistent with our findings. While older patients are at higher risk for sepsis and thus sepsis-associated AKI, some populations report that sepsis-associated AKI was more prevalent in the younger population ($\leq$45 years old) (Ghimire et al., 2014). These differences may be related to a younger population distribution and differences in access to care.

All but one of the studies we reviewed had excluded patients with CKD, which represents an important population that is at high risk for sepsis. We have recently shown that patients with CKD have a higher risk of readmissions with sepsis than patients with preexisting immunosuppressive conditions (Umberger et al., 2019). More research should be conducted to address this gap in "acute on chronic" kidney injury with sepsis. Because CKD was often an exclusion when studies were conducted to evaluate sepsis-induced AKI, very little is known about this phenomenon. We recognize the importance of exclusion criteria to assure patient safety and limit study attrition; however, this is an area that could benefit from more research. Long-term follow-up after AKI should continue for five years or longer post hospital discharge to obtain a true picture of the long-term effects of sepsis-induced AKI. Following for a longer period would be consistent with recommendations for future sepsis research (H. Prescott et al., 2019).

Finally, our work had limitations. First, we included a small number of articles in our sample. A larger review extending the time frame may be helpful. Second, the studies reviewed did not consider the histopathology that may influence long-term renal outcomes. Prospective research is needed that includes a more precise description of long-term renal outcomes. The use of existing electronic health records that provide details over many years may be helpful.

## 2.5 Conclusion

Long-term outcomes related to sepsis-induced AKI vary, ranging from complete recovery to dependence on RRT. All studies in this review have concurred that early treatment is essential to preventing debilitating damage from sepsis-induced AKI. Critical care nurses play a key role in the delivery of that treatment; however, none of these studies specifically focused on the role of the nurse. To understand the long-term impact of AKI after sepsis, consistent definitions for AKI should be used and reporting of long-term outcomes is needed to make comparisons across studies. This is particularly important for patients with CKD who have been less studied.

# Chapter 3

# Factors Influencing the Initiation of Sepsis Treatment: Nurses' Perspectives

## 3.1 Background

Sepsis is a life-threatening organ dysfunction triggered by an abnormal host reaction to infection (Singer et al., 2016) and is a significant cause of mortality and morbidity in intensive care unit (ICU) patients (Antal et al., 2020). It is the fifth leading cause of death in the United Sates and a major cause of death worldwide (CDC, 2021). According to the Centers for Disease Control (CDC), approximately 1.7 million adults in America develop sepsis (CDC, 2021). Nearly 270,000 Americans die as a result of sepsis, and 1 in 3 patients who die in a hospital have sepsis (CDC, 2021).

Early recognition of signs and symptoms of sepsis is extremely important in preserving organ function as well as preserving life, a finding that led to the development and the implementation of The Surviving Sepsis Campaign (SSC). The SSC is a joint initiative led by multidisciplinary, international experts dedicated to improving time to recognition and treatment of sepsis and septic shock (Barrier, 2018). Within these guidelines, providers have a one-hour window from the time of sepsis diagnosis to initiating critical treatments. These treatments include collecting lactate levels and blood cultures, administering broad-spectrum antibiotics, rapid administration of crystalloid for hypotension or lactate level $\geq$ 4 millimole/liter (mmol/L), and delivering vasopressors if the patient is hypotensive during or after fluid resuscitation to maintain mean arterial pressure (MAP) $\geq$ 65 mm Hg (Barrier, 2018). Compliance with the SSC bundle has been associated with a 25% reduction in the risk of death and overall cost. However, compliance can be difficult because it is challenging to identify sepsis (McVeigh, 2020).

Despite sepsis being a major cause of death, few people are aware of this disease state (Rubulotta et al., 2009). Increased awareness and education are imperative to facilitate early recognition and prompt treatment of sepsis (Young et al., 2017). Nurses are integral in the recognition of the early signs and symptoms of sepsis; therefore, it is vital that they both recognize and begin treatment within one hour of diagnosis. The more time that passes without treatment, the more damage is done in relation to organ failure, specifically kidney

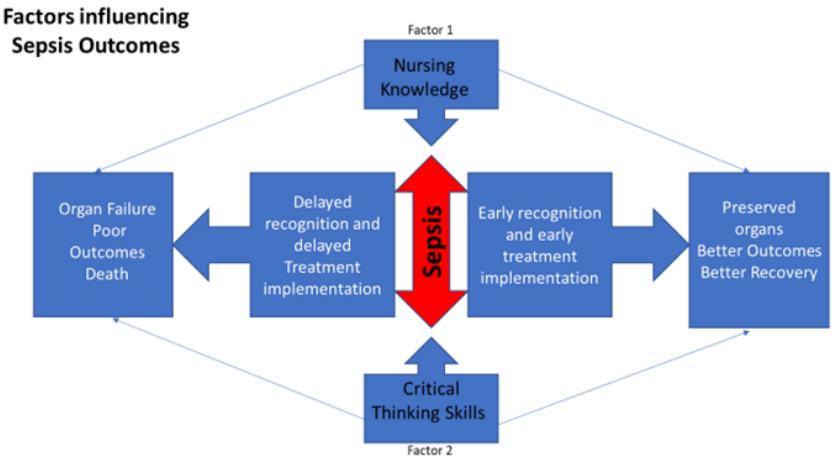


**Figure 3.1: Nursing actions in sepsis care that influece patient outcomes.** Neuman, B., & Fawcett, J. (Eds.) (2011). The Neuman systems model (5th ed., p.13). Upper Saddle River, NJ: Pearson. Modified with the permission of Betty Neuman and Jacqueline Fawcett. Neuman, B. M., & Fawcett, J. (2011). The neuman systems model. https://www.neumansystemsmodel.org/neuman-fawcett-2011.

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failure (Bellomo et al., 2017). Early implementation of treatment results in the preservation of renal function and decreased mortality rates (Bellomo et al., 2017). Because nurses spend more time with patients than any other healthcare personnel during their hospital stay, they are in prime positions for early recognition of sepsis (Torsvik et al., 2016). In the same manner, they are instrumental in the implementation of sepsis bundles, which include fluid resuscitation and antibiotic therapy (J. H. Kim et al., 2012). Early or delayed treatment can be measured by when treatment was started in relation to when sepsis recognition was made (Levy et al., 2018). According to the SSC, sepsis treatment should start immediately with the one-hour bundle implemented as soon as sepsis is recognized (Levy et al., 2018). Treatment that is not started immediately after sepsis recognition results in a delay in sepsis care and a likelihood of poorer outcomes.

Employing critical thinking skills to inform one's decision-making can assist nurses in correctly identifying sepsis early. Critical thinking is the psychological method of vigorous and proficient awareness, evaluation, synthesis, and appraisal of gathered data through observation, knowledge, and communication that guides a determination for action (Kang et al., 2020). **Figure** 3.1 indicates how nurses' decisions may affect patient outcomes, illustrating that sepsis, the primary problem, has outcomes that are dependent on nursing knowledge regarding the benefits of early sepsis treatment or the consequences of delayed sepsis treatment. Further, it shows that the nurse's ability to use critical thinking can mean

the difference between early treatment and preserved organs, better outcomes, and better recovery or delayed treatment and organ failure, poor outcomes, and death. When nurses are well-educated on the importance and implications of early and delayed treatment (Khanina et al., 2020), patients are less likely to experience organ failure and have better overall outcomes. Early recognition and best possible management of sepsis patients who are in danger of obtaining sepsis-induced acute kidney injury (AKI) may decrease related morbidity and mortality (Antal et al., 2020). Renal outcomes are largely dependent on time-based therapies (J. H. Kim et al., 2019), (J. A. Kellum et al., 2019); therefore, understanding the factors associated with timely implementation of sepsis treatment is essential. The purpose of this study, therefore, was to assess nurses' perspectives on what factors contribute to early or delayed sepsis treatment.

## 3.2 Methods

### 3.2.1 Research Design

Phenomenological inquiry was used as a guide for this study. Phenomenology investigates the lived experiences of participants. It involves an analysis of the meaning of events that participants in the study have experienced (Padilla-Diaz, 2015). Phenomenology was chosen as a guide for this study because nurses' experiences are important in describing what they feel and how those feelings contribute to early or delayed sepsis treatment. In most hospital settings, nurses are the healthcare providers who deliver treatments and general care. As a result, their input may provide insight into what should be done to prevent delayed treatment and enhance early treatment. The nurse's competence on sepsis care was a major contributor to early sepsis identification (Delaney et al., 2015).

### 3.2.2 Participant Selection and Setting

To achieve an idea of participant perspectives, we purposefully recruited nurses who were from one urban, level two hospital and worked in either the ED or ICU. Sepsis guidelines at this facility were based on a combination of the sepsis 2 and sepsis 3 definitions that form a hybrid system (Poutsiaka et al., 2019; Singer et al., 2016). Sepsis screening is conducted based on sepsis 2 criteria, but treatment is delivered based on sepsis 3 criteria. At this facility, the goal is to start antibiotics and fluids within one hour, which falls in line with SSC guidelines. Recruitment flyers were personally handed to nurses before and after their shifts and sent via email to elicit participation. Inclusion criteria consisted of nurses who had at least six months of experience caring for sepsis patients and those who worked in an ED or ICU. Exclusion criteria included nurses who did not provide consent to participate.

### 3.2.3 Data Collection

All Interviews were conducted by the same interviewer (PH) either via face-to-face (n=7) or telephone (n=7). Face-to-face interviews were conducted in a secure, quiet room at the

hospital. Due to COVID-19, all other interviews were conducted by telephone.

At the beginning of the interviews, nurses provided verbal consent. A 14-question demographic questionnaire was then completed, and the participants were informed that the interviews would be audio recorded and transcribed verbatim. Although interviews were relatively short, lasting 5-15 minutes, they were highly informative. The structured interview guide consisted of four questions to assess what nurses felt contributed to early or delayed sepsis treatment. Those questions were: 1) As a nurse, what have you experienced related to early sepsis identification and treatment; 2) What situations have influenced your experiences related to the timing to start sepsis treatment; 3) Tell me about your experience related to 'sepsis alerts' triggered by conditions other than sepsis; and 4) Tell me about your experiences related to how you determine when to contact the physician after a 'sepsis alert'.

### 3.2.4 Data Analysis

The interviews were semi-structured , with audio recordings being transcribed verbatim, verified, and anonymized. The transcribed interviews were compared to the audio recordings to check for accuracy. Thematic content analysis was performed to extract common themes. Next, a rigorous and comprehensive coding process was conducted to generate themes. The themes were then compared with one another as well as with the original data to ensure they were reliable, consistent, and unique. Rigor was verified by member checking. Initially, seven interviews were reviewed followed by a three-at-a-time review until saturation was reached. Participant recruitment was stopped after 14 interviews due to repeated and recurrent answers. Gift cards worth $10 were given as compensation for participating in the study. Approval for the study was obtained from the Institutional Review Board at the University of Tennessee Health Science Center. Due to low risk, only verbal consent was needed to participate in the study, and participants who were interviewed face-to-face were presented with a consent statement. Face-to-face and telephone interviews proved to be equally informative.

## 3.3 Results

Semi-structured interviews were conducted with 14 nurses. A total of 12 females and 2 males were interviewed. Eight of the nurses held bachelor's degrees, 3 had master's degrees (one of which was a nurse practitioner), 2 had associate degrees, and only 1 of the nurses held a doctorate as a nurse practitioner (DNP). The oldest nurse interviewed was 61, while the youngest was 24. The mean age of the participants was 38.7±10.53 years. In regard to nursing experience, the individual with the most experience had been a nurse for 29 years, while the individual with the least amount of experience had been a nurse for 1.5 years. The mean years of experience was 11.7±8.8 years. **Table** 3.1

**Table 3.1: Participant characteristics n=14.**

| Characteristics | Number of Participants with Percentage (%) |
|---|---|
| **AGE (years)** | |
| <25 | 1(7.1) |
| 25-34 | 6(43) |
| 35-44 | 3(21.4) |
| 45-54 | 3(21.4) |
| 55-64 | 1(7.1) |
| >65 | 0 |
| 38±10.53 years* | |
| **SEX** | |
| Male | 2(14) |
| Female | 12(86) |
| **RACE/ETHNICITY** | |
| Non-Hispanic White | 8(57) |
| Non-Hispanic Black | 5(36) |
| Hispanic | 1(7) |
| **DEGREE** | |
| *Non-Hispanic White* | |
| Associate Degree | 2(25) |
| BSN | 5(62.5) |
| MSN | 1(12.5) |
| *Non-Hispanic Black* | |
| BSN | 3(60) |
| MSN | 1(20) |
| DNP | 1(20) |
| *Hispanic* | |
| MSN | 1 (100) |
| **YEARS WORKING WITH SEPSIS PATIENTS** | |
| 1-5 | 5(35.7) |
| 6-10 | 4(28.6 |
| 11-15 | 2(14.3) |
| 16-20 | 2(14.3) |
| >21 | 1(7.1) |
| **AREA OF EMPLOYMENT** | |
| ICU | 12(85.7) |
| ED | 2(14.3) |
| **INTERVIEW TYPE** | |
| Face-to-Face | 7(50) |
| Phone | 7(50) |

* Mean standard deviation.

**Table 3.2: Common themes and illustrative quotes.**

| Themes | Quotes Related to Each Theme |
|---|---|
| Benefits and Harm of Early or Delayed Sepsis Treatment | "I think they [nurses tasked with identifying sepsis early] would be delayed if somebody brushes it off [signs and symptoms] as something else." "When we miss the boat and they are already septic by the time we get on board and then they're usually a lot sicker, so I think catching it early is very important." |
| Critical Thinking/ Recognition of Subtle Changes | "Um, really paying attention to a patient's vital signs, just even a slight increase when a patient becomes tachycardic or just a fever increase or even the white cells increasing, can really make a difference." "Um, you have to look at the overall picture." |
| Condition on Admission to the ICU or Condition Deterioration | "Yeah, yeah, because you know a lot of patients, especially in the ICU, will have a lot of, you know, different underlying conditions." "So, we're not, so we're not backtracking and trying trying to play catch up and they're already too sick by the time we recognize what's going on." |
| Communication Regarding Protocols and Guidelines: False Alerts and Adherence | "And we will be calling the doctors, cause some of them are not seeing these things." "I think generally our systems work when we have a a sepsis marker, so we notify the doctor. They're usually pretty good about starting the protocol with fluids and and antibiotics but not always." |

shows participant demographics. Four common themes were extracted from the interviews: 1) Benefits and Harm of Early or Delayed Treatment; 2) Critical Thinking/Recognition of Subtle Changes; 3) Condition on Admission to the ICU or Condition Deterioration; and 4) Communication Regarding Protocols and Guidelines: False Alerts and Adherence. These along with quotes from participants are depicted in **Table** 3.2.

### 3.3.1 Benefits and Harm of Early or Delayed Treatment

Every nurse expressed that recognizing sepsis early and beginning treatment would lead to better outcomes and fewer severe complications. Some of the quotes that fell into this category are as follows: "I think they [nurses tasked with identifying sepsis early] would be delayed if somebody brushes it off [signs and symptoms] as something else" and "When we miss the boat and they are already septic by the time we get on board and then they're usually a lot sicker, so I think catching it early is very important." These nurses recognized that early treatment is the goal and that delayed treatment caused more problems or severe complications.

### 3.3.2 Critical Thinking/Recognition of Subtle Changes

The nurse's ability to utilize critical thinking is extremely important because it assists in setting priorities and making decisions (Falco-Pegueroles et al., 2021). In this study, critical thinking embodied the ability to distinguish between taking a sepsis alert seriously and acting on it or looking at the whole picture and making critical decisions about notifying the medical doctor. Overall, comments from this theme showed nurses felt that small changes in the patient's conditions could be easily overlooked and that you must look at the overall picture. The quotes, "Um, really paying attention to a patient's vital signs, just even a slight increase when a patient becomes tachycardic or just a fever increase or even the white cells increasing, can really make a difference," and, "Um, you have to look at the overall picture," confirmed the ability to put the puzzle pieces together is a big part of critical thinking. Some of the nurses did mention that other conditions or procedures could cause symptoms that mimicked sepsis symptoms, which could complicate early sepsis identification. This made it difficult to rely on the sepsis alert systems for a true notification of the presence of sepsis. By the time septic patients are admitted to the ICU, they are already critically sick and are usually in severe sepsis or septic shock (R. J. Roberts et al., 2017), an occurrence alluded to in the 3rd theme.

### 3.3.3 Condition on Admission to the ICU or Condition Deterioration

By the time septic patients arrive in the ICU, they are already extremely sick and usually in severe sepsis or septic shock (R. J. Roberts et al., 2017). Underlying conditions can affect sepsis prognosis and sepsis outcomes (Rhee et al., 2019). Nurses stated, "Yeah, yeah, because you know a lot of patients, especially in the ICU, will have a lot of, you know, different underlying conditions," and, "So we're not, so we're not backtracking and trying to play catch up, and they're already too sick by the time we recognize what's going on." These quotes suggest the nurses felt that underlying conditions can influence sepsis progression and sepsis outcomes. The nurses who were interviewed felt that correct and effective communication could mean the difference between a patient going through severe complications and dying or getting early sepsis treatment started and saving a life. This was evident in the 4th theme.

### 3.3.4 Communication Regarding Protocols and Guidelines: False Alerts and Adherence

The nurses who were interviewed felt that correct and effective communication between the nurse and the physician could mean the difference between a patient going through severe complications and dying or getting early sepsis treatment started and saving a patient's life. In addition, they valued the protocols and guidelines, as they assisted and guided them through signs and symptoms and informed them of when to notify the physician. For example, nurses stated, "And we will be calling the doctors, cause some of them are not seeing these things," and, "I think generally our systems work when we have a sepsis

marker, so we notify the doctor. They're usually pretty good about starting the protocol with fluids and antibiotics but not always." The "But not always. . . " indicates that nurses and physicians are not always on the same page when identifying sepsis, which may be due to false alerts that mimic sepsis and instead could be an indication of some other condition. In this case, it is important for the nurse and physician to communicate effectively about rationales regarding why sepsis treatment is not currently indicated.

## 3.4 Discussion

Overall, nurses reported that timing was essential to achieving better outcomes, a delay in sepsis care contributed to sicker patients, and critical thinking and the ability to recognize and act on subtle changes contributed to getting treatment started early. These observations are noteworthy, as nurses play a significant role in treatment initiation and ensuring that sepsis alert systems are acted on quickly. They also are instrumental in ensuring that care bundles and protocols are implemented early.

Research has shown that screening and early identification by nurses is essential in decreasing patient death rates (Winters et al., 2017). Implementation of a screening tool by nurses that begins in the ED triage has been shown to increase 30-day survival and produce shorter hospital stays in adult patients (Torsvik et al., 2016). When antibiotics and fluid resuscitation are not implemented early, death rates rise by 7.6% for every hour that passes in the presence of septic shock (Borrelli et al., 2019). Health care facilities have implemented various types of sepsis alert systems to support early sepsis recognition. These sepsis alert systems facilitate early sepsis treatment.

As patient advocates, nurses are vital in recognizing signs and symptoms that may be missed by other healthcare personnel. They play a pivotal role in relaying information accurately and appropriately so that treatment is started in a timely manner. Nurses are often referred to as the eyes and ears for doctors. In the case of sepsis, those eyes and ears can make a considerable difference in getting treatment started early and possibly alleviating some of the signs and symptoms of long-term renal damage due to sepsis.

It is important to note that in the theme, "Communication Regarding Protocols and Guidelines: False Alerts and Adherence," false alerts and adherence referred to conditions other than sepsis that would trigger a sepsis alert, such as hemodynamic instability secondary to other conditions or surgeries. This theme showed that nurses need to be aware of and closely follow guidelines and protocols because they are set in place to guide nurses efficiently through detecting signs and symptoms as well as knowing when the physician should be notified. Early physician notification is critical for medical decision making so that the proper course of antibiotic treatment is initiated (H. C. Prescott & Iwashyna, 2019).

Because AKI is commonly seen in severe sepsis and septic shock (Wu et al., 2019), early identification of sepsis-associated AKI may be enhanced by detection of renal damage biomarkers. Creatinine is routinely monitored; however, newer biomarkers have been

proposed that allow earlier detection of renal damage (e.g., neutrophil gelatinase-associated lipocalin (NGAL), urinary kidney molecule-1 (KIM-1), urinary liver-type fatty acid binding proteins, urinary tissue inhibitor metalloproteinase-2 (TIMP-2), and insulin-like growth factor-binding protein 7(IGFBP7) (Peerapornratana et al., 2019). Early identification of these biomarkers is supported by the theme, "Benefits and Harm of Early or Delayed Sepsis Treatment." These biomarkers have a dependable predictive value that may be fruitful in early detection and treatment of sepsis-associated AKI. Routine analysis of these biomarkers may help nurses as well as medical staff facilitate early detection of sepsis in the presence of AKI. As more data are collected on the usefulness of renal damage biomarkers to monitor the development of sepsis, it may be beneficial to use them in conjunction with guidelines such as the SSC to optimize early sepsis identification. Early recognition of subtle changes in urinary biomarkers may enhance nurses' ability identify sepsis. This also connects with the theme, "Critical Thinking and Recognition of Subtle Changes," which was described in this study in detail by nurses.

Other studies found that lack of sufficient physicians on the wards, uncertainty of the experience of physicians regarding treatment procedures, poorly coordinated handovers or communication errors, too-short contact times with patients by nurses and physicians, and lack of nurse authorization were also barriers(Matthaeus-Kraemer et al., 2016). These themes, however, did not emerge in our study. Although communication regarding protocols and guidelines did emerge as a theme, communication errors were not discussed. Future research in this area may bring further insight into early or delayed sepsis treatment. Last, other studies also found that improving sepsis bundle performance by improving adherence to the one-hour implementation of bundles at the point of diagnosis would improve patient care(N. Roberts et al., 2017).

***Limitations.*** The small sample size and the insularity of participants all being from one facility reduced generalizability of the study. Using two interview methods may have also presented a limitation for this study due to inconsistencies in how the interviews were conducted, however due to the COVID-19 pandemic, converting interviews from face-to-face to telephone was necessary.

## 3.5 Conclusion

Sepsis bundles facilitate early sepsis treatment. Nurses play an essential role in early bundle implementation, a set of protocols that rely on accurate recognition of subtle changes, a patient's baseline condition, and communication with medical doctors. Delays in patient care risk dire patient outcomes. Educating nurses on the importance of recognizing early signs and symptoms of sepsis is essential in facilitating early treatment.

# Chapter 4

# Early Sepsis Identification and Management Among Critical Care Nurses: A Mixed Methods Study

## 4.1 Introduction

Sepsis is a syndrome caused by the body's response to infection. It can lead to life threatening organ dysfunction, severe hypotension and death when severe sepsis or septic shock is involved (Warstadt et al., 2022). Although sepsis can occur at any age, three-fourths of deaths from sepsis in 2019 occurred in people that were 65 or older (Kramarow, 2021). Among those 65 and older, non-Hispanic black adults had the highest sepsis related death rates with most of those deaths occurring in the male population and in rural areas (Kramarow, 2021).

A study done by Rhee et al., 2019 evaluated the prevalence, underlying causes and preventability of sepsis associated mortality in 568 patients from six U.S. hospitals. They found that the most common immediate cause of death was sepsis, and that 12% of the deaths were definitely or moderately likely preventable or possibly preventable (Rhee et al., 2019). Although 12% (36 patients) out of 568 is not a high incidence of preventable deaths, those deaths are meaningful for the families and the loved ones of those who died. Early sepsis treatment is essential to hinder preventable sepsis deaths. Nurses who work in the acute care setting are in an exceptional position because they spend a great deal to time with hospitalized patients, therefore they are essential in identifying early signs and symptoms of sepsis. Critical care nurses who work in the emergency department (ED) or intensive care units (ICU) are frequently confronted with severe sepsis or septic shock, which is associated with a substantially high mortality rate (N. Roberts et al., 2017). This makes it very important that critical care nurses are knowledgeable of tools that assist in early identification and treatment of sepsis.

The Surviving Sepsis Campaign (SSC) provides guidance for healthcare personnel who care for adults hospitalized with sepsis or septic shock (Evans et al., 2021). Sepsis and septic shock are medical emergencies, which require immediate treatment and resuscitation. Although the ability to use clinical decision-making is irreplaceable in certain circumstances, SSC guidelines signify best practice (Evans et al., 2021). Many health care facilities use

screening tools to assist nurses in identifying sepsis early for timely intervention. These include the Systemic Inflammatory Response Syndrome (SIRS) criteria, the National Early Warning Score (NEWS) and the Modified Early Warning Score (MEWS). These screening tools are supported by the SSC along with other important factors in identifying sepsis (Evans et al., 2021).

Because sepsis and septic shock are considered a medical emergency, treatment with antimicrobials should be started immediately, preferably within one hour of diagnosis (Evans et al., 2021). Critical care nurses must be aware of the importance of getting treatment started quickly to combat the progression of sepsis. Compliance with sepsis guidelines is associated with 25% decrease in death (McVeigh, 2020) while evidence shows that delayed sepsis treatment is associated with 3-10% increase for every hour that passes until antibiotics are given (Pelton & Liu, 2020). Critical care nurses must have the knowledge and skills to recognize sepsis early and prevent delays which could contribute to a more complicated course of treatment, poor outcomes, and death. Because critical care nurses spend a great deal of their time caring for hospitalized patients who are diagnosed with sepsis, severe sepsis or septic shock, their opinions on what contributes to early or delayed sepsis could give insight into barriers that cause delayed sepsis treatment. The purpose of this study is to gauge how critical nurses who work in ED and ICU perceive factors that might affect early or delayed sepsis treatment.

## 4.2 Methods

### 4.2.1 Design

An exploratory sequential mixed methods approach was performed to describe the study findings. Qualitative data were collected and analyzed, whereby themes were extracted and explained using a phenomenological method (see chapter 3). The qualitative portion of the study was performed in March 2020 in one acute care urban hospital in the mid south. Fourteen nurses were interviewed using four semi-structured interview questions. Each qualitative theme was sub-categorized into either primary, secondary, or tertiary prevention for this study. Descriptive statistics were used to analyze the results of a self-completed survey for the quantitative portion of the study. A paper survey devised of forty-two closed ended questions, some of which had parts A and B to them and/or an additional line for why or other answers. The questions were divided into three categories to support the Neuman Systems Model's Prevention as Intervention (Fawcett & Desanto-Madeya, 2013). This model was developed by nursing theorist, Betty Neuman. Prevention as Intervention is a middle range theory that focuses on primary, secondary and tertiary prevention. There were eight questions categorized under primary prevention, 20 questions categorized under secondary prevention, and seven questions categorized under tertiary prevention. The twenty questions under secondary prevention were mainly focused on the SSC guidelines. The remaining questions were those categorized under demographics. The quantitative

data was utilized to strengthen the themes of the qualitative themes. See the methods section of chapter 3 for qualitative methods.

### 4.2.2 Rigor and Validity

For the quantitative portion, leading questions were avoided by giving options of not sure, uncertain, or sometimes. Wording was carefully constructed to enhance participants' understanding of what the questions were asking, this added validity to the questions. The survey was given to four nurses to assess the time it took to complete as well as to assess its clarity and conciseness. A sepsis coordinator from the participating healthcare system also reviewed the form to evaluate its content and to ensure that it adequately covered the relevant domains. This also enhanced the validity of the instrument.

### 4.2.3 Participants

The survey was distributed among a total of one hundred nurses at two acute care hospitals (site 1 and site 2) within the same healthcare system in the state of Tennessee, USA. Twenty-one participants were from site 1 and 79 participants were from site 2. A convenience sample of critical care nurses from ED and ICU from both hospitals was taken to assess their opinions on factors that contribute to early or delayed sepsis identification and management. The nurses had various years of experience and time working in critical care. Participant demographics are displayed in **Table** 4.1

### 4.2.4 Data Collection

Surveys were given out to participants and collected between January 17th and 28th, 2022. Nominal scales were used to collect participant demographics while ordinal, interval and Likert scales were used to identify attitudes toward perceived delays in sepsis identification and management.

### 4.2.5 Ethical Considerations

Ethical approval was granted through the Institutional Review Board (IRB) at the University of Tennessee Health Science Center and the participating healthcare system. Because there was no invasive or physical contact, written consent was not required. Participation in filling out the survey implied consent.

### 4.2.6 Quantitative Data Analysis

There were one hundred participants with evaluable data. Summary statistics were provided as median and inter-quartile range or frequency and percentages as appropriate. Wilcoxon rank-sum test was used to compare the continuous demographic and outcome between nurses from site 1 and site 2 while the association between site and categorical variables was tested via Chi-square tests with p-values determined by 10,000 Monte Carlo

**Table 4.1: Participant demographics.**

| Demographics | N Subjects | Levels | Median IQR (%N) |
|---|---|---|---|
| Site | 100 | 1 | 21(21%) |
| | | 2 | 79(79%) |
| Age | 100 | | 35.5(28∼43) |
| Gender | 100 | F | 85(85%) |
| | | M | 15(15%) |
| Primary Language | 100 | Arabic | 1(1%) |
| | | Creole/French | 1(1%) |
| | | English | 96(96%) |
| | | Other | 2(2%) |
| Ethnicity | 98 | H | 1(1.2%) |
| | | NH | 97(98.98%) |
| Race | 100 | AA | 25(25%) |
| | | AI | 1(1%) |
| | | AS | 6(6%) |
| | | AS/W | 1(1%) |
| | | NHa | 1(1%) |
| | | W | 66(66%) |
| Degree | 100 | AD | 22(22%) |
| | | BSN | 70(70%) |
| | | DN | 2(2%) |
| | | MSN | 6(6%) |
| Yrs as a RN | 99 | | 8(3∼13) |
| Yrs Working in ED/ICU | 99 | | 6(3∼11.5) |
| Employment Area | 100 | ICU | 77(77%) |
| | | ED | 23(23%) |

Abbreviations: M=Male, F=Female, H= Hispanic, NH= non-Hispanic, AA= African American, AI= American Indian, AS= Asian, AS/W= Asian White, NHa= Native Hawaiian, W= White, AD= Associate Degree, BSN= Bachelor of Science in Nursing, DN= Diploma in Nursing, MSN= Master of Science in Nursing, ICU= intensive care unit, ED= Emergency Department, RN= Registered Nurse, IQR= interquartile range.

simulation. Statistical significance was evaluated by an alpha of <0.05. All analyses were performed in R-4.1.2. Qualitative themes from chapter 3 were further analyzed to assess their association with and influence on quantitative data.

## 4.3 Results

### 4.3.1 Qualitative Results

After interviews were transcribed and coded four mutual themes were obtained. 1) Benefits and Harm of Early or Delayed Treatment; 2) Critical Thinking/Recognition of Subtle Changes; 3) Condition on Admission to the ICU or Condition Deterioration; and 4) Communication Regarding Protocols and Guidelines: False Alerts and Adherence. See **Table** 3.2 for a list of the themes along with quotes from participants. Many quotes were given by nurses participating in the interviews, therefore, the quotes in chapter 3 are different from the quotes in this chapter, although the same interviews were used.

#### Themes

In line with the theoretical framework, Prevention as Intervention, the themes were subcategorized into primary, secondary or tertiary prevention in this chapter.

#### Primary prevention

Primary prevention promotes wellness by reducing known risk factors that can could cause harm (Fawcett & Desanto-Madeya, 2013). The following themes were placed in this category because early sepsis identification and management can prevent major health issues that could be related to delayed sepsis identification.

***Benefits and harm of early or delayed treatment.*** All nurses that were interviewed acknowledged that early sepsis recognition and management promoted better patient outcomes and fewer complications. Two of the phrases from nurses that fit into this theme were: "Ah, early sepsis identification and treatment has been proven to show decrease in mortality rate and less organ failure, such as kidney failure…as soon as the sepsis alert has occurred, we immediately start antibiotic treatment and of course, um start cardiac monitoring" and "The quicker you act on whatever you see, the better, cause usually it…time could be running out". These quotes show that nurses understand that early identification is critical in hindering further decline that is associated with delayed sepsis identification and treatment.

***Critical thinking/recognition of subtle changes.*** Critical thinking is the capability to set priorities and make decisions through skillful analysis, synthesis, and evaluation of gathered information which is obtained by observation, experience, and effective communication (Kang et al., 2020). This gathered information is used to guide reasonable decisions

for proper action (Kang et al., 2020). To set priorities and make sound and effective decisions, it is essential that nurses are able to use critical thinking (Falco-Pegueroles et al., 2021). In this study, nurses used critical thinking to differentiate between responding to every sepsis alert, whether it was a false alert or not or looking at the whole picture and deciding if reporting findings to the medical doctor is appropriate at the time. Overall, statements from this theme revealed that nurses believed that slight changes in the patient's condition could be easily ignored and that you must look at the complete picture. The quotes, "You just have to look at the whole patient, ah, and then, you have to look at the sepsis criteria, and go from there" and "I mean you have to, you have to really take a look at everything, you know the white blood count and what's going on, the whole issue with the patient" reinforced the fact that the ability to put the puzzle pieces together is an essential part of critical thinking. A few of the nurses did point out that other illnesses or medical procedures could produce signs or symptoms that mirrored sepsis, which could obscure early sepsis identification. This made relying on the sepsis alert systems for accurate identification of sepsis complicated.

**Secondary prevention**

Secondary prevention involves utilizing appropriate interventions to provide treatments to alleviate symptoms and attain optimal stability (Fawcett & Desanto-Madeya, 2013).

***Condition on admission to the ICU or condition deterioration.*** Sepsis patients are extremely sick and usually in severe sepsis or septic shock by the time they arrive in the ICU (N. Roberts et al., 2017). Prognosis and outcomes of sepsis patients could be impacted by underlying conditions (Rhee et al., 2019). Nurses stated, "Well, sometimes, they come in already septic and it's just hard to, to treat them," "by the time they get to us, you know, it's been going on for some time" and " I think it, ah, that depends really on the patient, um because you know with COPD patients, or if anyone that had kidney failure, you're automatically gonna screen them, but their baseline respirations can be greater than 20, their creatinine could be greater than 2, so I think it comes down to the patient. If their normal baseline is like, their heart rate is eighty and then now they're greater than 90, you're like yeah that is something to be concerned about". From these quotes, nurses indicated that they believed condition on admission could complicate sepsis management and that underlying ailments can impact sepsis progression and outcomes.

***Communication regarding protocols and guidelines: false alerts and adherence.*** In addition to correct and effective communication between the nurse and physician, nurses felt that the protocols and guidelines were valuable tools in assisting and guiding them through signs and symptoms of sepsis and in notifying them of when to contact the physician; however, sepsis alert systems could alarm at inappropriate times. They felt that effective communication among health care professionals (i.e., nurses and physicians) could hinder severe complications or death and assist in getting early sepsis treatment started thereby potentially saving a patient's life. This was evident in the following quotes from

nurses. "um, well, here in the unit, in ICU, whenever we do assessments, um the computer automatically pulls the criteria that's set by the protocol in the hospital and if we meet 2 or more of those criteria, the computer will automatically kick back the alert, and it's up to the nurse to be aggressive in contacting the ah, primary team that's on call, or the primary care provider. Let them know that a sepsis alert has been signaled and to get the next step in orders or to ask the physician to come to the bedside, which ever one is the most needed to them," and, "um, I feel like this hospital does a great job in notifying um, the nurses when a sepsis alert occurs and ah, which allows the nurses to notify the doctor immediately, which of course, increases um, treatment for the patient and benefits for the patient". An indication of how false alerts can influence a sepsis alarm was manifested in the following quote: "um, a lot of our patients are tachycardic after surgery or cold, which of course will immediately trigger a sepsis screening, so I think it's very important that we do pay attention that um, just because a lot of surgical patients can trigger that even if they're not septic". This is an example of why it is important that nurses and physicians effectively communicate regarding the necessity of sepsis treatment.

#### Tertiary prevention

Tertiary prevention is the re-adjustive process of returning to wellness or baseline health or maintaining wellness (Fawcett & Desanto-Madeya, 2013).

### 4.3.2 Consequences of delayed sepsis treatment

Because only eight out of fourteen nurses that were interviewed referred directly to the consequences of delayed sepsis treatment, this was not identified as a theme in chapter 3 but pertaining to tertiary prevention, it was appropriate to add this as a fifth theme here. Nurses spoke of the consequences of delayed sepsis treatment in the following statements. "Um, if we don't pay attention to the signs beforehand, um, usually by the time we get to it, they're already tachycardic, they're already febrile, they're usually hypotensive already and then we're trying to catch up to fix their heart rate, and fix their blood pressure and get everything on board where as if we started sooner, they wouldn't have been that bad and needed to be resuscitated as much I think" and "I think early treatment is always the best outcome for the patient, cause once you know, when sepsis gets into the late period, more than likely it's too far gone and death is usually imminent, so I do think that early awareness is, is the best". These statements signify that early treatment is best in returning the patient back to wellness or to their baseline state.

### 4.3.3 Quantitative Results

#### Respondent characteristics

One hundred surveys were given out, all of which were returned with usable data. Of the 21 participants from site 1, 9 were ICU nurses and 12 were ED nurses. Site 2 had 79

participants. Thirteen were from ED and the remainder were from multiple ICU units. Seventeen were from Neuro ICU, 13 were from Cardiovascular ICU, and 36 were from combined Medical and Surgical ICU. Participant were evaluated as one group of 100, by hospital site (site1 and site 2), by degree (BSN versus AD) and by years as a registered nurse; those who have been a nurse $\leq$5 years versus those who have been a nurse $\geq$ 10 years. See Table 1. for participant demographics.

**Identification of sepsis**

Of 99 respondents, 95% acknowledged that they were able to reliably recognize sepsis. By sites, 9.5% from site 1 and 3.8% from site 2 stated that they were not able to reliably recognize sepsis. There were no significant differences in the way Bachelor of Science (BSN) degree vs Associate Degree (AD) nurses answered this question. Additionally, there was no significant difference in answers between the participants who had been nurses less than or equal to 5 years ($\leq$5 years) and those who had been nurses greater than or equal to 10 years ($\geq$10 years). The **Supplemental Chart of Survey** is a complete chart of survey questions and answers gauging nurses opinions and perspectives on early or delayed sepsis treatment.

**Prevention practices**

When asked about prevention practices, 62% of participants were more likely to apply the SSC guidelines to patients with clinically recognizable signs of septic shock such as hypotension rather than biochemical evidence of septic shock such as elevated lactate. This remained relatively consistent when evaluated by degree level, years as a nurse and by site. When asked if a patient with a temperature $\geq$ 38.3°C is more likely to be assessed and treated for sepsis than a patient with a temperature $\leq$36.0°C, 93% of participants who had been nurses $\leq$5 years either agreed or strongly agreed whereas only 54.0% of participants who had been nurses $\geq$10 years either agreed or strongly agreed. Another question regarding preventative practices, Are the SSC treatments (i.e., antimicrobials and IV fluids) available at the point of care, revealed that 68.2% of participants who had been nurses $\leq$5 years answered yes however only 46% of participants who had been nurses $\geq$10 years answered yes to this question. When analyzed by degree, there was not much difference in how the question was answered. Fifty nine percent of AD nurses stated yes when asked if SSC treatments were available at the point of care, similarly 60% BSN nurses stated yes to this question. When evaluated by site, 71% of site 1 participants answered yes while 59% at site 2 answered yes. Overall, 33% of the 100 participants felt that SSC treatments are available at the point of care sometimes. The final question involving preventative practices, have you had training from your hospital system regarding the management of sepsis, revealed that overall, 95% of participants from both sites answered yes, they have had training from their hospital regarding sepsis management however only 76% felt that it was sufficient.

**Self-reported knowledge**

Self-reported knowledge regarding sepsis management was evaluated by asking questions regarding early sepsis management and regarding delayed sepsis management. Participant attitudes regarding early or delayed sepsis management was also evaluated. In relation to early sepsis management, participants were asked: Based on your education on sepsis guidelines and protocols, have you witnessed improved outcomes in the patients with sepsis that you have taken care of? Overall, 76% of participants answered yes while 19% were uncertain. When analyzed by degree, of 92 respondents, 91% of AD nurses answered yes to this question while only 74% of BSN nurses answered yes. Examination by years as a nurse revealed that 83% of participants who had been nurses $\leq$5 years answered yes while 73% of participants who had been nurses $\geq$10 answered yes. When analyzed by site, results were consistent with overall results. Site 1 had 76% answer yes and 76% from site 2 answered yes. An additional question related to early sepsis management was: based on your knowledge, has implementation of early sepsis treatment protocols impacted the outcome or end result in patients you have taken care of? Eighty-eight (88%) out of 100 participants answered yes. This result was consistent when analyzed by site, degree, and years as a nurse.

In relation to delayed sepsis management, participants were asked based on your knowledge of SIRS criteria, have you witnessed poor outcomes due to delayed SIRS recognition in patients that you have cared for? Overall, 73% of participants answered yes while 17% were unsure. These results remained consistent across each area of examination. For further inquiry into delayed sepsis management, we asked, have you ever identified poor renal outcomes after sepsis treatment is completed in patients that you have cared for. Overall, 59 (59%) out of 100 participants answered yes to this question. These results were also consistent across each level tested.

Self-reported attitudes regarding early or delayed sepsis management were also evaluated. Participants were asked: do you agree that the 4 main components of the SSC guidelines (i.e., lactate level, blood cultures, antimicrobials, and IV fluids) are necessary? Overall, 94% of participants agreed or strongly agreed that the 4 main components of the SSC guidelines were necessary. When evaluated by site, 80% of participants from site 1 agreed or strongly agreed that the 4 components were necessary while 96% of participants from site 2 agreed or strongly agreed that the 4 components were necessary. Results were consistent when evaluated by site and years of nursing experience. Participants were asked if they would welcome more education and training regarding the management of sepsis. All respondents answered this question similarly across each level tested with approximately 90-94% either agreeing or strongly agreeing that they would welcome more education and training regarding sepsis management. When asked what area of the sepsis education program can be improved, participants from both site 1 and site 2 chose identifying the septic patient as the greatest area of needed improvement. **Figure** 4.1 displays areas needing improvement in the sepsis education program as according to survey respondents.

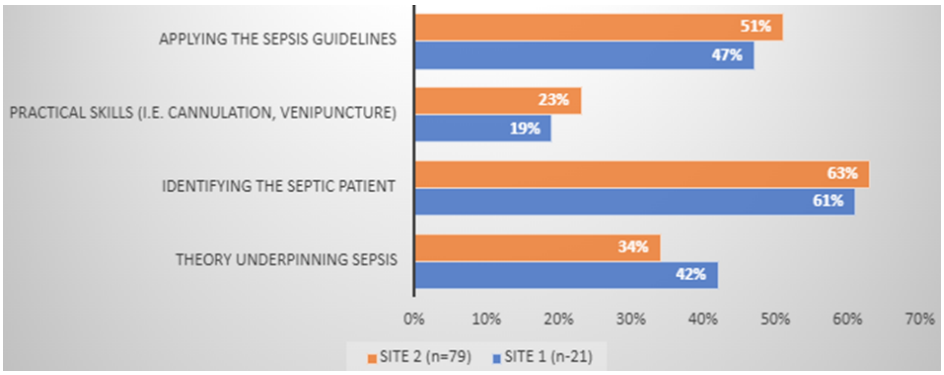


**Figure 4.1: Areas of the sepsis education program that need improvement as reported by survey participants**.

participants were asked if they agreed that the SSC guidelines can be completed within one hour, overall, 52% responded answered yes, 29% were unsure and 19% responded no. Thirty one percent of BSN nurses were unsure if the SSC guidelines can be completed in one hour however only 18% of AD nurses were unsure. Other areas surveyed on this question were consistent with overall results. When asked what is considered the greatest cause of delay in the identification of sepsis, overall, participants ranked lack of sepsis recognition (70%) and delay in receiving lab results (68%) as the first and second greatest cause of delay in sepsis identification.

**Impact of years of experience on sepsis identification and management**

During analysis of the data a difference in years of experience in relation to sepsis identification and management stood out. Novice nurses seemed to rely more on critical thinking than the ability to follow SSC guidelines and protocols. To gauge participants' opinions on what they felt was most important in early sepsis identification, participants were given a choice of choosing critical thinking or the ability to follow guidelines and protocols. Seventy seven percent of participants who had been nurses $\leq$5 years answered that critical thinking was more important whereas 59% of participants who had been nurses $\geq$10 years answered that critical thinking was most important. Only 10% of nurses with $\leq$5 years of nursing experience responded that both critical thinking and the ability to follow guidelines and protocols were most important however 24% of participants who had been nurses $\geq$10 years felt that both were equally important. When this question was analyzed by educational degree (BSN vs AD) there was a significant difference (p-value 0.0145) in how each group answered the question. Seventy four percent of BSN nurses felt that critical thinking was most important however only 57% of AD nurses felt that critical thinking was most important. Conversely, 33% of AD nurses believed that both were equally important compared to only 10% of BSN nurses believing that both were equally important. When

participants were asked if they were likely to recognize subtle changes that may represent early signs of sepsis such as hypotension, tachycardia, elevation in WBC or altered mental status, 83% of respondents with $\leq$5 years of nursing experience answered that they were likely or highly likely to recognize subtle changes compared to 95% of participants that have been nurses $\geq$10 years. Examination of this question in other areas did not yield any significant difference in the way participants answered.

To analyze sepsis management in relation to years of experience, participants were asked about their understanding of how a serum lactate test result can be used to influence the management of a patient with sepsis. There was a significant difference (p-value 0.0108) in how the two groups based on years of experience answered the question. Of participants who had been nurses $\leq$5 years, 71% compared to 95% of participants who had been nurses $\geq$10 years answered that they knew how a serum lactate test result could be used to influence the management of a patient with sepsis. There were no other significant differences seen in other areas where this question was analyzed. Overall, 83% of participants felt that they knew how serum lactate results could influence sepsis management.

## 4.4 Inferences Drawn

Quantitative (QUAN) surveys were developed and tailored to further analyze, expand on, and support the qualitative (QUAL) themes that were extracted from the interviews with nurses. The QUAL themes were compared to QUAN results, with findings revealing that most of the QUAN results supported the QUAL themes. Analysis for most of the survey questions addressed here were from the pooled one hundred survey participants. In one of the questions, only ninety-eight participants answered the question.

Regarding the first theme, 'Benefits and harm of early or delayed sepsis treatment,' 93% of participants surveyed answered that they were either familiar or very familiar, when asked if they were aware of the benefits of early sepsis treatment. Over half of the participants, 76%, answered that they were either familiar or very familiar when asked if they were able to list SIRS criteria. Familiarity with SIRS criteria promotes early sepsis identification. Because nurses alluded to the benefits of early sepsis treatments in their quotes, these survey questions supported the QUAL theme.

The next theme was 'Critical Thinking/Recognition of Subtle Changes.' In the QUAL portion of the study, nurse felt that seeing the whole picture was important. This required the ability to use critical thinking. When asked which was most important in early sepsis identification, critical thinking or the ability to follow guidelines and protocols, 68% of the 98 respondents felt that critical thinking was most important. Ninety percent of 100 respondents answered likely or highly likely when asked if they were likely to recognize subtle changes that may represent early signs of sepsis development. Again, the survey results supported the fact that nurses felt that critical thinking/recognition of subtle

changes was most important. The theme 'Condition on Admission to the ICU or Condition Deterioration,' was a recurrent reference in the QUAL interviews. When asked about condition on admission and its impact on sepsis treatment, 84% of survey respondents answered yes, condition on admission or condition deterioration had an impact on sepsis treatment. With over half of respondents answering yes to this question, it was evident that the QUAN findings supported the QUAL findings. Survey participants were also asked if a patient's condition on admission negatively contributed to their having worse outcomes. Sixty-six percent of respondents answered yes which further supports the QUAL theme.

The fourth theme that was extracted from the interviews was 'Communication Regarding Protocols and Guidelines: False Alerts and Adherence.' The questions related to this theme were: 1. How likely are false sepsis alerts to interfere with early recognition of sepsis? Seventy-one percent answered that false sepsis alerts were somewhat likely or likely to interfere with early sepsis recognition. 2. How do you consider the communication with physicians regarding sepsis protocols and guidelines? Sixty-three percent answered that communication with physicians regarding sepsis protocols was neither difficult nor complex. 3. Based on your experience, has poor communication with physicians led to poor outcomes in the management of patients with sepsis that you have taken care of? 51% answered yes while 49% answered no or uncertain. These survey results support the theme Communication Regarding Protocols and Guidelines: False Alerts and Adherence but they also suggest that some nurses may have had ineffective communication with physicians which could negatively influence sepsis management.

Finally, the last theme, which was identified as a theme here because over half of the nurses interviewed alluded to it, 'Consequences of delayed sepsis treatment' was supported in the QUAN survey in the question; based on your experience, have technical and procedural issues led to poor outcomes in patients with sepsis that you have taken care of? Seventy-nine percent of respondents answered yes to this question. This is evidence that technical and procedural issues can lead to delayed sepsis management, which can be detrimental to sepsis patients. **Table** 4.2 is collaborative display charts designed to allow QUAN and QUAL data to be seen as a joint convergence where interviews and survey data can be compared.

## 4.5 Discussion

This study, comprised of 14 participants for the QUAL interviews and 100 participants for the QUAN analysis, was created to evaluate the perspectives and opinions of nurses toward sepsis identification and management. All participants, who were nurses from various backgrounds and years of experience, had cared for sepsis patients during their careers. The QUAL portion of the study was formatted after the Breen and Rees, 2018 study highlighting the barriers to implementing the Sepsis Six Pathway among doctors and nurses in an acute teaching hospital in the United Kingdom (UK). Although this study was structured after the Breen and Rees, 2018 article, we did add our own characteristics by only including

## Table 4.2: Collaborative display chart of themes and survey data.

| Theme | Interview Quotes | Survey Data |
|---|---|---|
| **Benefits and Harm of Early or Delayed Treatment** | "Ah, early sepsis identification and treatment has been proven to show decrease in mortality rate and organ failure, such as kidney failure…as soon as the sepsis alert has occurred, we immediately start antibiotic treatment and of course, um start cardiac monitoring" | 93% of participants surveyed answered that they were either familiar or very familiar, when asked if they were aware of the benefits of early sepsis treatment. |
| | "The quicker you act on whatever you see, the better, cause usually it…time could be running out". | Over half of the participants, 76%, answered that they were either familiar or very familiar when asked if they were able to list SIRS criteria. |
| **Critical Thinking/Recognition of Subtle Changes** | "You just have to look at the whole patient, ah, and then, you have to look at the sepsis criteria, and go from there" | 68% of 98 respondents felt that critical thinking was most important. |
| | "I mean you have to, you have to really take a look at everything, you know the white blood count and what's going on, the whole issue with the patient" | 90% of 100 respondents answered likely or highly likely when asked if they were likely to recognize subtle changes that may represent early signs of sepsis development |
| **Condition on Admission to the ICU or Condition Deterioration** | "Well, sometimes, they come in already septic and it's just hard to, to treat them" | 84% of survey respondents answered yes, condition on admission or condition deterioration had an impact on sepsis treatment. |
| | "by the time they get to us, you know, it's been going on for some time" | 66% of respondents answered yes when asked if a patient's condition on admission negatively contributed to their having worse outcomes |
| | " I think it, ah, that depends really on the patient, um because you know with COPD patients, or if anyone that had kidney failure, you're automatically gonna screen them, but their baseline respirations can be greater than 20, their creatinine could be greater than 2, so I think it comes down to the patient. If their normal baseline is like, their heart rate is 80 and then now they're greater than 90, you're like yeah that is something to be concerned about". | No responses |
| | "um, well, here in the unit, in ICU, whenever we do assessments, um the computer automatically pulls the criteria that's set by the protocol in the hospital and if we meet 2 or more of those criteria, the computer will automatically kick back the alert, and it's up to the nurse to be aggressive in contacting the ah, primary team that's on call, or the primary care provider. Let them know that a sepsis alert has been signaled and to get the next step in orders or to ask the physician to come to the bedside, which ever one is the most needed to them," | 71% answered that false sepsis alerts were somewhat likely or likely to interfere with early sepsis recognition. |
| **Communication Regarding Protocols and Guidelines: False Alerts and Adherence** | "um, I feel like this hospital does a great job in notifying um, the nurses when a sepsis alert occurs and ah, which allows the nurses to notify the doctor immediately, which of course, increases um, treatment for the patient and benefits for the patient" | 63% answered that communication with physicians regarding sepsis protocols was neither difficult nor complex |
| | "um, a lot of our patients are tachycardic after surgery or cold, which of course will immediately trigger a sepsis screening, so I think it's very important that we do pay attention that um, just because a lot of surgical patients can trigger that even if they're not septic" | 51% answered yes while 49% answered no or uncertain when asked has poor communication with physicians led to poor outcomes in the management of patients with sepsis that you have taken care of |
| **Consequences of Delayed Sepsis Treatment** | "Um, if wd don't pay attention to the signs beforehand, um, usually by the time we get to it, they're already tachycardic, they're already febrile, they're usually hypotensive already and then we're trying to catch up to fix their heart rate, and fix their blood pressure and get everything on board where as if we stated sooner, they wouldn't have been that bad and needed to be resuscitated as much I think" | 79% of respondents answered yes when asked if technical and procedural issues led to poor outcomes in patients with sepsis that you have taken care of |
| | "I think early treatment is always the best outcome for the patient, cause once you know, when sepsis gets into the late period, more than likely it's too far gone and death is usually imminent, so I do think that early awareness is, is the best" | No responses |

nurses in our study and analyzing survey answers by degree, years as a nurse, hospital site and as a group of 100 participants.

Overall, QUAL data was supported by QUAN data. Both studies revealed that nurses understand sepsis and its implications if early identification and management is not initiated. A study by Öztürk Birge et al., 2021 found that nurses had the ability to recognize early signs of sepsis, however they were unable to distinguish between signs of early sepsis and signs of late sepsis (Öztürk Birge et al., 2021). Ninety-five percent of the participants in this study felt that they were able to recognize sepsis.

Overall, 85% participants stated that they knew how a serum lactate test result can be used to influence the management of a patient with sepsis, however 85% of respondents also stated that they do not have access to equipment such as blood gas analyzer, including the password for its operation to measure lactate. This could potentially have an impact on early sepsis treatment. In relation to the themes, this would be categorized under 'benefit/harm of early or delayed treatment.' When analyzed by years of experience, 95% of participants who had $\geq$10 years of experience as a nurse knew how serum lactate test result can be used to influence the management of a patient with sepsis compared to 71% of those who had $\leq$5 years of experience as a nurse. This was a significant difference (p-value 0.0108) in terms of years of experience which may indicate that experience plays a part in ability to accurately manage sepsis patients. One study found that triage Point of Care (POC) fingertip lactate is a reasonable technique for increasing early identification of lactate levels in sepsis patients (Goyal et al., 2010).

Participants were asked, which was most important in early sepsis identification, critical thinking, or the ability to follow guidelines and protocols. Overall, 68% of participants felt that critical thinking was most important, however when analyzed by years of experience, 77% of respondents with $\leq$5 years of experience stated that critical thinking was most important whereas only 59% of respondents with $\geq$10 years felt that critical thinking was most important. Nursing should teach specific mental behaviors and encourage the development of critical thinking in the education process (Pucko & Przybek-Mita, 2020). This assists nurses in identifying logical-linguistic flaws, differentiating between facts and assumptions, revealing ways of using statistical data, and identifying eristic tactics (Pucko & Przybek-Mita, 2020). This may indicate that nurses who have recently finished their nursing education may have been better trained on critical thinking than nurses who finished their nursing programs over 10 years ago. Critical thinking may assist nurses in recognizing subtle changes that may assist in early sepsis identification. This supports the theme 'critical thinking/recognition of subtle changes.'

Study participants ranked poor communication and coordination of care, knowledge deficit regarding appropriate management, and lab delays as the 1st, 2nd, and 3rd greatest cause of delays in sepsis treatment, respectively. **Figure** 4.2 displays ranked causes of delays in sepsis treatment by sites. While 63% of survey participants acknowledged that they consider communication with physicians neither difficult nor complex, 51% of participants

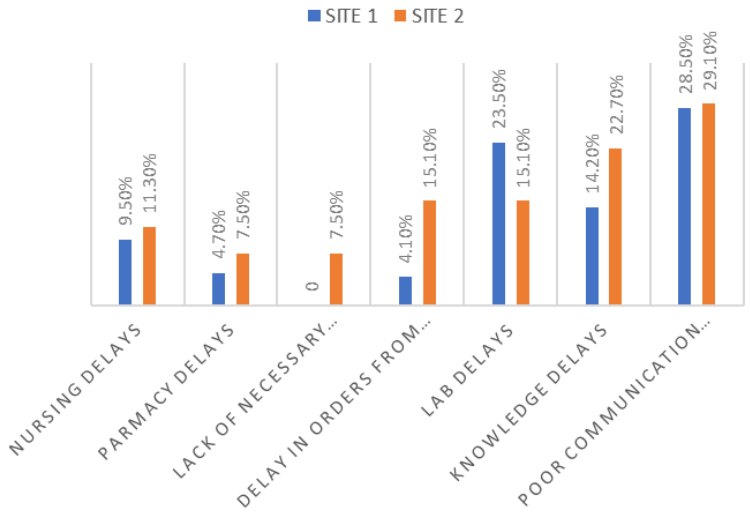


**Figure 4.2: Chart of ranked causes of delays in sepsis treatment by sites**.

answered yes when asked if poor communication with physicians has led to poor outcomes in the management of sepsis patients that they have taken care of. The difference in these answers may be conflicting, however with poor communication and coordination of care chosen as the greatest cause of delays in sepsis treatment, it is obvious that poor communication is a dilemma. Because 'communication regarding sepsis protocols and guidelines' was a recurrent theme in the QUAL interviews, there is valid concern that this is an area where effective communication should be discussed in in-services and educational programs. For safety and quality care, effective communication among nurses and physicians is imperative (Wang et al., 2018).

Nurses face several challenges when caring for sepsis patients. Early identification and management can be complicated because timing is essential as mortality rates increase when treatment is delayed. When nurses can detect what contributes to early or delayed sepsis identification and management, they have an advantage in decreasing complications related to sepsis. Although the nurses in this study appear to be very knowledgeable about early sepsis management and identification, there were areas that need improvement, such as effective communication.

### 4.5.1 Practice Implications

Study findings indicate that nurses could benefit from more education on sepsis management and effective communication. Improved education on hospital units and in hospital educational programs that stress the importance of early sepsis recognition and management are essential. Implementation of yearly continuing education programs to keep

nurses abreast of latest trends and data on sepsis identification and management would be beneficial.

### 4.5.2 Limitations

The study participants were all from one hospital system in the mid-south which limits generalizability. Also sample size is small, therefore sub analysis may be limited.

## 4.6 Conclusion

Critical care nurses who work in ED or ICU can assist in early sepsis identification and management if they are truly knowledgeable of its benefits. Poor communication and coordination of care among nurses and physicians was found to be one of the greatest causes of delay in care, therefore effective communication is an area that needs to be woven into education programs. There were some differences in how the questions were answered according to educational degree and years of experience, therefore, more analysis in these areas is needed to better assess their association. Although self-knowledge of sepsis identification was high among participants, sepsis management was more difficult. More education is needed on sepsis management and should be provided in hospital ED and ICU units. Yearly continuing education programs should be implemented to keep nurses well informed on sepsis identification and management.

# Chapter 5

# Conclusion

## 5.1 Summary

There is a rise in the prevalence and seriousness of sepsis which impacts a substantial number of populations worldwide. This contributes to a higher rate of death and severe illness internationally. The kidneys are frequently among the first organs to suffer the loss of function due to sepsis, leading to sepsis-induced acute kidney injury (AKI). As a prominent reason of death and adverse renal outcomes, this has become an increasing concern globally.

To assess the current literature concerning long-term renal outcomes and renal consequences after sepsis-induced AKI in adults, a state of the science review was conducted (Harris & Umberger, 2020). Four common themes were identified among 12 selected articles. They were (1) AKI determination criteria, (2) severity of disease/prognosis related factors, (3) time frame for long-term outcome measures, and (4) CKD and renal-related exclusion criteria. We found that a consensus definition was developed to produce a standardized method of measuring AKI (Harris & Umberger, 2020). This gives healthcare personnel a way of detecting and treating AKI sooner, thus decreasing the prevalence of secondary long-term renal damage. Most of the studies found that AKI severity and acuity had an impact on prognosis. AKI was related to inauspicious outcomes such as CKD, ESRD, and RRT or death but if sepsis was treated in its early stages, AKI exhibited less severity as seen in severe sepsis or septic shock. Sepsis induced AKI was usually seen in the ED and had higher in-patient rates of mortality. Patients who recover from sepsis induced AKI by hospital discharge, progress as well as AKI patients who did not have sepsis; however, death rates are increased if full kidney recovery is not obtained at hospital discharge. Long-term renal outcomes were measured from 28 days to 3 years (Harris & Umberger, 2020). Outcomes varied from complete recovery to dependence on RRT. Patients with CKD at any stage were excluded from the studies that we evaluated.

AKI treatment and its long-term renal outcomes can be heavily impacted by nurses' timely implementation of appropriate treatments. They are encouraged to "think sepsis" when subtle changes appear in patients with potential infection. To restrain the effects of

sepsis induced renal complications, early identification and aggressive sepsis treatment are imperative.

When we interviewed nurses in a qualitative inquiry to evaluate their perspectives on what contributed to early or delayed sepsis treatment, four themes were extracted. They were: 1) Benefits and Harm of Early or Delayed Treatment; 2) Critical Thinking/Recognition of Subtle Changes; 3) Condition on Admission to the ICU or Condition Deterioration; and 4) Communication Regarding Protocols and Guidelines: False Alerts and Adherence. This first study found that nurses felt timing was vital to accomplishing improved outcomes, a delay in sepsis care caused sicker patients, and critical thinking and the ability to identify and take action on subtle changes impacted early sepsis treatment. The nurses revealed that condition on admission could lead to poor prognosis, hence the importance of early treatment and that underlying comorbidities could contribute to deterioration in patient condition. The nurses also felt that effective and correct communication with physicians could enhance early identification but that false alerts due to other conditions are a significant issue.

Early identification of sepsis is especially important in protecting organ function as well as preserving life, a conclusion that led to the development and execution of the Surviving Sepsis Campaign (SSC). Sepsis bundles assist nurses in facilitating early sepsis treatment. These bundles guide nurses in getting treatments started in a timely manner, with a goal of implementation within a hour of sepsis diagnosis. Many studies have established that early treatment is vital to avoiding debilitating injury from sepsis in general and from organ failure specifically.

Nurses have a significant role in early bundle application which have been shown to decrease delays in patient care and reduce the risk of poor patient outcomes. Early treatment is enhanced by ensuring that nurses are educated on the value of early recognition of sepsis signs and symptoms. Timely implementation of sepsis management is crucial to patient survival and outcomes because organ failure increases as more time passes without treatment. Therefore, nurses are on the front line in identifying signs of sepsis and getting treatment started as soon as possible. Early sepsis identification and management are major factors in protecting renal function. Swift implementation of treatment from the nurse's standpoint saves function and saves lives because they devote more time to patients care than most other healthcare disciplines during their hospital stay, therefore they are in prime positions for early recognition of sepsis.

Ensuring that nurses understand how timing impacts renal outcomes and could possibly lead to improved prioritizing by nurses so that time is not wasted when getting treatment started. Substantial improvement toward imminent renal complications will be accomplished when nurses have obtainable resources and effective collaboration with ancillary departments such as pharmacy and when nurses are equipped with appropriate education on how their actions have an immediate influence on renal outcomes.

A mixed methods study was conducted to further validate the findings of the qualitative inquiry. The quantitative portion of the study was composed of a survey gauging nurses' opinions of what contributes to delayed sepsis treatment. Survey results corroborated the themes that were derived from the qualitative study. Survey answers were analyzed by degree, years as a nurse, hospital site and as a group of 100 participants. Ninety-five percent of the quantitative participants felt that they were able to recognize sepsis. This supported the qualitative theme of 'Benefits/harm of early or delayed sepsis treatment.'

In regard to critical thinking, or the ability to follow guidelines and protocol, 77% of the study participants with $\leq$5 years of experience stated that critical thinking was most important but only 59% of participants with $\geq$10 years felt that critical thinking was most important. Overall, 68% of survey respondents felt that critical thinking was most important. This suggest that nursing education programs may be focusing on the ability to use critical thinking during patient care. This supported the theme, Critical thinking/recognition of subtle changes, from the qualitative. Nurses felt that this was essential in early sepsis recognition.

Although 'Consequences of delayed sepsis treatment' was not identified as a theme in our qualitative study because only 8 out of 14 nurses alluded to it, we chose to use it as a theme in the quantitative study because it was supported in the question; based on your experience, have technical and procedural issues led to poor outcomes in patients with sepsis that you have taken care of? With seventy-nine percent of respondents answering yes to this question, it is confirmation that technical and procedural issues contribute to delayed sepsis management, which can be to harmful to sepsis patients.

Because sepsis is deemed a medical emergency, management with antimicrobials should be started right away, if possible, within one hour of diagnosis. Compliance with sepsis guidelines has shown a 25% reduction in death whereas research has shown that delayed sepsis treatment is related to a 3-10% rise for each hour that passes until antibiotics are given. Critical care nurses must be knowledgeable and skilled in recognizing sepsis early and to avoid delays which may add to a more difficult course of treatment, poor outcomes, and death. Critical care nurses dedicate most of their time assisting hospitalized patients who have been identified as having sepsis, severe sepsis or septic shock, therefore their opinions on what contributes to early or delayed sepsis identification and management could bring awareness to barriers that cause delayed sepsis treatment.

## 5.2 Implications

Education programs dedicated to ED and ICU nurses are needed. Yearly continuing education programs focusing on sepsis management should be implemented to keep nurses well informed on sepsis identification and management.

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# Vita

Pamela L. Harris was born in Memphis, Tennessee, in 1968 but spent most of her formative years in Chattanooga, Tennessee. Her research interest is focused on what contributes to early or delayed sepsis identification and treatment among ICU and ED nurses. Her curiosity in contributors to early or delayed sepsis treatment began as a bedside nurse noticing the effects of delayed sepsis treatment. Her interest in nursing began in childhood when she was affected by chronic issues that led to multiple encounters with nurses. She started her nursing career as a licensed practical nurse and continued her studies in nursing, obtaining both an associate's and bachelor's degree in nursing from Excelsior College. She has worked in the clinical field as a bedside nurse for 28 years with 13 years of ICU experience. Pamela began her doctoral studies at The University of Tennessee Health Science Center in Nursing Science in 2018 under the mentorship of Drs Ann Cashion, Carolyn Graff, Casba Kovesdy, Lacretia Carroll, and Xueyuan Cao. She has one published work on sepsis induced acute kidney injury. Pamela expects to receive her PhD degree in July 2022.