

**Early Recognition and Treatment of Pediatric Sepsis: The Development  
of an Education Resource for Registered Nurses**

by © Danielle Ryder A Practicum Report submitted

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## Abstract

**Background:** Sepsis is a potentially fatal condition and is a major cause of mortality among pediatric populations. Delayed recognition of sepsis symptoms and delayed or insufficient treatment have been identified as contributing factors to increased mortality rates among pediatric patients with sepsis. Due to their frequent interactions with patients, research has shown that providing nurses with education about the signs and symptoms of sepsis and evidence-based sepsis treatments can significantly improve patient outcomes.

**Purpose:** The purpose of this practicum was to develop a self-learning for registered nurses in NL to improve their knowledge and understanding of the signs and symptoms of sepsis and evidence-based sepsis treatment guidelines.

**Methods:** Three methodologies were used in this practicum. These methodologies included an integrated literature review, a series of consultations with key stakeholders, and an environmental scan to review other educational resources on sepsis.

**Results:** An online educational module on pediatric sepsis was developed using the information collected from the literature review and consultations. The module was developed using the eportfolio program available through Memorial University of Newfoundland and Labrador's desire2learn (D2L) website. The module consisted of three units describing sepsis and nursing, the symptoms of sepsis, and treating sepsis.

**Conclusion:** The goal of this practicum was to develop an educational resource to increase nurses' knowledge of sepsis to improve their recognition of sepsis symptoms and their compliance with evidence-based treatment guidelines. The module was not piloted during this practicum, however, future evaluation plans have been developed.

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## **Introduction**

Sepsis is a potentially fatal, progressive illness characterized by injury to the body's organs caused by the body's immune response to a severe infection (Singer et al., 2016). In 2008, the World Health Organization considered sepsis to be one of the main causes of pediatric deaths as nearly 6 million child deaths were associated with infectious disease (Black et al., 2010). In 2011, approximately 6% of all deaths in Canada were associated with sepsis and it was a contributing factor in nearly 50% of deaths associated with infectious disease (Navaneelan, Alam, Peters, & Phillips, 2015). The most vulnerable populations were children under the age of one and the elderly.

Sepsis in children can be difficult to diagnose during the early stages of the illness due to their unique pathophysiological response and varying ranges of normal vital signs for pediatric age groups (Byrne, 2014; Goldstein, Giroir, & Randolph, 2005). In contrast to adults, hypotension is considered to be a latent symptom of sepsis in children and is associated with severe septic shock (Goldstein et al.). As a result, sepsis may be diagnosed late in pediatric patients. Once the severity of sepsis progresses to septic shock the risk of mortality increases to approximately 40%, which highlights the importance of diagnosing and treating sepsis early (Singer et al., 2016). Treating sepsis and septic shock is considered time-sensitive and involves patients receiving treatment to improve perfusion and halt progression of the illness within the first hour of symptom onset (Brierley et al., 2009; Davis et al., 2017; Dellinger et al., 2013; Rhodes et al., 2017). Receiving treatment in this first hour is considered crucial to improved patient outcomes and mortality rates.

Children diagnosed with sepsis often get admitted to a Pediatric Intensive Care

Unit (PICU) due to the severity of their illness and the need for extensive medical care. Pediatric patients with sepsis requiring PICU care have put a burden on healthcare systems due to their long hospital admissions and complex medical care, such as mechanical ventilation and numerous medication therapies (Weiss et al, 2015; Wolfer, Silvani, Misicco, Antonelli, & Salvo, 2008). Despite receiving intensive care for sepsis, approximately 25% of these PICU patients succumbed to their illness and were determined to be at a greater risk of dying than their non-septic counterparts. Due to the considerable expense and resources associated with caring for sepsis and the severe negative outcomes associated with the illness, improving sepsis management and patient outcomes would be beneficial to future patients and healthcare systems.

## **Background**

The setting for this practicum was the PICU at the Janeway Children's Health and Rehabilitation Centre in Newfoundland and Labrador (NL). The PICU is the only pediatric critical care unit in the province of NL and the Janeway is the only children's hospital. Due to the Janeway's location, children located in rural NL that require hospital care often receive initial medical treatment from other acute care facilities and are transferred to the Janeway if needed. Children diagnosed with sepsis are typically admitted to the PICU for monitoring and treatment. Staff in the PICU at the Janeway often discuss their patients' history and treatment during bedside rounds and debriefings. These meetings usually involve registered nurses, pediatric intensivists, PICU residents, respiratory therapists, and other necessary healthcare professionals. During these discussions involving patients diagnosed with sepsis, delayed recognition of sepsis symptoms and delayed or inadequate sepsis treatment by various healthcare professionals

have been identified as patient care issues that have may have impacted patient outcomes.

As part of their scope of practice, nurses in NL are responsible for assessing their patients, monitoring their health, and administering necessary nursing interventions (Association of Registered Nurses of Newfoundland and Labrador, 2006). Due to their extensive involvement in patient care, nurses are in a prominent position to detect early signs and symptoms of sepsis in their patients. As well, depending on their location and responsibilities, they may be required to administer emergency treatment to patients experiencing severe sepsis or septic shock.

### **Rationale**

As a result of NL's healthcare system, requiring some pediatric patients to receive medical care from non-pediatric based facilities, and the role of nurses in assessing and treating patients with sepsis, it is important for nurses to be knowledgeable of pediatric sepsis. Due to the time-sensitive nature of sepsis treatment and serious complications associated with its later stages, it is important for nurses to recognize signs and symptoms of sepsis early and help initiate the proper treatments in a timely manner to prevent progression of the illness. Consequently, improving nurses' ability to recognize sepsis symptoms and administer sepsis treatment may improve mortality rates among children and reduce healthcare expenditure in NL.

The overall goal of this practicum was to increase the knowledge of registered nurses in NL that provide care to pediatric patients about early recognition and treatment of sepsis. To accomplish this, an online education module on pediatric sepsis was developed. Having knowledge of early signs and symptoms of sepsis in children and evidence-based treatment guidelines will allow nurses to recognize indicators of sepsis in

their patients and provide evidenced-based care, improving patient outcomes.

### **Methods**

To achieve the goal of the project, two methodologies were used. These included an integrated literature review and a series of consultations with key stakeholders. A summary of these methodologies is included in the following report.

### **Literature Review**

For this practicum, an integrated literature review was completed by searching CINAHL, PubMed, Google Scholar, and the Cochrane library database. Due to the limited number of studies that involved pediatric populations and the similarities in sepsis symptoms and treatments between pediatric and adult populations, the literature search was expanded to include articles involving adult populations as well. The literature was searched for evidence to demonstrate a need to improve sepsis management of pediatric populations and educating nurses as an effective method to accomplish this goal. A full description of this literature review can be found in Appendix A.

Overall, four main themes of this literature review were identified: a) evidence-based sepsis treatment; b) nursing competency with sepsis; c) sepsis education; and d) sepsis screening tools and protocols. The literature review was also used to establish an appropriate theoretical framework that would be used during the development of the pediatric sepsis educational module.

### **Evidence-Based Sepsis Treatment**

Due to the seriousness of the adverse effects associated with sepsis when treatment is delayed or inadequate allowing the illness to progress to the later stages, several organizations have developed evidence-based treatment guidelines to assist

healthcare professionals when treating patients for sepsis and septic shock (Brierley et al., 2009; Davis et al., 2017; Dellinger et al., 2013; Rhodes et al., 2017). One of these organizations was the Surviving Sepsis Campaign (SSC) who developed guidelines to provide healthcare professionals with guidance about different areas of sepsis management, including initial resuscitation, antibiotic therapy, infectious pathogen identification, and vasoactive medication therapies (Dellinger et al.; Rhodes et al.).

Although the SSC guidelines were developed mainly for caring for adult populations, they are also applicable to pediatric populations and include pediatric specific recommendations. When caring for patients with sepsis or septic shock, research indicates that increased adherence to the SCC sepsis treatment guidelines by healthcare professionals correlated with improved mortality rates among patients with sepsis (Castellanos-Ortega et al., 2008; Levy et al., 2014). Similarly, improved patient outcomes were also noted in pediatric patients when they received treatment for sepsis or septic shock based on the timing recommendations of the SSC guidelines (Samransamruajkit et al., 2014; Weiss et al., 2014; Workman et al., 2016). When children received sepsis treatments during the early stages of sepsis, based on the timetable recommended by the SSC guidelines, researchers noted the patients' risk of mortality and health outcomes were improved when compared to patients who received delayed sepsis treatment.

The American College of Critical Care Medicine (ACCCM) also developed evidence-based guidelines for restoring the hemodynamic status of pediatric patients with sepsis or septic shock (Davis et al., 2017; Brierley et al., 2009). These guidelines highlight the importance of administering interventions to improve the perfusion of children within the first hour of sepsis symptom onset to improve the patient's chance of

survival. The American Heart Association (2015) used these guidelines when they developed the Pediatric Advanced Life Support (PALS) treatment algorithm for managing septic shock in children. The intended result of the ACCCM's guidelines is to improve cardiac output and, consequently, oxygen delivery throughout the body to prevent organ dysfunction and death.

### **Sepsis Competency of Healthcare Professionals**

**Sepsis management issues.** The medical records of pediatric patients diagnosed with sepsis were examined to determine the relationship between patient outcomes and the performance of healthcare professionals during treatment (Launay et al., 2010; Pedro, Morcillo, & Baracat, 2015). In one study researchers determined that misdiagnosis of sepsis severity, delayed initiation of treatment, and insufficient interventions to improve perfusion, were common errors made by healthcare professionals in instances when the patient died due to sepsis (Luanay et al.). In another, researchers concluded that pediatric patients were more likely to experience health complications when their sepsis progressed to include poor perfusion and organ dysfunction (Pedro et al.). The findings of these studies emphasize the importance of healthcare professionals being able to recognize sepsis in the early stages and provide effective treatments to improve patient outcomes.

**Nursing knowledge of sepsis.** Due to nurses close relationship with patients and their role in diagnosing and treating sepsis, it is important for nurses to have adequate knowledge of sepsis symptoms and treatments. Several studies evaluated nurses' knowledge of sepsis through the use of questionnaires (Jeffery, Mutsch, & Knapp, 2014; Robson, Beavis, & Spittle, 2007; Stamataki et al., 2014). The findings of these questionnaires revealed that nurses require further education about sepsis symptoms,

especially those associated with the earlier stages of the illness, and were unfamiliar with or uncertain of certain evidence-based sepsis treatments. Results of the questionnaires showed that increased serum lactate levels, hypothermia, tachycardia, tachypnea, and decreased oxygen saturations as common signs or symptoms that nurses were unfamiliar with (Jeffery et al.; Robson et al.; Stamataki et al.). As well, only 17% of nurses indicated they would be comfortable administering large volumes of intravenous fluid to children showing signs of poor perfusion and only 55.4% recognized mechanical ventilation as an evidence-based treatment for sepsis (Jeffery et al.; Robson et al.).

### **Sepsis Education**

Despite the development of evidence-based treatment guidelines to improve sepsis management and patient outcomes, research illustrates that insufficient knowledge of sepsis among healthcare professionals continues to negatively impact patient outcomes. As a result, researchers have attempted to improve this lack of sepsis knowledge and adherence to evidence-based treatment guidelines by implementing education programs on sepsis (Ferrer et al., 2008; Herràn-Monge et al., 2016; Moser, 2014). After receiving education and training about sepsis symptoms and the SSC evidence-based treatment guidelines, significant improvement ( $p=0.001$ ) with staff's compliance with the SSC resuscitation and management recommendations was noted (Ferrer et al.). Education was also associated with significant improvement with antibiotic administration (91.8% versus 63.1%,  $p < 0.001$ ), fluid and vasopressor administration (93.1% versus 69.1%,  $p < 0.001$ ), and measurement of serum lactate levels (85.7% versus 69.6%,  $p < 0.001$ ), as recommended by the SSC (Herràn-Monge et al.). In addition to improved adherence to SSC guidelines, before and after tests revealed that nurses' knowledge of sepsis

significantly improved after they participated in sepsis training programs (Moser, 2014).

Although some studies evaluated nursing knowledge and compliance with evidence-based treatment guidelines, others evaluated the impact of sepsis education on nurses' self-perceived competence in recognizing and treating sepsis (Delaney, Friedman, Dolansky, & Fitzpatrick, 2015; Yousefi et al., 2012). After participating in sepsis education programs, testing and questionnaires demonstrated that not only did nurses' knowledge of sepsis symptoms and evidence-based treatment guidelines significantly improve but so did their self-confidence in recognizing and treating the illness (Delaney et al.; Yousefi et al.). Although further research to evaluate which types of education programs are most effective at improving the performance of nurses, the findings of these studies indicate that education does positively impact nurses knowledge, competency, and practice concerning sepsis.

### **Sepsis Screening and Protocols**

Due to their frequent interaction with patients, nurses are in a favourable position to observe for signs and symptoms of sepsis and begin the treatment process by notifying physicians of their assessment findings. For this reason, several studies have evaluated the effect of incorporating sepsis assessment and initiating medical directives as standardized nursing roles on patient outcomes (Gyang, Shieh, Forsey, & Maggio, 2015; Jones et al., 2015; Moore et al., 2009; Noritomi et al., 2014; Tromp et al., 2010). Although it is important for nurses to have sufficient knowledge of sepsis and evidence-based sepsis treatments, it is also essential for nurses to be able to incorporate this knowledge into practice. Sepsis assessment tools and treatment protocols are effective techniques to assist with this process.

**Performance improvement programs.** After providing nurses, and other healthcare personnel, with sepsis education and incorporating sepsis screening tools and medical directives, researchers noted improvement in patient mortality rates and staff adherence to evidence-based treatments (Noritomi et al., 2014; Tromp et al., 2010).

One study noted multiple positive outcomes after emergency nurses received sepsis training and were allowed to implement a sepsis treatment protocol when they suspected a patient had sepsis, prior to consulting a physician (Tromp et al., 2010). These outcomes included significantly improved compliance rates with serum lactate measurements (80% versus 23%), collection of microbial cultures (67% versus 49%), and antimicrobial administration within the first three hours of diagnosis (56% versus 38%). As well, nurses correctly identified 82% of patients positively diagnosed with sepsis and mortality rates among patients had decreased.

Researchers noted similar benefits in another study that evaluated the impact of implementing a sepsis performance improvement program consisting of sepsis education, a sepsis screening tool, and a treatment protocol on staff adherence to treatment guidelines and patient outcomes (Noritomi et al., 2014). Results of this study noted a significant decrease in the time it took staff to diagnose sepsis in patients (2.2 hours versus 0.7 hours) and a significant improvement in patient mortality rates (55% versus 26%). As well, staff's compliance with serum lactate measurement and administration of intravenous fluid and vasopressors to restore hemodynamic stability were almost 100%.

**Nurse initiated screening protocols.** Several research studies evaluated in this literature review, assessed the effect of implementing screening protocols initiated by nursing staff. After implementing nurse-led screening tools to routinely assess for

symptoms of sepsis in patients, researchers determined that screening tools had an extremely high accuracy rate in diagnosing sepsis in patients and were associated with significantly improved mortality rates among patients (Gyang, Shieh, Forsey, & Maggio, 2015; Jones et al., 2015).

The results of this literature review emphasize the important role nurses play in improving sepsis management, as well as the positive impact sepsis education can have on nursing practice and patient outcomes. Although sepsis education is beneficial, the literature also demonstrates that corresponding screening tools and protocols can further improve sepsis management among nurses and other healthcare professionals.

### **Theoretical Framework**

The target audience for the education module was professional nurses, of varying levels of experience, that are responsible for providing care to pediatric patients. In NL nurses working in adult facilities in rural areas may need to provide care to children due to a lack of pediatric-based healthcare services. Therefore, the education module needed to meet the learning needs of nurses who are unfamiliar with providing care to pediatric populations, as well as those with more experience. For the purpose of this practicum, Knowles' Adult Learning Theory was chosen as the theoretical framework for the development of the pediatric sepsis education module.

Knowles describes adult as learners that need to be taught differently due to their unique characteristics (Lieb, 1991). Adults are considered self-directed, autonomous learners who want to actively participate in their learning and possess experiential knowledge that needs to be acknowledged and enhanced by education opportunities. Adult learners are goal- and relevancy-oriented, therefore, they pursue education that is

relevant to their learning needs and will assist them in meeting their professional goals. As practical individuals, adult learners want to learn about subjects they can use to improve their lives.

Adult learners' motivation to learn is another consideration that educators need to contemplate when developing education programs. These motivations include a) forming social relationships; b) fulfilling the external expectations of others; c) being able to contribute to the social welfare of others; d) personal advancement; e) relieving boredom or providing stimulation; or f) satisfying a cognitive interest in obtaining knowledge (Lieb, 1991). These motivators need to be considered during the development process to encourage adults to participate in the learning process.

### **Consultation Report**

For this practicum project, a learning needs assessment was completed through a series of one-on-one consultations with key stakeholders, as well as, an environmental scan of alternative education resources. The consultations consisted of a total of five interviews being conducted with a PICU intensivist, the PICU clinical educator, the pediatric Emergency Department clinical educator, and two PICU registered nurses (one novice and one senior). Approval from a research ethics board was not required as indicated by the Health Research Ethics Authority Screening Tool (see Appendix B3). The interview responses were transcribed and organized into a Word Document table (see Appendix B6). A content analysis of the responses was then completed to identify any common themes or ideas. During the environmental scan the SSC and Translating Emergency Knowledge for Kids (TREKK) websites were reviewed for sepsis education content and resources. Any identified sepsis topics and education material was then

evaluated. A complete report of the consultations and environmental scan can be found in Appendix B.

### **Consultation Results**

After completing the consultations, there was 100% consensus among the key stakeholders that an online education module on pediatric sepsis would be beneficial for nurses in NL. Common themes identified in the interview responses included sepsis learning needs, sepsis education content, module design, dissemination methods, and alternative sepsis education resources. Three distinct ideas identified during the responses were dividing the module into multiple sections, including patient experiences into the module, and arranging dissemination measures around peak times of the year that require nurses to complete continuing education as part of their nursing practice.

**Sepsis learning needs.** During the consultations, key stakeholders identified delayed recognition sepsis symptoms and inadequate administration of essential sepsis treatments as common issues with sepsis care for pediatric patients in NL. Furthermore, a lack of knowledge about evidence-based sepsis treatments, especially the administration of antibiotic therapy and fluid resuscitation within the first hour of symptom onset, were characterized as common errors during patient care.

**Sepsis education content.** Educational content on early sign and symptoms of sepsis and evidence-based treatment guidelines, particularly the SSC and ACCCM guidelines, were classified as essential content to be included in the module. Emphasis on educating nurses about the importance of administering sepsis treatments, especially fluid resuscitation and antibiotic therapy, within the first hour of severe sepsis onset was also noted.

**Education module design.** Key stakeholders agreed that the module limit the use of written material and instead use interactive components, instructional videos, and case-study scenarios to teach the material. These methods would improve attentiveness and comprehension of the material.

**Dissemination methods.** Online forums, such as social media, and posters in high traffic areas were noted as common methods of disseminating information to nurses.

**Alternative educational resources on sepsis.** The SSC and TREKK websites were identified as additional resources that nurses could use to further their sepsis education. Alternatively, beyond nurses independently locating journal articles about sepsis, key stakeholders were unable to identify other sepsis resources available to nurses in NL.

### **Environmental Scan**

As a result of the consultation process and the environmental scan, only the SSC and TREKK websites were identified as educational resources available to nurses in NL to supplement their sepsis knowledge. Although the content of these websites is suitable for nursing staff, further information about the pathophysiology and sepsis treatments is needed to improve nurses comprehension of sepsis in children.

**SSC website.** The SSC website provides access to articles detailing the “The SSC International Guidelines for Management of Severe Sepsis and Septic Shock: 2016”. The website also provides webcasts and podcasts explaining pediatric sepsis and nurses role in recognizing and treating sepsis. The majority of the educational content on the SSC website focuses on how to improve sepsis management on an organizational level by organizing a sepsis quality committee to monitor sepsis compliance rates with SSC

guidelines and patient outcomes. Disadvantages to this website include their use of lengthy podcasts and webcasts that require learners to read or listen to the material rather than interactive formats that would be more appealing to adult learners. As well, a large portion of the website's content is not relevant to nursing practice and is organized based on format, such as podcasts, rather than topic. This may limit the websites appeal to nurses and make it difficult for nurses to find relevant information easily.

**The TREKK website.** The TREKK website provides healthcare professionals, including nurses, with multiple resources they can print and use to improve their recognition and treatment of pediatric sepsis. A sepsis screening tool, pediatric vital sign guidelines, and guide to recognizing septic shock are available. As well, a pediatric sepsis medical directive and management algorithm to assist patient treatment are also available. Other available resources include links to sepsis based research studies and evidence-based treatment guidelines. Disadvantages of the website, include a lack of educational content about the septic process and rationale for evidence-based treatments.

### **Development of the Module**

Based on the data collected from the integrated literature review and consultations, an online education module on early recognition and treatment of pediatric sepsis was developed. The purpose of the education module is to educate nurses about pediatric sepsis with the intention of improving their competency in caring for patients with sepsis and, consequently, patient outcomes. A copy of the information included in the online pediatric sepsis education module can be found in Appendix C.

To create an education module that would be accessible to all nurses in NL that may be required to care for pediatric patients, an online format was used. A webpage was

created using Wordpress' e-portfolio program, available through Memorial University of Newfoundland and Labrador's desire2learn (D2L) website. By changing the privacy settings to public, the online module will be accessible through the use of an electronic device with internet access, such as a computer or tablet. The use of an online format will also allow the content of the module to easily be updated as new literature and evidence-based treatment guidelines become available.

The education module was divided into several webpages, including 3 pages of sepsis education, one page containing access to three post-tests of review questions, one page of links to additional resources of sepsis education, one page of literature references, and an evaluation page. By dividing the module into several units, nurses can choose which information to study based on their level of expertise or sepsis-associated learning needs. Each of the sepsis educational units includes a list of learning objectives which participants are meant to meet after reviewing the module content. Units two and three include two, interactive online presentations that were developed to include learners in the learning process. One presentation is on sepsis signs and symptoms and the other is on evidence-based treatment guidelines. These presentations require learners to actively participate to review the presentation content and use graphics and animations to highlight crucial information.

Unit One of the module is devoted to illustrating the impact of sepsis on patient populations, particularly children. The purpose of this unit is to describe why improving sepsis management is important to improve patient outcomes and why this problem is relevant to nurses by explaining their role sepsis care. It also informs learners of how sepsis education is an effective method to improve nurses' ability to recognize and treat

sepsis and, consequently, improve patient outcomes.

Unit Two focuses on the signs and symptoms associated with the different stages of sepsis. First, the pathophysiological of sepsis is described and the differences between sepsis symptoms in adults and children is distinguished. The diagnostic criteria and the signs and symptoms associated with different stages of sepsis, including the systemic inflammatory response syndrome (SIRS), sepsis, and septic shock, are organized into an interactive, online PowerPoint presentation.

Finally, Unit Three describes the SSC's and the ACCCM's evidence-based guidelines for treating sepsis and septic shock in pediatric patients. An interactive, online PowerPoint presentation was used to provide learners with a comprehensive summary of the evidence-based treatments required within the first hour of severe sepsis or septic shock onset. Due to the fact that the first hour of care is considered crucial to the patient's survival, the actions required by nurses and other healthcare professionals was highlighted throughout the presentation. The presentation mainly focuses on the initial resuscitation patients, including obtaining vascular access, obtaining bloodwork and cultures, and administering intravenous fluid boluses and antibiotics.

The review questions section consists of three, post-tests consisting of multiple choice, case-study questions. The tests examine learners' knowledge of sepsis signs and symptoms and sepsis treatments. As well, one test examines the learner's comprehension of all the material and requires the learner to utilize their knowledge and critical thinking skills to answer progressive case-study questions. The results of these tests are available to both the learner and module developer. These tests were created using Google Forms connected to a Google Drive account and, as a result, the developer is able to view which

questions learners are getting correct or incorrect. In addition, learners are able to review their answers and are provided explanations on why their answers were right or wrong.

Finally, the evaluation page contain access to an evaluation form for learners to use to anonymously provide their feedback to the module's developer. The evaluation form was also created using Google Forms and allows the developer to review learner feedback through Google Drive. Likert scales, checklists, and short answer questions were included in the evaluation form.

### **Advanced Nursing Practice Competencies**

The Canadian Nurses Association (CNA) describes advanced nursing practice competencies as the ability to provide high quality nursing care through the combination of one's expertise, personal qualities, and clinical and decision-making skills (CNA, 2008). These competencies are classified into four categories: clinical, research, leadership, and consultation and collaboration. During the planning and development of the pediatric sepsis education module, I demonstrated several of these advanced nursing practice competencies.

#### **Clinical Competency**

The CNA (2008) describes proficiency of specialty clinical competencies as the foundation of advanced nursing practice. These competencies require nurses to use their personal expertise and judgement, in collaboration with the opinions and values of their clients and other healthcare professionals, to provide holistic nursing care.

During the course of this practicum project I demonstrated clinical nursing competency by identifying improved sepsis care for the pediatric population of NL as a learning need of nurses that is impacting the health of children across the province. I then

consulted with other members of my healthcare team to identify strategies to improve this healthcare concern among our patients. After gathering information from my personal experience with patients, other healthcare professionals, and research literature, this data was used to develop the pediatric sepsis education module to improve sepsis care among nurses and patient outcomes.

All these actions demonstrated my clinical competence throughout the course of this practicum project. These experiences will improve my competency in collaborating with patients and other healthcare professionals to identify research and theories that could be incorporated into my practice to resolve issues in my future practice.

### **Research Competency**

Research competency refers to an advanced practice nurses' contribution to nursing research by conducting or participating in research studies (CNA, 2008). It also describes a nurses' ability to analyze research studies and use evidence-based findings to improve their nursing practice.

During the development of the pediatric sepsis education module, I first had to complete a literature review and analyze research for evidence supporting nursing education as an effective method of improving patient outcomes of pediatric patients with sepsis. My competency in research will be further demonstrated during the implementation and evaluation of my education module. To evaluate my education module, data will need to be collected and analyzed to determine if my education module is achieving its objective of improving nurses' sepsis knowledge and competency.

### **Leadership Competency**

The CNA (2008) describes advanced practice nurses as mentors within their

organization and advocates for change. They are influential members of the healthcare team, with obligation to implement change to improve the nursing profession and patient care.

I demonstrated leadership competencies by identifying sepsis care as an area of nursing care requiring improvement in NL and developing an education module to contribute to this change. Further evidence of my leadership competencies include working with other nursing professionals to identify the sepsis-associated learning needs of nurses in NL and then developing an educational resource to meet these needs. Advocating for improved sepsis care for the pediatric population of NL and developing methods to accomplish this goal required competencies characteristic of an advanced practice nurse.

### **Consultation and Collaboration Competency**

Finally, it is essential for advanced practices nurses to be able to consult and collaborate with other members of the healthcare team, to provide effective, comprehensive care (CNA, 2008). Nurses need to utilize team dynamics to encourage change and implement improvement strategies. I demonstrated several of these competencies during the planning stage of this practicum project.

Prior to developing the pediatric sepsis education module, I consulted with various healthcare professionals, including clinical educators, physicians, and nurses, to obtain their expertise about sepsis management and education strategies. Through these consultations, my colleagues were able to share with me their experiential knowledge of sepsis care issues and preferred teaching strategies.

As well, during this practicum I collaborated with clinical educators and registered

nurses to identify the sepsis-associated learning needs of nurses and how they prefer to learn new information. This permitted me to develop an education module with relevant sepsis content using their preferred learning techniques.

### **The Next Steps: Implementation and Evaluation of the Module**

Prior to implementing the pediatric sepsis education module, its content and format will need to be reviewed by key stakeholders. This includes the PICU clinical educator and the Emergency Department clinical educator. These educators are responsible for educating and training nurses on providing emergency care to children, such as treating septic shock. Their insight will ensure the content of the module is suitable for nurses in NL caring for pediatric patients and corresponds with their current teachings about pediatric sepsis. Based on their feedback, necessary changes will be made prior to the module's dissemination.

Before disseminating the pediatric sepsis education module on a large scale, a pilot trial will be completed involving a small sample consisting of PICU nurses. This sample of PICU nurses is representative of my target audience of registered nurses caring for children in NL that may develop sepsis or require sepsis treatment. Patients in the PICU are at an increased risk of developing sepsis due to their weakened immune system and numerous invasive devices (Hazinski, 1999; Hockenberry & Wilson, 2011). Therefore, it is important for PICU nurses to be able to recognize symptoms of sepsis in their patients to implement proper treatments early in the illnesses. This sample group consists of both novice and experienced nurses. Answers from the post-test questions and the feedback from nurses collected using the evaluation form will be used to complete a preliminary evaluation of the module's content and teaching strategies. A review of the

post-test answers will allow me to evaluate if the module has improved nurses' knowledge and understanding of sepsis and evidence-based treatments or if further educational content is needed to improve their comprehension of this topic. The responses collected using the evaluation form will inform me if nurses are satisfied with the module or if improvements are needed.

After this initial trial, the module will be made accessible to all nurses in NL. Dissemination methods of the module include use of social media and posters to inform nurses of the module, its content, and how to access it. As well, clinical educators of nursing areas that may care for children with sepsis will be contacted and informed of the module. Ideally, short workshops or information sessions will be arranged with nurses in these areas to provide them with instructions on how to access and navigate the module. As well as, these sessions will allow me to explain why the module's topic is relevant to their nursing practice and could improve patient outcomes of children with sepsis in NL. After the module has been published to the internet and made accessible to my target audience, the post-test and evaluation form responses will be reviewed on an on-going basis to evaluate the module and nurses' knowledge of pediatric sepsis.

### **Conclusion**

The goal and objectives of this practicum have been met by completing an integrated literature review and a needs assessment consisting of consultations with key stakeholders. The literature supports the use of nursing education programs on the signs and symptoms of sepsis and evidence-based sepsis treatments as an effective method to improve nurses' recognition of sepsis in patients and compliance with evidence-based

guidelines when administering treatment. The literature also demonstrates that improving nurses' ability to care for patients with sepsis is also associated with improved patient outcomes, such as decreased mortality rates. Responses from the consultations revealed that key stakeholders unanimously agree that a pediatric sepsis education module would be beneficial to nurses in NL caring for pediatric patients. Other themes uncovered in the consultation responses were that the signs and symptoms of sepsis and evidence-based treatment guidelines are learning needs of nurses in NL and an accessible module that utilizes interactive methods to teach the material is preferred. Knowles' Adult Learning Theory was used as a theoretical framework for the development of the education module.

The information collected from the literature review and consultations was used to develop an education module to increase nurses' knowledge of sepsis signs and symptoms and treatments in pediatric patients. This module consists of three educational units, two interactive presentations, three online post-tests, and learner evaluation feedback form. Moving forward, the next steps. Once published online, this module will be accessible to all nurses with access to an electronic device with internet access. Moving forward, the next steps of this project include getting the module reviewed by key stakeholders involved in educating nurses in NL about pediatric-based nursing care. The module will then be made available to a small sample of nurses, representative of the target audience, in a preliminary implementation trial of the module. After the necessary changes have been based on evaluation of the post-test answers and feedback of the sample group, the module will be disseminated to the rest of the entire target audience of nurses across NL. Ongoing changes to the module and its content will be completed based on future evaluation methods and as new literature become available.

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## **Appendix A**

### Understanding Sepsis and Sepsis Treatment among Pediatric Populations:

#### A Literature Review

Sepsis is a potentially life-threatening condition and, therefore, should be considered a medical emergency when suspected in patients. The health outcomes associated with a sepsis-diagnosis rely heavily on the timing of initial treatment after sepsis symptoms present and the type of treatment given. As a result, it is important for healthcare professionals to be able to recognize sepsis symptoms quickly and initiate proper treatment in a timely manner to improve patient outcomes. On account of nurses being in close contact with their patients, they are often the first professionals to be exposed to the patients presenting sepsis symptoms. Therefore, nurses should be familiar with how to assess for sepsis and the actions that should be taken if sepsis is suspected. Pediatric patients in Newfoundland and Labrador (NL) diagnosed with sepsis, requiring critical care are admitted to the Pediatric Intensive Care Unit at the Janeway Children's Hospital and Rehabilitation Centre in St. John's. Either these patients present initially to their local emergency department or general practitioner office due to their symptoms or they are already inpatients at the Janeway Hospital and have developed sepsis during their admission. Outpatients suspected of sepsis are often transferred to the Janeway by air or road ambulance to receive the appropriate care. Therefore, it is important for all nurses in NL, urban or rural, to be able to identify sepsis symptoms in children to initiate prompt treatment. For that reason, a pediatric-focused education module to teach nurses about early sepsis symptoms and proper treatment would be a beneficial training tool to

improve the nursing care pediatric patients with sepsis in Newfoundland and Labrador receive.

The following literature review was conducted to highlight the issue of sepsis among pediatric populations as a significant healthcare concern and to support the development of a sepsis education module to teach nurses about pediatric sepsis. The information included in this literature review will provide background information about sepsis, the burden of sepsis, and effective learning techniques to educate nurses. The main themes of this literature review include: a) evidence-based sepsis treatment; b) nursing competency with sepsis; c) sepsis education; and d) sepsis screening tools and protocols.

To conduct the literature review, the search engines CINAHL, PubMed, and Google Scholar and the Cochrane library databases were searched using the following keywords: ‘sepsis’, ‘recognition’, ‘pediatric sepsis’, ‘nursing’, ‘sepsis education’, ‘sepsis management’, ‘sepsis treatment’, ‘sepsis knowledge’, and ‘nursing competency’. Articles that were published in English from 2006-2017 were included in the literature analysis. The methodologies of these articles included experimental, observational, systematic literature reviews, and qualitative studies. After an initial literature review focusing on pediatric-based populations resulted in only a small number of relevant research articles, the literature review was expanded to also include literature concerning sepsis in the adult populations. Considering the many similarities in sepsis symptoms and treatments between adult and pediatric populations, especially for older adolescents, it is presumed that the outcomes and revelations discovered in adult-based research could be applicable to pediatric populations as well. Studies involving neonatal sepsis were excluded because sepsis in this population is often caused by an infection spread from the mother to the

newborn before or during the delivery process and symptoms and treatments may vary due to their unique physical characteristics, such as gestational age and low weight. Consequently, sepsis within the neonatal population involves cause and treatment considerations that are not applicable when caring for pediatric populations. The intended use of the education module is to provide nurses with information about sepsis in a pediatric population from the age of 28 days old to 18 years of age (adult). Due to the intended target audience of this module, research that either evaluated or implemented interventions not applicable to nursing care or did not include nurses in their research process were excluded. The quantitative literature was critiqued using the Public Health Agency of Canada's (2015) Critical Appraisal Tool Kit, while the scientific merit, clarity, methodology, rigour, ethics, and conclusions of qualitative studies were critically analyzed.

## **Background and Rationale**

### **Sepsis Definition**

Sepsis is a progressive illness with varying signs and symptoms dependent of the level of severity. Goldstein, Giroir, and Randolph (2005) define systemic inflammatory response syndrome (SIRS) in children as when at least two of the following symptoms are present; a) hypothermia (i.e., core body temperature less than 36 degrees Celsius) or fever (i.e., core body temperature greater than 38.5 degrees Celsius); b) tachycardia, or bradycardia in children under the age of one with no known contributing cause; c) tachypnea, or need for mechanical ventilation with no known contributing cause; and d) an increased or decreased leukocyte count not related to chemotherapy. Children must exhibit abnormal body temperature or abnormal leukocyte count in combination with

another symptom to meet the criteria of a diagnosis of SIRS. Children meeting the criteria of SIRS, as well as exhibiting signs and symptoms of an infection, are diagnosed with sepsis (Goldstein et al., 2005).

Sepsis is defined as a potentially fatal immune response to a serious infection that results in injury to the host's organs (Singer et al., 2016). Once children diagnosed with sepsis exhibit symptoms of cardiovascular organ dysfunction, acute respiratory distress syndrome (ARDS), or organ dysfunction of at least two body systems, they are considered to have severe sepsis (Goldstein et al., 2005). Sepsis progresses to septic shock when the body is unable to maintain hemodynamic stability without medical assistance, significantly increasing the possibility of fatality to approximately 40% (Singer et al.). In pediatric populations hypotension is not required to be diagnosed with septic shock as children in shock can use compensating mechanisms for brief periods to maintain normal blood pressures (Goldstein et al.). Pediatric patients exhibiting symptoms of infection, such as fever, tachycardia, and vasodilation, and poor tissue perfusion should be considered to have septic shock that requires immediate treatment (Brierley et al., 2009). Poor tissue perfusion can be exhibited as an altered mental status (e.g., irritability, decreased level of consciousness, and confusion), abnormal capillary refill (e.g., prolonged or rapid), abnormal pulses (e.g., diminished or bounding), blood pressure abnormalities (e.g., hypotension or widened pulse pressure), mottling of extremities, or decreased urine output. Considering these symptoms are common for other illnesses as well, and symptoms of poor perfusion can be latent in children, knowledge of sepsis symptoms is crucial to an early diagnosis.

### **Incidence of Sepsis**

In 2011, sepsis caused or contributed to almost 6% of all Canadian deaths and was associated with almost 50% of the deaths caused by an infectious disease (Navaneelan, Alam, Peters, & Phillips, 2015). Children are at a higher risk of death associated with sepsis when compared to adults, especially children under the age of one. Weis et al. (2015) demonstrated that treating pediatric sepsis has been a burden on healthcare systems worldwide, as treating sepsis has required Pediatric Intensive Care Units (PICUs) to provide extensive medical interventions over long periods of time. Researchers examined the medical records of 567 children that had been diagnosed with sepsis and were admitted to one of 128 different PICUs around the world, including North America. They determined that the majority of pediatric patients diagnosed with sepsis required complex medical care including mechanical ventilation, antibiotic therapy, vasoactive medication infusions, and corticosteroid medications (Weiss et al., 2015). Despite receiving these treatments, approximately one quarter of these PICU patients died as a result of severe sepsis.

After comparing the health outcomes of 320 children diagnosed with sepsis to 2,421 children with a non-sepsis diagnosis, admitted to one of fifteen PICUs over the course of a year, researchers determined that patients diagnosed with sepsis had longer hospital admissions and higher incidences of death when compared to their non-septic counterparts (Wolfer, Silvani, Misicco, Antonelli, & Salvo, 2008). Specifically, the mortality rate and the length of hospital stay for children diagnosed with sepsis was approximately three times greater than those of their non-septic counterparts. As well, patients with known comorbidities were more susceptible to sepsis-associated deaths than those without them (24% versus 8.9%).

Considering that Weiss et al. (2015) and Wolfer et al. (2008) only assessed the outcomes of pediatric patients with sepsis in PICUs over brief periods of time using cross-sectional studies, further research is needed to determine if these outcomes can be generalized for all PICU septic patients. However, both studies did include a population sample that included a wide-range of patient characteristics, such as varying ages and ethnicities, indicating that the populations were representative of the general pediatric population. Based on the statistics and findings of these studies, there is evidence to support the opinion that sepsis continues to be a significant health problem in PICU environments due to its association with higher healthcare costs and mortality rates. Therefore, measures to improve sepsis management and reduce adverse effects are warranted. However, further research is needed to determine the exact burden of sepsis in different locations, specifically Canada, to assess the impact of early intervention on reducing this burden.

## **Sepsis Management**

### **The Surviving Sepsis Campaign Guidelines**

Due to the severe adverse effects associated with sepsis, extensive research has been conducted to determine the interventions that are the most effective to treat it (Brierley et al., 2009; Dellinger et al., 2013; Rhodes et al., 2017). Some organizations have used scientific research to develop evidenced-based guidelines to improve sepsis management and reduce mortality rates. Based on the results of this literature review, the Surviving Sepsis Campaign guidelines was the most commonly utilized practice guidelines in research studies and education initiatives. The Surviving Sepsis Campaign (SSC) panel developed evidenced-based guidelines to help healthcare professionals

effectively treat and manage sepsis and septic shock in patients (Rhodes et al., 2017). These guidelines were initially developed in 2004 and have been updated regularly based on new evidence. The guidelines incorporate several aspects of sepsis treatment, including: a) initial resuscitation; b) screening for sepsis and performance improvement; c) diagnosis; d) antimicrobial therapy; e) source control; f) fluid therapy; g) vasoactive medications; h) corticosteroids; i) blood products; j) immunoglobulins; k) blood purification; l) anticoagulants; m) mechanical ventilation; n) sedation and analgesia; o) glucose control; p) renal replacement therapy; q) bicarbonate therapy; r) venous thromboembolism prophylaxis; s) stress ulcer prophylaxis; t) nutrition; and u) setting goals of care.

The SSC guidelines promote urgent fluid resuscitation within the first three hours of sepsis symptoms appearing as best practice among healthcare professionals (Rhodes et al., 2017). When administering initial resuscitation efforts the SSC advises a 30ml/kg intravenous (IV) crystalloid fluid bolus be administered to treat poor perfusion, followed by further IV fluid administration based on frequent hemodynamic reassessment. The amount of required fluid resuscitation will vary among patients, therefore, frequent reassessment of vital signs and hemodynamic status are necessary to determine if the patient has received adequate fluid to maintain hemodynamic stability.

Other SSC best practice statements include the recommendation that healthcare centres implement interdisciplinary-based programs designed to improve early recognition and treatment of sepsis among healthcare professionals through improved sepsis screening methods (Rhodes et al., 2017). Although no specific performance improvement program is recommended, the SSC suggests the implementation of early

sepsis screening tools and management protocols for healthcare professionals to follow when a suspected septic patient has been identified. In addition, the SSC promotes frequent evaluation of sepsis care by measuring and assessing quality of care metrics, such as sepsis-associated mortality, to determine if healthcare professionals are following protocols and providing high-quality sepsis care (Murphy, Ogbu, & Coopersmith, 2015). As well, when attempting to implement new practice guidelines and generate behavior changes in healthcare professionals, the SSC promotes continuing education and knowledge translation strategies as valuable approaches to use (Black, Schorr, & Levy, 2012; Rhodes et al.).

The SSC also recommends collecting microbiological cultures as soon as sepsis is suspected but prior to the administration of antibiotic medications if possible (Rhodes et al., 2017). Antimicrobial treatments should be administered within one hour of sepsis being diagnosed but should not be delayed if microbiological cultures have not been collected. Broad-spectrum antibiotic medications should be administered initially and then customized based on the pathogen identified and the patient's bodily response to treatment. As well, the source of the infection should be identified promptly and be medically controlled or removed, if possible.

Other guidelines the SSC strongly recommend include the use of vasopressor medications to maintain hemodynamic stability, administration of red blood cells to maintain hemoglobin levels, use of mechanical ventilation to treat sepsis-induced respiratory failure, maintaining serum glucose levels, and administration of early enteral nutrition (Rhodes et al., 2017). Previous versions of the SSC guidelines recommended sepsis care bundles that involved specific treatments that were to be administered within

the first six hours of a sepsis diagnosis to reach specific hemodynamic endpoints, known as early goal-directed therapy (Dellinger et al., 2013). That recommendation has been updated in the newest SSC guidelines and has eliminated the requirement to maintain CVP and Scvo<sub>2</sub> measurements (Rhodes et al.). This change in practice was due to strong literature evidence disputing the necessity of maintaining these strict hemodynamic values to improve mortality rates (Mouncey et al., 2015; Peake et al., 2014; Yealy et al., 2014). Research studies highlighted the importance of initial resuscitation but concluded that following the previously recommended SSC resuscitation protocol to maintain CVP and Scvo<sub>2</sub>, versus less invasive hemodynamic measurements, had no significant effect on mortality rates (Mouncey et al.; Peake et al.; Yealy et al.). As a result, the recommendation of maintaining a Svco<sub>2</sub> greater than 70% will not be included in the education module.

**SSC guideline utilization in adult populations.** Since the development of the SSC guidelines, several researchers have attempted to evaluate the impact the implementation of these guidelines had on patient outcomes. Castellanos-Ortega et al. (2008) compared sepsis-associated mortality rates among adult patients being cared for in three intensive care units, before and after the implementation of a sepsis management protocol following the SSC's sepsis care bundles. The patient outcomes of 384 adult patients with sepsis cared for after the management program was implemented were compared to a historical group of 96 adult patients with sepsis that received care prior the program's implementation. The researchers discovered that SSC bundle compliance rates were strongly associated with patients' mortality rates, as mortality rates among the post-intervention group were significantly decreased (37.5%) when compared to that of the

historical group (57.3%). It was also determined that mortality rates decreased as the number SSC bundle interventions implemented increased. These interventions included serum lactate measurements, blood culture collection, antibiotic administration, and prevention of hypotension through IV fluid administration.

Levy et al. (2014) also completed a study to determine the impact of complying with the SSC 2004 guidelines when caring for patients with sepsis on patient outcomes. The medical records of 29,470 patients diagnosed with severe sepsis or septic shock that were being cared for in one of 218 hospitals across the United States, South America, and Europe were evaluated to determine the staff's compliance with the SSC's sepsis bundles and patient mortality rates. Hospitals that were considered to have a high compliance rate with the SSC guidelines when providing resuscitation care to patients had significantly lower mortality rates (29%) than hospitals that had low compliance rates (38.6%). The results of both Castellanos-Ortega et al. (2008) and Levy et al. (2014) indicate that the utilization of the SSC sepsis guidelines when providing care to adult patients with sepsis is associated with improved patient outcomes, such as mortality rates.

**SSC guidelines utilization in pediatric populations.** Although developed to treat sepsis in the adult population, the SSC sepsis guidelines are also utilized to treat sepsis in pediatric populations. Samransamruajkit et al. (2014) studied the impact of utilizing the SSC sepsis guidelines on outcomes in pediatric patients with sepsis to determine if they were effective in pediatric populations. After the SSC guidelines were implemented in a PICU, the mortality rates of 47 children diagnosed with severe sepsis or septic shock were compared to the mortality rates of a historical groups of patients with sepsis. The researchers concluded that when pediatric patients received care according to the SSC

guidelines (i.e., proper and timely bloodwork, proper IV fluid resuscitation, administering antibiotics, and use of vasopressor agents), mortality rates within 28 days of initial diagnosis had significantly decreased from 42% in the historical group to 19.1% in the post-intervention group.

Weiss et al. (2014) assessed the impact of the timing of antimicrobial therapy administration, as recommended by the SSC guidelines, on pediatric health outcomes. The medical records of 130 pediatric patients diagnosed with severe sepsis or septic shock were reviewed to compare the initial timing of antimicrobial administration and patient outcomes, such as mortality rate and duration of organ dysfunction. Overall, sixteen (12%) of these patients died as a result of sepsis. After examining the records of the deceased patients, researchers concluded that the risk of mortality increased with every hour that antimicrobials were delayed after sepsis was diagnosed. Antimicrobials administered after three hours of the sepsis diagnosis were associated with a significant risk of mortality (21.2%). Although researchers could not conclude that antimicrobials administered within one hour of sepsis diagnosis, as recommended by the SSC guidelines, significantly improved outcomes, they were able to determine that the risk of mortality significantly increased when antimicrobials were delayed three hours or more after sepsis diagnosis.

Finally, the impact of using the SSC guidelines' recommended timing of resuscitation interventions on patient outcomes of children in septic shock were evaluated when compared to resuscitation efforts administered over a longer period of time (Workman et al., 2016). In total 321 children in septic shock that received care in a single emergency department were included in the study. From these participants, 117 children

were determined to have received care compliant with the SSC guidelines, while the other 204 received care that was outside the SSC one hour recommended time limit. However, the majority (75%) of these 204 children did receive the proper care within three hours of their sepsis diagnosis. The researchers were not able to conclude that receiving the SSC guideline recommended care within the first hour of care versus receiving the same care over a two to three hour span significantly impacted the progression of multiple organ dysfunction syndrome or mortality rates. However, they did conclude that earlier sepsis recognition and treatment was associated with improved patient outcomes. Also, even though all patients did not receive resuscitation interventions within the first hour they did receive the SSC recommended guidelines, which may have positively impacted patient outcomes. Further research involving more healthcare settings and a larger sample size is needed to definitively conclude that resuscitation efforts administered within the first hour have no significant impact on patient outcomes.

### **American College of Critical Care Medicine Guidelines**

Another popular set of evidenced-based guidelines developed by the American College of Critical Care Medicine, focuses on treating the hemodynamics of pediatric patients with sepsis (Brierley et al., 2009; Davis et al., 2017). The American College of Critical Care Medicine states that when treating pediatric patients for septic shock the first hour of care is crucial and should focus on restoring hemodynamic stability by caring for the patient's airway, breathing, and circulation. Therefore, oxygen and mechanical ventilation should be utilized to maintain proper ventilation and oxygenation and treat symptoms of shock. As well, obtaining vascular access is essential and should be obtained immediately so that IV fluid can be administered rapidly to restore

hemodynamic stability. After the patient's respiratory and hemodynamic statuses have been restored to fairly normal levels, the focus of care should shift to frequent assessment of the patient's vital signs and maintaining hemodynamic stability through continued use of mechanical ventilation, IV fluid administration, and medications. These guidelines are consistent with the American Heart Association's (2015) Pediatric Advanced Life Support (PALS) guidelines for management of septic shock in children. These guidelines centre on optimizing oxygen delivery throughout the body to prevent multisystem organ failure and cardiac arrest by increasing cardiac output.

The most crucial component of sepsis treatment is the timing of treatment initiation following presentation of sepsis symptoms. There is strong evidence supporting that treatment should be administered within the first three hours of developing sepsis, with treatment within the first hour showing the best health outcomes and treatment delayed more than three hours having the worst. Within the first three hours of sepsis development, it is a priority to restore and maintain hemodynamic stability through the use of IV fluid administration, vasopressor medications, and mechanical ventilation. Hemodynamic stability should be monitored through physical assessment of perfusion, heart rate, respiratory rate, MAP, and organ dysfunction. It is also important to collect microbial cultures and administer appropriate antimicrobial therapy. When caring for children in sepsis, it is important to monitor for signs of fluid overload and titrate IV fluid administration in response.

## **Sepsis Competence**

### **Sepsis Management Issues**

As patient outcomes associated with sepsis are negatively impacted by delayed

recognition and treatment, it is important for healthcare professionals to have adequate knowledge and comprehension of how to treat this illness. One study examined the medical records of 21 pediatric patients who experienced a sepsis-associated death, at one of two participating hospitals, from a severe bacterial infection to determine which medical care issues within the first hour of treatment were associated with patient mortality (Launay et al., 2010). It was determined that 76% of the cases had some component of mismanagement by either the parents or healthcare professionals. The most common mistakes made by healthcare professionals included improper diagnosis of sepsis severity (38%), delayed initiation of treatment once sepsis was diagnosed (38%), and insufficient interventions to properly maintain hemodynamic stability. This included inadequate fluid resuscitation (24%) and absence of vasoactive medications (43%). Although evidenced-based practice guidelines are available, the researchers determined that patients continue to receive medical care that is non-compliant with these guidelines, resulting in poorer outcomes.

Another study reviewed the medical records of 115 pediatric patients, admitted to a single PICU with sepsis, to determine the relationship between sepsis etiology and progression with patient prognosis (Pedro, Morcillo, & Baracat, 2015). Researchers determined that when patients' sepsis had progressed to include poor perfusion and early stages of multisystem organ dysfunction prior to initiation of treatment, patients were more likely to experience complications while in hospital. The presence of complications during hospitalization was associated with a greater risk of patient death (Odds Ratio= 27.7). Unfortunately the definition of complications was not provided and the relationship between the occurrence of specific complications and mortality rates was not evaluated.

However, the results of this study do highlight that delayed sepsis recognition and initiation of treatment lead to sepsis progression and increased risk of mortality. Although further research is needed to determine what contributes to delayed recognition or treatment of sepsis among healthcare professionals, lack of sepsis knowledge may be one associated factor.

### **Nursing Knowledge of Sepsis**

Nurses often spend more time with their patients than other healthcare professionals and, as a result, are often the first to be exposed to early symptoms of sepsis. Therefore, it is important for nurses to be aware of the early signs and symptoms of sepsis to ensure it is recognized and treated early.

Several research studies reviewed the lack of sepsis knowledge among nursing staff. One study evaluated the knowledge of sepsis symptoms and SSC guidelines among 73 of ward nurses through the administration of a questionnaire consisting of case studies, true or false questions, and symptom identification questions (Robson, Beavis, & Spittle, 2007). Results of the questionnaire showed that the nurses generally lacked knowledge about increased lactate levels (90%), oxygen saturations less than 93% (36%), low blood pressure (34%), and decreased body temperature (78%), as possible symptoms of sepsis. As well, results indicated that only 17% of the nurses questioned would administer repeated IV fluid boluses in a patient displaying signs of persistent low blood pressure and urine output, indicating the majority of nurses lacked knowledge concerning proper fluid resuscitation guidelines. Insufficient knowledge of sepsis symptoms and treatments among this population of nurses is apparent from these results.

Another study administered sepsis knowledge questionnaires to 835 registered

nurses working in various medical, surgical, and critical care units, in 14 different hospitals (Stamataki et al., 2014). The self-administered questionnaire was designed to evaluate the nurses' knowledge of sepsis symptoms and their opinions on the current prevalence of sepsis and their hospital's management of septic patients. Results of the questionnaire showed that less than half the nurses recognized signs of tachycardia (49.9%), tachypnea (46.3%), increased serum glucose (23.2%), and decreased oxygen saturations (43.5%), as signs of sepsis. As well, 96.5% of the nurses replied that sepsis guideline education was needed and wanted among participating nurses. These results indicate a lack of knowledge regarding sepsis symptoms and a desire for further sepsis education.

Jeffery, Mutsch, and Knapp (2014) examined the ability of 242 pediatric nurses, working in acute and critical care, to recognize early symptoms of SIRS and sepsis and their knowledge of proper treatment. Their knowledge was tested through use of case studies and direct sepsis related questions posed through the use of a questionnaire. The results of the questionnaire indicated that pediatric nurses were very familiar with symptoms of septic shock, however, there were significant knowledge gaps about early symptoms of SIRS and sepsis. Only 57.9% of the nurses surveyed stated they felt comfortable recognizing the symptoms of SIRS and only 74.4% stated they felt comfortable notifying a physician of their suspicion of SIRS or sepsis based on their assessment abilities. The questionnaire also revealed that only 69% of nurses recognized tachypnea, 64.9% recognized hypothermia, and 50.8% recognized decreased white blood cell count, as possible symptoms of SIRS or sepsis. As well, only 55.4% of nurses were familiar with mechanical ventilation being used as a sepsis treatment intervention.

Although only a small sample size was used in this study, the results indicate further sepsis training is required among this population of nurses to improve SIRS and sepsis symptom recognition and nursing confidence in reporting their assessment findings to others.

Based on the results of the studies discussed above, a lack of knowledge about sepsis symptoms and management among nurses continues to be a significant issue within the healthcare community (Jeffery et al., 2014; Robson et al., 2007; Stamataki et al., 2014). Furthermore, these knowledge deficits have impacted the care received by patients with sepsis and, at times, have been a contributing factor to their deaths. Despite extensive literature being available detailing appropriate evidenced-based sepsis management for healthcare professionals, mismanagement and discrepancies in healthcare practices continue to be a factor in the poor health outcomes of children diagnosed with sepsis (Launay et al., 2010; Pedro et al., 2015). As a result, providing nurses with frequent, evidenced-based education on how to recognize sepsis early and initiate proper treatment promptly is a good strategy to help patients with sepsis receive timely, consistent, and appropriate treatment to improve their health outcomes.

### **Sepsis Education**

Continuing education is a professional responsibility of nurses, to improve their practice and learn new competencies. Sepsis education is one intervention that could improve nurses' competency in recognizing and reporting early sepsis symptoms. Consistent, efficient sepsis education could help improve sepsis-related knowledge and confidence levels among nurses and, consequently, improve sepsis patient care and outcomes. Given that the purpose of this literature review is to support the development

of a nursing education module to improve sepsis care competency among nurses, only education initiatives that included nurses were included in this literature review.

Gaps in the knowledge of sepsis symptoms and management guidelines continue to be an ongoing issue among healthcare professionals, despite the development of evidenced-based guidelines (Jeffery et al., 2014; Launay et al., 2010; Robson et al., 2007; Stamataki et al., 2014). Researchers have tried to determine if education initiatives can improve this issue. The effect of implementing a nationwide sepsis education program for nurses and physicians working in emergency departments and Intensive Care Units (ICU) on sepsis practices and patient outcomes was evaluated using a before and after study design (Ferrer et al., 2008). The content of the sepsis education program consisted of sepsis definitions, symptoms, and treatment based on the SSC guideline's resuscitation and management bundles of care. A total of 59 ICUs participated and the outcomes of 854 patients prior to education implementation and 1465 patients post-education implementation were evaluated. Prior to receiving sepsis education, the overall SSC guideline compliance rates were 5.3% for resuscitation interventions within the first six hours and 10.9% for management interventions within the first 24 hours. These compliance rates improved significantly ( $p=0.001$ ) after staff received training, with the overall resuscitation bundle compliance rate increasing to 10% and the management bundle compliance rate increasing to 15.7%. Although the difference in compliance rate of the individual interventions varied, improvement was noted in all interventions post-education. In addition, patients with sepsis that received care in the post-education period had significantly decreased ( $p=0.04$ ) hospital mortality rates from those of the pre-education patients. Even though researchers could not eliminate the effect of casual

factors on these results, formal sepsis education was considered to be a contributing reason for improved sepsis management and patient outcomes. One year post-education resuscitation and management bundle intervention compliance rates, with the exception of broad spectrum antibiotic administration and maintaining a Svco<sub>2</sub> level greater than 70%, and patient mortality rates remained stable. This indicates that sepsis education can have long-term benefits.

Herrán-Monge et al. (2016) also examined the effect of SSC sepsis guideline based education program on staff compliance rates and patient outcomes in an ICU setting. A before and after comparison was completed between 217 documented episodes of severe sepsis before the implementation of the education program and 231 episodes after its implementation. After the sepsis education program was implemented, researchers concluded that a significant increase in compliance rates for antibiotic administration (91.8% versus 63.1%,  $p < 0.001$ ), fluid and vasopressor administration (93.1% versus 69.1%,  $p < 0.001$ ), and measurement of serum lactate levels (85.7% versus 69.6%,  $p < 0.001$ ), as recommended by the SSC guidelines. The overall compliance with the recommended resuscitation bundle improved significantly from 9.7% to 27.3% post-education, however, this is still considered to be a low rate of compliance. One contributing factor for this low overall compliance rate with administering all six recommended resuscitation interventions included a low compliance (37.8%) with the recommended maintenance of Svco<sub>2</sub> greater than 70%. This recommendation has since been eliminated in the updated SSC guidelines (Rhodes et al., 2017). ICU mortality rates also decreased significantly ( $p = 0.02$ ) post-education implementation (27.19% versus 37.33%). Insufficient information is available to determine how much the overall

compliance rate would change if the compliance rate data for the Svco<sub>2</sub> intervention was excluded. However, data does show that the risk for mortality does not significantly change if all other recommended resuscitation interventions, excluding maintenance of the Svco<sub>2</sub> level, were completed. These results indicate that education can be a useful strategy for healthcare institutions to use to standardize care and improve staff performance with evidence-based guidelines, which could positively impact patient outcomes.

Education programs designed to improve nursing knowledge and confidence in caring for septic patients were also evaluated. One study evaluated if implementing a sepsis focused education program for emergency room (ER) triage nurses was effective at improving their knowledge sepsis symptoms, screening policies, and the SSC resuscitation bundle stages (Moser, 2014). The purpose of the education program was to potentially improve the nurses' performance in managing sepsis during the first hour of a sepsis diagnosis. This study provided 38 triage trained nurses with sepsis education and evaluated knowledge differences using one pre-test and two post-tests, one immediately after receiving education and one a month later. After receiving this education, testing showed that the nurses' mean scores improved significantly (9.32 versus 13.55) and remained improved a month later (9.28 versus 13.84). Although further research involving a larger sample size and evaluation of the effectiveness of different teaching strategies is needed, the results from this study indicate that formal nursing education has a positive impact on sepsis knowledge among nurses.

Similarly, Yousefi et al., (2012) evaluated the difference in nurses' knowledge, attitude, and practices after a participating in an eight hour sepsis education workshop. A

sample of 64 ICU, critical care unit, hemodialysis, and emergency room nurses participated and half were randomly placed in a control group, while the other half was placed in the intervention group. The test group participated in an education workshop about sepsis causes, prevention, and treatments and it consisted of PowerPoint presentations, guest speakers, and patient case studies. The knowledge, attitude, and practice scores of all the nurses was measured using a questionnaire. Results of the questionnaire showed that significant improvement in the mean test scores for knowledge ( $p < 0.001$ ), attitude ( $p = 0.008$ ), and practice ( $p = 0.001$ ) for the test group of nurses, whereas the mean scores in all areas for the control group had no significant change.

Finally, the impact of sepsis education on the self-perceived competence in sepsis care among 82 critical care and emergency room nurses was evaluated (Delaney, Friedman, Dolansky, & Fitzpatrick, 2015). Sepsis education was provided through various means, such as online modules, videos, and simulation, and knowledge and competency scores were measured using pre and post-knowledge tests and Nurse Competence Scale (NCS) surveys. After receiving sepsis education, there was significant improvement in the nurses' staging sepsis knowledge scores ( $p < 0.001$ ), self-perceived competence in recognizing sepsis (65.89% versus 87.34%,  $p < 0.0001$ ), and competence in caring for patients with sepsis (62.48% versus 86.64%,  $p < 0.0001$ ). Although this study utilized a small sample size and did not evaluate which education strategies were most effective, the implementation of a sepsis focused education program was associated with improved sepsis knowledge and nursing confidence in sepsis care.

The results of the studies discussed above provide evidence that sepsis education can be an effective strategy in improving sepsis performance among nurses. The

education techniques utilized in these studies varied making it difficult to determine which techniques would be most effective when developing a sepsis education program. Therefore, further research is required to determine which method of teaching nurses about sepsis would be most effective. However, all the education programs discussed incorporated similar information, indicating that evidenced-based content is an important aspect when providing effective education. These studies indicate that nursing education can possibly improve sepsis care, patient outcomes, and nursing knowledge and confidence in caring for septic patients.

### **Sepsis Screening and Protocols**

The 2016 SSC guidelines for managing sepsis recommend improving sepsis performance of healthcare professionals by implementing sepsis protocols (Rhodes et al., 2017). Implementing valid sepsis-associated assessment tools or protocols into nursing practice could help nurses identify septic patients earlier. For the purpose of this literature review, only studies evaluating sepsis screening tools or protocols for nurses were included as nurses are the intended target audience of the proposed education module.

### **Performance Improvement Programs**

Certain studies included in this literature evaluation, assessed the impact SSC guideline-based sepsis management protocols had on guideline compliance rates and patient outcomes (Noritomi et al., 2014; Tromp et al., 2010). One study that focused on sepsis recognition and management, evaluated the impact of a nursing-based sepsis program on the performance of nurses working in an emergency department (Tromp et al.). The purpose of the program was improve sepsis recognition among nursing staff, provide patients with sepsis with earlier treatments, and to improve compliance with SSC

guideline interventions. After nurses received this training, they were able to initiate a treatment protocol when they suspected a patient was experiencing sepsis based on their assessment. The protocol allowed the nursing staff to initiate standard treatments prior to a physician's order. In total 825 patients with sepsis were included in the data analysis, 159 prior to the program's implementation, 447 patients after staff received training, and 219 patients after staff received performance feedback to improve their practice. After the program's implementation, significant increases in staff compliance with serum lactate measurements (80% versus 23%), collection of microbial cultures (67% versus 49%), and antimicrobial administration within the first three hours of diagnosis (56% versus 38%) were noted. Although significant difference in mortality rates was not found (6.3% versus 5.5%), improvement was noted. Additionally, after nurses received sepsis education and performance feedback they were able to positively identify 82% of patients diagnosed with sepsis, which was a significant improvement from prior occasions ( $p= 0.005$ ).

Similarly, Noritomi et al. (2014) evaluated the impact of a multifaceted, sepsis performance improvement program on SSC guideline compliance and patient outcomes. The program consisted of multidisciplinary sepsis education, development of early sepsis screening tools, and the implementation of sepsis treatment protocols for patients positively diagnosed with sepsis. The medical records of 2,120 patients with sepsis, being cared for in one of ten possible hospitals, were analyzed in this study. The researchers determined that after the program's implementation, the average time to diagnose sepsis had decreased significantly from 2.2 hours to 0.7 hours ( $p < 0.001$ ). In addition, compliance rates with serum lactate measurement and administration of IV fluids and vasopressors to restore hemodynamic stability had reached 99% by the end of

the study. Finally, the overall sepsis-associated mortality rate among patients had significantly decreased to 26% after the program's implementation, compared to 55% before the program ( $p < 0.001$ ).

The incorporation of sepsis guideline education and treatment protocols into nursing practice were associated with improved sepsis recognition and compliance with evidenced-based treatment guidelines in both of the studies discussed above. Consequently, improved patient outcomes, such as decreased mortality rates, were also noted. As a result, it is evident that improving the management of sepsis can be accomplished through the implementation of education initiatives and management protocols, as recommended by the SSC guidelines (Rhodes et al., 2017).

### **Nurse Initiated Screening Protocols**

Several of the research studies evaluated in this literature review, assessed the effect of implementing screening protocols initiated by nursing staff. One study that was included in this evaluation assessed the impact of implementing a sepsis screening protocol on identifying sepsis early and implementing appropriate treatment in a timely manner on patient outcomes (Moore et al., 2009). The sepsis protocol consisted of a three level multi-disciplinary hierarchy of sepsis assessments and decision-making opportunities, beginning with nursing staff. First, bedside nurses in a surgical ICU completed a SIRS assessment at least twice a day on all their patients. If patients met the criteria for SIRS, they were then assessed by other healthcare professionals and examined for symptoms of infection. If patients were deemed to have SIRS in combination with an infection, they were diagnosed with sepsis and treated accordingly. The study took place over a five month period and 4,991 sepsis screens were completed on 927 ICU patients.

After comparing the predictive results of the screening protocol with the number of patients diagnosed with or without sepsis, the protocol was proven to have a sensitivity of 96.5% and a specificity of 96.7%. Researchers determined that the screening protocol has a positive predictive value of 80.2% and a negative predictive protocol of 99.5%. In addition, sepsis-associated mortality rates within the surgical ICU decreased from 35.1% from the previous year to 24.2% post-protocol implementation. Although the level of significance was not discussed, it was noted that sepsis-associated mortality rates among patients in the cardiac and medical ICUs within the same hospital, that did not implement the sepsis protocol, had not changed within the same time period.

Similarly, Gyang, Shieh, Forsey, and Maggio (2015) also evaluated the impact of a nurse-initiated sepsis screening tool on sepsis identification within a medical and surgical unit. The sepsis screening tool consisted of bedside nurses completing a three part assessment identifying symptoms of SIRS and infection. Based on the results of the assessment, if patients were found to meet the criteria for a sepsis diagnosis then nurses reported the result to the appropriate personnel to initiate further treatment. During the study, 2,143 screens were completed on a total of 245 medical or surgical patients over a one month period. After the results of the screening tool were compared to the patients documented diagnosis, the screening tool was found to have a 92% accuracy rate, a 95.5% sensitivity, and 91.9% specificity.

A final study evaluated the impact of a sepsis screening program, focusing on early recognition and treatment, directed towards nurses and nurse practitioners on patient outcomes and hospital costs (Jones et al., 2015) The sepsis program consisted of four components; 1) leadership; 2) development of sepsis screening tools; 3) screening and

response protocols; and 4) education and training of nurses. Nurses were responsible for completing sepsis screens on patients at admission, once a shift, and any time a patient's condition had deteriorated. If a patient screened positive, then a nurse practitioner was alerted and treatment protocols were implemented within an hour of the diagnosis. These protocols were based on the SSC sepsis guidelines. The study was conducted over a period of three years and in that period 127,447 sepsis screens had been conducted on a total of 21,096 inpatients in a single, academic hospital. The percentage of patients that were positively identified with sepsis was 11% in 2009, 12% in 2010, and 11% in 2011. The researchers concluded that sepsis-associated mortality rates had significantly decreased from 29.7% in the pre-implementation period, down to 21.1% in the post-implementation period.

Although further research is required to determine if these screening tools are reliable in all areas of care, there is evidence that incorporating screening tools into routine nursing practice can improve sepsis recognition among nurses. Consequently, septic patient outcomes, such as mortality rates, could also improve as evidenced by these results. The results of the studies discussed above highlight the important role nurses play in identifying septic patients and initiating the treatment process. As a result, they are a significant component of sepsis management improvement initiatives that require consideration during the development and implementation phases of these programs.

## **Practicum Project**

### **Theoretical Framework**

In an attempt to improve the competency of nurses in Newfoundland and Labrador in recognizing and treating sepsis in pediatric patients, this practicum project

will focus on the development of a pediatric sepsis online learning module for nurses. The content for this online learning module will include sepsis definitions and diagnosis criteria, evidenced-based management guidelines, and sepsis screening resources. Since the target audience of this project is a group of adult, professional learners, the conceptual framework that will guide the development of this online module will be adult learning theory. Knowles' Adult Learning Theory recognizes the unique learning needs of adult learners and provides educators with insight on how to effectively teach this population (Lieb, 1991). Knowles characterized adult learners as being self-directed individuals with prior knowledge derived from past life experiences. They are goal-oriented learners that choose learning experiences based on relevancy and practicality, and they require respect from their educators. As a result, to create an effective learning experience educators need to consider these unique characteristics throughout the development process.

As self-directed learners, adults desire learning experiences that allow them to be involved in the learning process and accomplish their learning goals (Lieb, 1991). These experiences should enhance previous learning and further their understanding of familiar topics. Adult learners often choose to participate in learning experiences that they believe will help them achieve their personal or work-related goals (Lieb). Additionally, adult learners desire experiences that are relevant and will provide them with information they perceive as valuable. Finally, successful adult educators provide adults with practical information they can use, while respecting their personal opinions and treating them as equals rather than students.

Another difference educators must consider when teaching adult learners, is their motivation for learning. Common motivations among adult learners include; a) to form

social relationships; b) to fulfil the external expectations of others; c) to be able to attribute to the social welfare of others; d) personal advancement; e) to escape from boredom or provide stimulation; or f) to satisfy a cognitive interest in obtaining knowledge (Lieb, 1991). Educators should determine what is motivating an individual to seek learning, and then identify any barriers that may be preventing them from participating. Motivation to learn can be improved by promoting personal participation benefits, while utilizing teaching methods that can overcome learning barriers (Lieb). Consequently, the sepsis online learning module will utilize the Adult Learning Theory by selecting education techniques that reflect the unique characteristics of its intended adult audience. Professional motivations to learning, and participation barriers, will also be considered throughout the development process.

### **Online Learning Module**

For my education session to be effective in teaching an audience of adult nurses, the unique characteristics of this population will need to be taken into consideration throughout the development process. The development of an online education module will allow nurses to participate and complete at their own pace. The content of the module will be designed to enhance their current sepsis knowledge, while providing them with new information they can use to improve their nursing practice. The sepsis content will be presented using real-life situations that nurses are familiar with and will provide them with the problem-solving opportunities so they can practice applying their knowledge of sepsis to improve their comprehension of the material. Considering this education will be voluntary, strategies to promote participation will also need to be considered.

As my education module will use an online teaching format, it is important to evaluate the

literature to determine if there are any disadvantages to using this type of format compared to more traditional teaching methods.

Morente, Morales-Asencio, and Veredas (2014) compared the use of online training versus in-person, classroom education on pressure ulcer training in undergraduate nursing students. This study utilized a randomized control trial design and provided the same information to both groups through two different education forums. Post-test results indicated that the online educated group's pressure ulcer knowledge scores were either comparable, or significantly higher ( $p= 1.142502E-09$ ), with those of the traditionally educated group. Powers and Candela (2016) evaluated the impact of using an online education program to teach critical care nurses about implementing the practice of family presence during resuscitation (FPDR). Two groups of critical care nurses were provided online training; the control group was provided education about resuscitation interventions and the intervention group was provided resuscitation training that incorporated FPDR information. Pre- and post-test results indicated that FPDR online training improved nurses' self-perception and confidence that they could successfully incorporate FPDR into future resuscitation experiences based on the training they received. Although these studies did not focus on sepsis education, the results provide supporting evidence for the use of online education methods to teach nursing populations. Online learning is useful in achieving knowledge acquisition, as well as improving self-perceived competency among nurses.

While developing an online education module it is also necessary to evaluate relevant literature to learn about the thoughts and feelings of those who have participated in online education activities. This will help identify common benefits and difficulties

expressed by previous learners that can be considered throughout the development process to improve the final product.

Kim (2009) interviewed a group of adult learners after they completed a self-directed online learning course to gain insight to the motivational challenges they faced throughout their completion of the course. Six motivational themes were emerged from data collected; a) interactivity of the course content; b) absence of human interaction; c) application and integration of content by the learner; d) learner control; e) psychological influences; and f) lack of external motivators. Positive opinions of a self-directed learning module expressed by the participants included use of interactive elements (e.g., animations or quizzes), integration of familiar, real-life situations (e.g., simulations or case-studies), schedule flexibility, and reduced anxiety to meet deadlines. Participants differed on their opinions of lack of human interaction and extrinsic motivation. Some individuals felt a lack of human interaction and external motivators (e.g., assignment deadline dates) hindered their learning experience, while others felt these elements had no negative impact on their performance. These themes will be taken into consideration to help develop an online learning module that will promote participation and learning among nurses.

### **Conclusion**

Sepsis-associated death continues to be a significant problem, despite precise diagnostic criteria and the development of evidence-based treatment guidelines. Contributing factors associated with sepsis-associated mortality include inadequate sepsis knowledge among healthcare professionals and delayed treatment efforts. Sepsis among pediatric populations can be difficult to diagnose due to their physical ability to

compensate for hemodynamic instability, concealing obvious symptoms of inadequate perfusion. As a result, children experiencing septic shock may not be diagnosed correctly, resulting in delayed treatment and increased risk of poor health outcomes. To reduce the risk of poor sepsis-associated outcomes, aggressive, effective treatment needs to be administered as soon as possible once sepsis symptoms present themselves. Evidenced-based practices in treating sepsis include administering resuscitation IV fluids to and vasoactive medications to restore hemodynamic stability, collection of microbiology cultures, and administration of broad-spectrum antimicrobial therapy.

Education is a useful method for improving sepsis recognition and treatment performance among healthcare professionals. Nurses are an important population to consider when trying to improve sepsis management, as they are often the first to be exposed to presenting sepsis symptoms. As a result, nurses play an important role in activating early sepsis treatment. Online education methods can be useful tools in providing nurses with the information to improve their knowledge and nursing practice.

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## Appendix A1

### Literature Summary Tables

Table 1

Burden of Sepsis Literature Summary Table

<b>Author/Date/Objective</b>	<b>Study Design/Sampling/ Setting Characteristics</b>	<b>Measured Outcomes/ Reliability/ Validity</b>	<b>Relevant Outcomes</b>	<b>Limitations/ Quality of Study</b>
<p>Weiss et al., 2015</p> <p>Objective: to characterize the global prevalence, therapies, and outcomes of severe sepsis in PICUs to better inform interventional trials</p>	<ul style="list-style-type: none"> <li>- Prospective cross-sectional study</li> <li>-conducted on five days over the course of 1 year</li> <li>-involved 128 PICU in 26 countries</li> <li>-567 records of pediatric patients meeting the criteria for diagnosis of severe sepsis or septic shock with complete documentation available</li> </ul>	<ul style="list-style-type: none"> <li>-Characteristics of patients with sepsis (age, sex, race, comorbid conditions, Pediatric Overall Performance Category, types of PICU admission, source of admission, and organ dysfunction present at screening).</li> <li>-Site of infection and microbiologic etiology of severe sepsis (primary site of infection, microbiology, gram-positive bacteria, anaerobic bacteria, other bacteria, fungi, parasites, and viruses).</li> <li>-Therapies used within the 48 hour data collection</li> </ul>	<ul style="list-style-type: none"> <li>-Most common primary sites of infection were respiratory (40%) and bloodstream (19%)</li> <li>-98% of patients received antibiotics, 19% antivirals, and 33% antifungals.</li> <li>-Median duration of mechanical ventilation was 13 days</li> <li>-Median duration of vasopressor use was 7 days</li> </ul>	<ul style="list-style-type: none"> <li>-Cross-sectional method of data collection</li> <li>-Majority of participating PICUS were from developed countries and large institutions therefore limiting the generalizability of results to resource-limited and community-based settings</li> <li>-Small number of data collection days</li> <li>-Small sample size</li> </ul>

		<p>window (vasoactive infusions, invasive mechanical ventilation, corticosteroids, albumin, synthetic colloid, blood products enteral nutrition, parenteral nutrition, gastric ulcer prophylaxis, insulin, granulocyte/ granulocyte-monocyte colony-stimulating factor, intravenous immunoglobulin, renal replacement therapy, plasma exchange, and ECMO)</p> <p>-Outcomes for total cohort and by age category (vasoactive-free days, ventilator-free days, new or progressive multi-organ dysfunction syndrome, PICU mortality, hospital mortality, mild disability, moderate disability, and death or disability)</p>	<p>-PICU mortality was 24%</p> <p>-Hospital mortality was 25%</p>	<p>Quality of study design: <b>weak</b></p> <p>Quality of study: <b>Medium</b></p>
<p>Wolfer et al., 2008</p> <p>Objective: To assess the incidence of sepsis, severe sepsis, and septic shock and</p>	<p>-Prospective cross-sectional study design</p> <p>-15 participating PICUs</p>	<p>-Characteristics of the PICUs</p> <p>-Patient characteristics (sex, age, surgical patients, mean length of hospital</p>	<p>-320 of the pediatric participants had a sepsis-related diagnosis (77.5%</p>	<p>-Cross-sectional method of data collection</p> <p>-Statistical analysis methods (confidence</p>

<p>their mortality in Italian PICUs</p>	<p>-2,741 children participated from newborn to 16 years old</p>	<p>stay, pediatric index of mortality, standardized mortality ration, chronic underlying disease, sepsis-related diagnosis, and mortality rate), distribution of sepsis-related diagnosis for type of admission (medical, elective surgery, non-elective surgery, trauma, cardiac surgery, neuro surgery), distribution of sepsis-related diagnosis for site of infection (respiratory, central nervous system, blood stream infection, gastrointestinal, and other), and mortality rates.</p>	<p>had sepsis on PICU admission, 22.5% developed sepsis while admitted to a PICU).  -216 children were diagnosed with sepsis, 45 with severe sepsis, and 59 with septic shock -8(3.7%) of the children with sepsis, 11(24%) with severe sepsis, and 30(50.8%) with septic shock died  -Mortality rates were significantly higher in septic children with an underlying disease  -Patients with 5 body systems displaying dysfunction had a 100% mortality</p>	<p>interval) not mentioned  Quality of study design: <b>Weak</b>  Quality of study: <b>Low</b></p>
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			-Children with sepsis had a mean length of hospital stay of 8 days versus 2 days on non-septic patients	
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Table 2

Sepsis Management Literature Summary Table

<b>Author/Date/Objective</b>	<b>Study Design/Sampling/Setting Characteristics</b>	<b>Measured Outcomes/Reliability/ Validity</b>	<b>Relevant Outcomes</b>	<b>Limitations/ Quality of Study</b>
Brierley et al., 2009  Objective: to update the 2002 American College of Critical Care Medicine clinical guidelines for hemodynamic support of neonates and children with septic shock	<ul style="list-style-type: none"> <li>-Systematic literature review</li> <li>-Several literature databases were searched using relevant keywords</li> <li>-Best practice outcomes were identified.</li> <li>-Only studies involving children were included</li> <li>-Clinical practices and guidelines were</li> </ul>	<ul style="list-style-type: none"> <li>-Clinical signs and hemodynamic variables to direct treatment of neonatal pediatric shock (intravascular access, fluid therapy, mechanical ventilation, sedation for invasive procedures and intubation, and intravascular catheters and monitoring), cardiovascular drug</li> </ul>	<ul style="list-style-type: none"> <li>-The goals for the first hour of caring for pediatric septic shock are restoring and maintaining airway, oxygenation, ventilation, and circulation</li> <li>-Restore perfusion so that capillary refill is 2 seconds or less, peripheral and central pulses are normal and equal, warm</li> </ul>	<ul style="list-style-type: none"> <li>-Statistical analysis process (confidence interval) was not discussed for the studies included in the literature review</li> <li>Quality of study design: <b>Strong</b></li> <li>Quality of study: <b>Medium</b></li> </ul>

	<p>developed based on these best practices</p>	<p>therapy, inotropes, vasodilators, vasopressor therapy (glucose, calcium, thyroid, and hydrocortisone replacement)</p>	<p>extremities, urine output is greater than 1ml/kg/hr, normal mental status, normal blood pressure, and normal serum glucose and ionized calcium concentrations</p> <ul style="list-style-type: none"> <li>-Frequent assessment and monitoring of pulse oximeter, electrocardiography, blood pressure, pulse pressure, temperature, urine output, serum glucose, serum ionized calcium, and airway and breathing</li> <li>-obtain intravascular access immediately</li> <li>-administer rapid, repeated boluses of a crystalloid solution (20ml/kg) to restore perfusion unless symptoms of fluid overload are present</li> <li>-administer inotrope therapy peripherally if needed until central access can be acquired</li> </ul>	
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<p>Castellanos-Ortega et al. 2008</p> <p>Objective: to describe the effectiveness of the Surviving Sepsis Campaign bundles with regard to both implementation and outcome in patients with septic shock and to determine the contribution of the various elements of the bundles to the outcome</p>	<p>-Quasi-experimental design with a historical comparison group (Cohort design)</p> <p>-3 medical-surgical intensive care centres in a hospital</p> <p>-n=384 adult patients diagnosed with septic shock</p> <p>-n=96 adult patients in the historical comparison group</p>	<p>-Hospital-wide sepsis quality improvement program based on the implementation of the Surviving Sepsis Campaign guidelines</p> <p>-Primary outcome: hospital mortality</p> <p>-Secondary outcomes: ICU mortality, hospital length of stay, ICU length of stay, and compliance for each sepsis bundle and each single intervention</p>	<p>-Hospital mortality (37.5%) was significantly lower in the SSC group compared to the historical group (57.3%)</p> <p>-Compliance with sepsis bundles improved from 1% to 11.3% post education</p> <p>-Lower mortality rates were associated with the higher number of recommended intervention performed</p>	<p>-Due to the study's design it is difficult to determine the strength of the relationship between SSC bundle compliance and mortality rates of septic shock</p> <p>-Sepsis severity between patient groups may have contributed to mortality rate differences</p> <p>-Single-centre study</p> <p>-Possibility of temporal trends in mortality rates biasing results</p> <p>Quality of study design: <b>Moderate</b></p> <p>Quality of study: <b>Medium</b></p>
<p>Levy et al., 2014</p> <p>Objective: to determine the association between compliance with the Surviving Sepsis</p>	<p>-Prospective cohort study design</p> <p>-Participants met the criteria for a sepsis diagnosis</p>	<p>-Compliance with SSC sepsis bundles and associated mortality rates</p> <p>- Institutions labelled as high or low</p>	<p>-Mortality rates were less (29%) in high compliant centres when compared to low compliant centres (38.6%)</p>	<p>-Lack of a randomized control design means that compliance rates can be conclusively associated with mortality rates</p>

<p>Campaign performance bundles and mortality</p>	<p>-N= 29, 470 over 7.5 year span -Adult participants -Institutions from Europe, United States, and South America were involved</p>	<p>compliance with the SSC sepsis bundles -Duration of participation in study</p>	<p>-Compliance with these sepsis guidelines resulted in a 25% reduction in risk of sepsis-associated mortality</p>	<p>-Other performance improvement initiatives were not analyzed and may have impacted mortality rates -No rigorous quality control of data collection</p> <p>Quality of study design: <b>Moderate</b></p> <p>Quality of study: <b>Medium</b></p>
<p>Mouncey et al, 2015</p> <p>Objective: To determine if septic patients receiving EGDT versus usual resuscitation care had any impact on mortality rates</p>	<p>-Randomized control trial -N=1260 adult patients -n=630 patients assigned to EGDT -n=630 patients assigned to control group -Patients selected from 56 hospitals throughout England -Patients were assigned to their groups within 2 hours of being</p>	<p>-EGDT group: a central venous catheter was inserted into to monitor Scvo<sub>2</sub> and resuscitation efforts were followed based on the SSC 6-hour bundle guidelines -Control group: received continued monitoring, investigations, and interventions based on clinician judgement</p>	<p>-Patients in the EGDT received more IV fluids within the first 6 hours than the control group -By 90 days 184 (29.5%) of the patients in the EGDT group had died and 181 (29.2%) of the control group patients had died -EGDT therapy had increased associated hospital costs</p>	<p>- Due to the selection process of patients only approximately 1/3 of possible patients were included due to varying times patients and staff were available. -the intervention and control groups could not be blinded.</p> <p>Quality of study design: <b>Strong</b></p>

	admitted to hospital and meeting the sepsis criteria	(still received early fluid administration and antibiotics) -Primary outcome: all-cause mortality at 90 days. -Cost-effectiveness measure were also examined		Quality of the study: <b>Strong</b>
Peake et al., 2014  Objective: To determine if septic patients receiving EGDT versus usual resuscitation care had any impact on mortality rates	-Randomized control trial. -Stratified random sampling used. -n= 1600 adult patients with sepsis -n=796 patients were assigned to the EGDT group -n= 804 patients were assigned to the control group -Patients were selected from 51 hospital across Australia and New Zealand	-Patients who met inclusion criteria were selected within 6 hours of presenting to the emergency department. Control group: received continued monitoring, investigations, and interventions based on clinician judgement (still received early fluid administration and antibiotics, no Svco <sub>2</sub> monitoring permitted) -EGDT group: an arterial catheter and a central venous catheter capable of continuous Scvo <sub>2</sub> measurement	-Patients in the EGDT received more IV fluids within the first 6 hours than the control group -147 deaths (18.6%) had occurred in the EGDT group and 150 (18.8%) had occurred in the usual-care group. -No significance in mortality rate found.	-Groups could not be blinded.  Quality of study design: <b>Strong</b>  Quality of study: <b>Strong</b>

		<p>were inserted within 1 hour after randomization. The resuscitation algorithm was based on the original EGDT algorithm and was followed until 6 hours after randomization</p> <p>--Primary outcome: all-cause mortality at 90 days.</p>		
<p>Rhodes et al., 2017</p> <p>Objective: To provide an update to the Surviving “Sepsis Campaign Guidelines for Management of Sepsis and Septic Shock: 2012”</p>	<p>-Systematic literature review</p> <p>-questions were developed about sepsis management focusing on hemodynamics, infection, adjunctive therapies, metabolic, and ventilation</p> <p>-questions were answered using a literature review</p> <p>-Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) principles were applied to determine the</p>	<p>-Initial resuscitation, screening for sepsis and performance improvement, diagnosis, antimicrobial therapy, source control, fluid administration, vasoactive medications, corticosteroids, blood products, immunoglobulins, blood purification, anticoagulants, mechanical ventilation, sedation and analgesia, glucose control, renal replacement therapy,</p>	<p>-sepsis and septic shock are medical emergencies requiring immediate treatment</p> <p>-fluid resuscitation using 30ml/kg IV boluses of crystalloid solution within the first 3 hours of sepsis presentation</p> <p>-administer further IV fluid based on frequent assessment of hemodynamic status</p> <p>-maintain a MAP of greater than 65mmHg using fluid administration and</p>	<p>-analytical process for each study included in the literature review was not discussed</p> <p>Quality of study design: <b>Strong</b></p> <p>Quality of the study: <b>medium</b></p>

	strength of the recommendations of sepsis management	bicarbonate therapy, venous thromboembolism prophylaxis, stress ulcer prophylaxis, nutrition, and setting goals of care.	vasopressor medications -obtain microbial cultures promptly without delaying antimicrobial therapy -administer appropriate antimicrobials within the first hour of sepsis presentation -healthcare institutions should implement sepsis programs aimed at recognizing sepsis in high-risk patients	
Samransamruajkit et al., 2014  Objective: to determine the clinical outcomes of SSC implementation and to investigate the prognostic value of initial plasma NT-proBNP and procalcitonin in children	-Prospective cohort study -n= 66 pre-intervention participants -n= 47 pediatric post-intervention participants -Patients aged 1 month-15 years -Single PICU in a Thailand hospital -Patients diagnosed with severe sepsis or septic shock	-Educational program followed SSC sepsis guidelines and involved lectures presented to multiple disciplines -Primary outcome: PICU mortality -Amount of resuscitation fluids administered -Compliance of sepsis bundle care (hemodynamic fluid resuscitation, superior vena cava oxygen	-Septic shock mortality rates significantly decreased from 42% in the 3 years prior to the intervention to 19.1% in the year after the intervention -Compliance with SSC bundle care increased from 30% prior to intervention to more than 70% post-intervention	-Single unit used as the setting meaning results may not be generalized to other PICU units -No other performance improvement initiatives examined to determine if other factors caused causation effects on measured outcomes  Quality of study: <b>Moderate</b>

		saturation greater than 70%)		Quality of study: <b>Medium</b>
Weiss et al., 2014  Objective: to determine the impact of antimicrobial timing on mortality and organ dysfunction in pediatric patients with severe sepsis or septic shock	-Retrospective cohort study -N= 130 pediatric patients cared for in a PICU from February 2012 to January 2013 -n= 27 patients had severe sepsis -n= 103 patients had septic shock	-Primary outcome: PICU mortality -PICU length of stay -Number of vasopressor free days -Number of mechanical ventilator free days -Number of organ dysfunction free days -Measured the amount of time between sepsis recognition and administration of antimicrobial therapy	-Patients treated following the organizations treatment pathway received antibiotics earlier than those that did not follow the pathway -Mortality rates increased with increased delay in initial antimicrobial administration -Mortality rates increased significantly ( 21.2%) when antimicrobial administration was delayed beyond 3 hours since sepsis recognition	-Single centre setting, therefore, generalization of results may not be suitable -Small sample sized so unable to determine if antimicrobial therapy administered between 1-3 hours after sepsis recognition significantly affected mortality rates -Unable to determine if severity of sepsis impacted antimicrobial timing.  Quality of study design: <b>Moderate</b>  Quality of study: <b>Medium</b>

<p>Workman et al., 2016</p> <p>Objective: To determine if outcomes in patients who received initial care compliant with the Surviving Sepsis Campaign time goals differed from those treated more slowly</p>	<p>-Single centre retrospective cohort study -N=321 patients treated for sepsis in the ER department and then admitted to the PICU</p>	<p>-Exposure: ER care compliant with SSC recommendations (administration of IV fluids, antibiotics, and vasoactive infusions within 1 hours of sepsis recognition) -Primary outcome: development of new or progressive organ dysfunction -Secondary outcomes: mortality rates, need for mechanical ventilation, need for vasoactive medications, and hospital and PICU lengths of stay</p>	<p>-117 children received care compliant SSC guidelines -204 children received care not compliant with the SSC guidelines -Of those that did not receive care within the recommended time frame of 1 hour most patients (75%) received care within the first 2-3 hours since sepsis recognition -No significant difference in mortality rates among those who received care within the first hour and those within the first 2-3 hours</p>	<p>-Single centre setting limiting generalizability of results -Small sample size -determination of wanted exposure based on documentation -Severity of illness at time of presentation to ER may have impacted the care patient received and outcomes -Validity and reliability not discussed</p> <p>Quality of study design: <b>Moderate</b></p> <p>Quality of study: <b>Medium</b></p>
<p>Yealy et al., 2014</p> <p>Objective: To determine if septic patients receiving EGDT versus usual resuscitation care</p>	<p>-Randomized control trial. -N=1341 adult patient with sepsis -n=439 patients assigned to protocol-based EGDT group.</p>	<p>-Protocol-based EGDT group: Placement of a central venous catheter to monitor pressure and Scvo2 and to administer initial resuscitation fluids.</p>	<p>-By 60 days, there were 92 deaths in the protocol-based EGDT group (21.0%), 81 in the protocol-based standard-therapy group (18.2%), and 86 in the</p>	<p>-Intervention could not be blinded to data collectors.</p> <p>Quality of study design: <b>Strong</b></p>

<p>had any impact on mortality rates</p>	<p>-n= 446 patients assigned to protocol-based standard therapy group.          -n= 456 patients assigned to usual care group.          -Patients selected from 31 hospitals across the United States.          -Patients assigned to group within 2 hours of presenting with shock symptoms and within 12 hours of presenting to the emergency department.</p>	<p>The protocol guided initial fluid resuscitation only.          -Protocol-based standard therapy group; required adequate peripheral venous access (with placement of a central venous catheter only if peripheral access was insufficient). Initial resuscitation was based on systolic blood pressure and shock index (the ratio of heart rate to systolic blood pressure) and to address fluid status and poor perfusion,          -Usual care group: The bedside providers directed all care.          -Primary outcome: The all-cause mortality rate at 60 days.          -Secondary outcomes: all-cause mortality rate at 90 days and cumulative mortality at 90 days and 1 year.</p>	<p>usual-care group (18.8%).          -No significant difference in mortality rates for either group.</p>	<p>Quality of study:  <b>Strong</b></p>
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Table 3

Sepsis Competence of Nurses Literature Summary Table

Author/Date/Objective	Study Design/Sampling/Setting Characteristics	Measured Outcomes/Reliability/ Validity	Relevant Outcomes	Limitations/Quality of Study
<p>Jeffery et al., 2014</p> <p>Objective: To assess the knowledge of acute and critical care pediatric nurses of SIRS diagnostic criteria, sepsis guidelines, and the importance of SIRS recognition.</p>	<p>-Cross-sectional, quantitative, correlational descriptive study.</p> <p>-N= 242 acute and critical care pediatric nurses in an urban pediatric hospital.</p>	<p>-Nurses demographic information.</p> <p>-Questionnaire used scenarios, case studies, yes or no questions to determine the nurses' knowledge of SIRS and sepsis recognition and sepsis treatment.</p> <p>-Likert questions to assess nurses' self-reported competence in caring for sepsis</p> <p>-Questionnaire was developed by multiple experts and pilot-tested for reliability.</p>	<p>_Results determined that many nurses were able to recognize septic shock but had trouble recognizing early symptoms of sepsis.</p> <p>-Less than half (43%) of nurses considered measuring serum lactate level.</p> <p>-Only 45% of nurses were able to recognize need for mechanical ventilation.</p> <p>-Only 60% of the questions were answered correctly.</p> <p>-Only 57.9% of nurses felt comfortable recognizing symptoms of SIRS.</p>	<p>-Small sample size so results may not be representative of all the nurses in the hospital.</p> <p>Quality of study design: <b>Weak</b></p> <p>Quality of study: <b>Medium</b></p>

<p>Launay et al., 2010</p> <p>Objective: To study the frequency and types of suboptimal care and medical errors in children who died of severe bacterial infection as the first-stage procedure intended to improve quality of care</p>	<p>-Retrospective, cohort study  -2 adjoining administrative districts  -Sample: all children aged 3 months to 14 years living in this geographical area that died from a severe bacterial infection between January, 2000 and March, 2006.  n= 21 children</p>	<p>-Management of care evaluated  -Classification of errors in management:  diagnostic errors (underestimation of severity, failure to act on results of a test), treatment errors (error in the dose or method of using a drug or treatment, avoidable delay in treatment after diagnosis, error in performance of a procedure), system failure, and failure of communication.  -Internal validity: determination of suboptimal care was determined by 2 independent experts that were not informed of patient's final diagnosis or outcome.  -External validity: prevalence of suboptimal care was</p>	<p>-76% of cases were determined to have at least one medical error or suboptimal decision before their arrival in the PICU  -Identified errors included delay in administering appropriate treatment (ex., emergency antibiotic therapy for patients with a purpuric rash), dose errors (ex., insufficient or unrepeatable fluid resuscitation, and overall underestimation of disease severity.</p>	<p>-No comparison group comparing care of severe bacterial infection survivors to determine causal relationship between care and outcomes.</p> <p>Quality of study design:  <b>Moderate</b></p> <p>Quality of study:  <b>Strong</b></p>
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		similar to that reported in other countries		
<p>Pedro et al., 2015</p> <p>Objective: To determine the etiology and clinical disease progression variables of sepsis associated with the prognosis of patients admitted to a PICU</p>	<p>-Prospective, retrospective cohort series</p> <p>-n= 115 children (mean age of 30.5 months)</p> <p>-Participants were admitted to a general hospital PICU with a diagnosis of sepsis</p>	<p>-General characteristics of patients, presence or absence of complications, mortality and survival rates, and bacterial etiology.</p>	<p>-The main factor associated with death was the presence of complications during hospitalization (p &lt; 0.001)</p> <p>-Altered perfusion and symptoms of severe sepsis on arrival were most associated with complications during hospitalization.</p>	<p>-Single centre setting</p> <p>-Small sample size meaning results may not be generalized for other samples</p> <p>-Data collector process and training were not discussed</p> <p>Quality of study design: <b>Moderate</b></p> <p>Quality of study: <b>Medium</b></p>
<p>Robson et al., 2007</p> <p>Objective: To survey nurses' knowledge of sepsis definitions and early management against standard definitions and the SSC management guidelines</p>	<p>-Cross-sectional descriptive design</p> <p>-Questionnaire (3 phases)</p> <p>-n=73 registered nurses working in medical, surgical, or orthopedic wards</p>	<p>-Phase 1: identifying believed symptoms of sepsis from a list of signs and symptoms.</p> <p>-Phase 2: Review of case studies to determine if diagnosis of sepsis was warranted and</p>	<p>-Majority of nurses were aware that hypothermia or low white blood cell count were a sign of sepsis</p> <p>-Case study results indicated that nurses may not recognize that signs of infection</p>	<p>-Validity of questionnaire not tested</p> <p>-Small sample size from one hospital meaning results may not be generalizable for</p>

		<p>determine appropriate management</p> <p>-Phase 3: 10 true and false statements about sepsis.</p>	<p>and SIRS may indicate sepsis</p> <p>-Many nurses do not consider infection as a source of illness initially</p> <p>-Many nurses are unaware of increased lactate levels (78%) and signs of organ dysfunction ( low oxygen saturation, low systolic blood pressure [19%], or low platelet levels) are indicators of severe sepsis</p>	<p>other groups of nurses</p> <p>Quality of study design: <b>Weak</b></p> <p>Quality of study: <b>Low</b></p>
<p>Stamataki et al., 2014</p> <p>Objective: To evaluate nurses' knowledge of sepsis in Greece.</p>	<p>-Self –administered questionnaire</p> <p>-Cross-sectional descriptive design</p> <p>-n= 835 registered nurses from tertiary hospital across Greece</p> <p>-Questions to evaluate the nurses' knowledge regarding assessment and management of sepsis.</p>	<p>-Knowledge of clinical characteristics of SIRS</p> <p>-Awareness of sepsis</p> <p>-Knowledge of sepsis</p> <p>-Nurses role in sepsis care</p>	<p>-Only 50% of the sample of nurses were aware of the importance of tachycardia, tachypnea, decreased urine output, an decreased oxygen saturation in diagnosing sepsis</p> <p>-Majority of the nurses requested educational programs</p>	<p>-Questionnaire not validated through testing. Questionnaire questions were not exhaustive of sepsis assessment.</p> <p>-Only tertiary hospitals included in studies meaning result may not be generalized</p>

	-Random sampling selected 14 hospitals to participate.		updating them of sepsis care	for other institutions.  Quality of study design: <b>Weak</b>  Quality of study: <b>Medium</b>
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Table 4

Sepsis Education Literature Summary Table

<b>Author/Date/Objective</b>	<b>Study Design/Sampling/ Setting Characteristics</b>	<b>Measured Outcomes/ Reliability/ Validity</b>	<b>Relevant Outcomes</b>	<b>Limitations/ Quality of Study</b>
Delaney et al., 2015  Objective : To evaluate the impact of a sepsis education program on the knowledge and competency of nurses in early recognition and management of sepsis	-Cross-sectional descriptive study -Purposive sampling -Registered Nurses (RNs) from emergency departments and critical care areas completing fellowship training. -RNs chosen from 5 hospitals. -n= 87 RNs	-Intervention: Taming Sepsis Educational Program (TESP) that consisted of 2 parts. -Part 1: education was presented in 4 online learning modules and video vignettes of patient interactions. Pre- and post-tests were completed. -Part 2: high-fidelity simulation.	-Post-tests revealed comprehension significantly improved ( $p < 0.0001$ ) in sepsis bundles, sepsis severity, team communication. - Significance difference was found in nurses' self-assessed competency in recognizing early sepsis symptoms, caring for patients with	-Self- assessment questionnaire used to collect data -Purposive sampling method used -Sample consisted of nurses with similar training and education backgrounds making generalization of results low  Quality of study design: <b>Weak</b>

		-Nurse competence surveys administered post-education.	SIRS, sepsis, and septic shock, and ability to organize health care team to initiate treatment in patient exhibiting symptoms of sepsis (p < 0.0001).	Quality of study: <b>Medium</b>
Ferrer et al., 2008  Objective: To evaluate the effect of an education program based on the SSC guidelines had on patient care and mortality.	-Cohort study. -Comparison group: All patients admitted with sepsis to participating ICUs 2 months prior to the education program (n= 854). -Intervention group 1: All patients admitted with sepsis to participating ICUs four months post-education (n= 1465). Intervention group 2: All patients admitted with sepsis to participating ICUs during a 2 month period 1 year post-education (n=247). -23 ICUs participated.	-Intervention: SSC guideline and sepsis education was provided to physicians and nurses using PowerPoint presentations and posters. -Measured outcomes: Hospital mortality, compliance to sepsis bundles, ICU mortality, 28-day mortality, hospital length of stay, and ICU length of stay.	-Post-intervention period: Only blood cultures before antibiotics and early broad-spectrum antibiotic administration had greater than 50% competency. -All compliance rates with the elements of the sepsis resuscitation bundles (except antibiotic administration) and sepsis management bundle significantly improved. -Post-intervention groups had statistically lower risk of hospital mortality than the pre-	-Study design means other causations for improved results cannot be ruled out. -No control group. -Patients only selected from ICUs.  Quality of study design: <b>Medium</b>  Quality of study: <b>Medium</b>

			intervention group. (44% versus 39.7%)	
Herràn-Monge et al., 2016  Objective: To determine the long-term compliance with SSC bundles and effect on patient outcomes of an education program on sepsis after 5 years.	-Prospective, cohort design. -5 year group: n= 231 episodes of septic shock -Historical group (1 year): n= 217 episodes of sepsis -Sample chosen from patients, admitted to ICUs from 10 hospitals in Spain, with a sepsis diagnosis.	-Intervention: Sepsis education campaign provided to staff over the course of 5 years. -Outcomes: SSC bundle compliance, mortality, length of stay, relationship between bundle compliance and patient outcomes.	-ICU mortality decreased significantly (27.1% versus 37.3%; p=0.02). -Compliance with entire initial resuscitation bundle had reduced risk of mortality (OR= 0.51). -Administration of broad-spectrum antibiotics, IV fluids, and vasopressors had 90% compliance rates for the 5 year group episodes.	-Septic patients not in ICU were not included. -Causation may have been impacted by individual staff training and education,  Quality of study design: <b>Medium</b>  Quality of study: <b>Medium</b>
Moser, 2014  Objective: To determine the effect of implementing an educational program detailing the steps of early recognition and intervention of SIRS/sepsis in the emergency department.	-Uncontrolled before-and-after design. -Sample: n= 38 emergency room nurses with triage training.	-Intervention: Education program, offered as a house-wide annual competency, surrounding early recognition and intervention of sepsis for acute care registered nurses. -Pre- and post-tests covering sepsis knowledge.	-Significant knowledge gain and comprehension noted among nursing staff immediately after and 1 month after receiving sepsis education compared to baseline knowledge level (p= 0.0001).	-No control group. -Small sample size making results less generalizable.  Quality of study design: <b>weak</b>  Quality of study: <b>Medium</b>

<p>Yousefi et al., 2012</p> <p>Objective: To determine the effects of an educational program on the attitudes, knowledge, and practices of ICU nurses in an Iranian hospital.</p>	<p>-Randomized control trial. -N= 64 ICU nurses with at least 1 year experience. -Control group: n= 32 nurses. -Intervention group: n= 32 nurses. -Random sampling. -Setting: Single, Iranian hospital.</p>	<p>-Intervention: Educational sepsis program (8 hour workshop; sepsis principals, nosocomial infections and sepsis, and sepsis prevention, treatment, and nursing care. -Outcomes: Nursing attitude, knowledge, and practice. -Data collection: questionnaire.</p>	<p>-Mean scores of knowledge, attitude, and practice were not significantly different before intervention. -Intervention group's mean scores for knowledge, attitude, and practice significantly improved post-intervention versus the control group (84.9, 79.9, and 90.5 versus 63.9, 73.3, and 82.2).</p>	<p>-Small sample size. -Single centre setting making generalization of results difficult. -Individual nursing training and education could have impacted results.</p> <p>Quality of study design: <b>Strong</b></p> <p>Quality of study: <b>Medium</b></p>
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Table 5

Sepsis Screening and Protocol Literature Summary Table

Author/Date/Objective	Study Design/Sampling/ Setting Characteristics	Measured Outcomes/ Reliability/ Validity	Relevant Outcomes	Limitations/ Quality of Study
<p>Gyang et al., 2015</p> <p>Objective: To examine the performance of a nurse-driven, sepsis screening tool in a</p>	<p>-Cross-sectional study. -Medical/ surgical intermediate care unit. - 245 patients (2143 sepsis screens).</p>	<p>-Intervention: A sepsis screening tool was developed as part of a broader initiative to improve sepsis related morbidity and</p>	<p>- The screening tool had 95.5% sensitivity and 91.9% specificity. - Screening tool accuracy for medical and surgical patients was 92%.</p>	<p>- Small sample size. - Single study.</p> <p>Quality of study design: <b>Moderate</b></p>

<p>medical and surgical non-ICU setting.</p>		<p>mortality at our hospital</p> <ul style="list-style-type: none"> <li>- The first tier of the tool screened for the presence of SIRS.</li> <li>-The 2<sup>nd</sup> tier: If patients met <math>\geq 2</math> SIRS criteria, the nurse would consider possible infection as a contributor to a patient's clinical condition, as well as a source of infection.</li> <li>-If the patient screened positive for sepsis or severe sepsis, nurses called call the primary team to initiate actions following the hospital-wide sepsis guidelines.</li> <li>-Measured outcomes: Documented clinical decision processes by healthcare staff on patients with a positive screen or those who did not screen positive but were diagnosed with sepsis, severe sepsis, or septic shock</li> </ul>		<p>Quality of study: <b>Medium</b></p>
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		during their hospitalization or at discharge.		
<p>Jones et al., 2015</p> <p>Objective: To determine the outcomes of initiating a sepsis performance improvement initiative among nursing staff.</p>	<p>- Cohort study design</p> <p>-Setting: Houston Methodist Hospital (HMH) teaching hospital.</p> <p>- 2009: number of patients screened= 3413 (11% were positive)</p> <p>-2010: number of patients screened= 7965 (12% were positive).</p> <p>-2011: number of patients screened= 9718 (11% were positive)</p>	<p>-Intervention: HMH sepsis program (4 components; 1) organizational commitment and data-based leadership; 2) development and integration of an early sepsis screening tool into the electronic health record; 3) development and implementation of screening and response protocols; and 4) education and training of clinicians (RNs, NPs), who serve as the program's first and second responders.</p> <p>-Nursing education: Courses cover the epidemiology, signs and symptoms, and impact of sepsis, inservicing. NP's undergo simulation scenarios, online</p>	<p>- Sepsis-associated inpatient deaths: pre-implementation period (29.7%); post-implementation period (21.1%). This was significantly lower (<math>p &lt; 0.0001</math>).</p>	<p>- Single centre setting, therefore, generalization of results is difficult.</p> <p>-Multiple components of intervention so unable to determine the individual impact of each component on the outcomes.</p> <p>-No control group used for comparison.</p> <p>Quality of study design: <b>Moderate</b></p> <p>Quality of study: <b>Medium</b></p>

		<p>course, and simulation workshop.</p> <p>-Outcomes: Number of patients screened, screens per patient, proportion of patients with positive screens, sepsis-associated mortality rates.</p>		
<p>Noritomi et al., 2013</p> <p>Objective: to evaluate whether a multi-faceted, centrally coordinated quality improvement program in a network of hospitals can increase compliance with the resuscitation bundle and improve clinical and economic outcomes in an emerging country setting.</p>	<p>-Pre- and post-intervention study</p> <p>-10 hospitals in Brazil</p> <p>-N- 2, 120 adult patients with severe sepsis or septic shock</p>	<p>-Intervention: quality improvement program consisting of screening strategies, multidisciplinary education sessions, case management, and continuous performance assessment.</p> <p>-Primary outcomes: compliance with resuscitation bundle</p> <p>-Secondary outcomes: hospital mortality, hospital and ICU length of stay, quality-adjusted life year (QALY) gain, and cost-effectiveness</p>	<p>-Mortality rates decreased significantly from 55% at baseline to 26% post-intervention</p> <p>-Compliance improved post-intervention</p> <p>-Compliance with serum lactate measurements and treatment of hypotension with IV fluids reached 99% compliance post-intervention</p>	<p>-No control group</p> <p>-Influence of other performance initiatives were not included therefore other factors could have impacted outcomes</p> <p>Quality of study design: <b>Weak</b></p> <p>Quality of study: <b>Low</b></p>
<p>Moore et al., 2009</p>	<p>-Cross-sectional study.</p> <p>-Single surgical ICU</p>	<p>-Intervention: Sepsis screening tool initiated</p>	<p>- Screening tool: 96.5% sensitivity,</p>	<p>- Single study setting.</p>

<p>Objective: To validate a screening tool in identifying sepsis early and reducing sepsis-associated mortality.</p>	<p>-921 patients (4991 sepsis screens).</p>	<p>by the bedside nurse once a shift. SIRS score determined by bedside nurse and notify staff if score is high. Further screening is accomplished by NP/ Resident and Intensivist. -Measured outcomes: Screening results, patient diagnosis, and mortality.</p>	<p>96.7% specificity, 80.2% positive predictive value, and 99.5% negative predictive value. - Mortality rates decreased from 35.1% to 24.2% with after implementation of the screening protocol.</p>	<p>Quality of study design: <b>Moderate</b>  Quality of study: <b>Medium</b></p>
<p>Tromp et al., 2010  Objective: To determine the effects of a nurse-driven, care bundle based, sepsis protocol followed by training and performance feedback.</p>	<p>-Cohort design. -Setting: emergency department of a single hospital. -N= 24, 412 adult patients presenting to the ER -Pre-intervention sample: n= 159 patients with sepsis. -Post-protocol implementation: n= 447 patients with sepsis. -Post-performance feedback: n= 219.</p>	<p>-2 consecutive interventions: 1) Implementation of a nurse-driven, care bundle based, sepsis protocol; 2) Sepsis training that included feedback about performance before and after the sepsis protocol was introduced. -3 measurement periods: 1) pre-intervention period; 2) post-sepsis protocol period; and 3) post-feedback period.</p>	<p>-Post-protocol: 71% of septic patients to receive protocol were identified by nurses. (p=0.005). -Post-Feedback: 82% of septic patients to receive protocol were identified by nurses. (p= 0.005). -Bundle compliance was significantly better in cases initiated by nurses (13% versus 7%).</p>	<p>-No control group. -Single centre study meaning results may not be generalizable. -Other performance improvements occurring simultaneously may have effected outcomes.  Quality of study design: <b>Moderate</b>  Quality of study: <b>Moderate</b></p>

		-Outcomes: Bundle compliance, length of hospital stay, and mortality rate.		
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Table 6

Online Learning Literature Summary Table

<b>Author/Date/Objective</b>	<b>Study Design/Sampling/Setting Characteristics</b>	<b>Measured Outcomes/Reliability/ Validity</b>	<b>Relevant Outcomes</b>	<b>Limitations/ Quality of Study</b>
Kim, 2009  Objective: To investigate the motivational challenges of self-directed e-learning participants.	-Qualitative, interview approach used. -Diverse population sample. -Interviews conducted until data saturation acquired. -20 participants total. -Open-ended questions used. -One on one interviews,	-Interview protocol used with same 12 leading questions proposed.	-6 emerging themes: interactivity of the course content; absence of human interaction; application and integration of content by the learner; learner control; psychological influences; and lack of external motivators	-Qualitative study design  Quality of study: <b>Medium</b>
Morente et al., 2014  Objective: To evaluate the effectiveness of online pressure ulcer training in	-Randomized control trial -Control group: 43 students -Experimental group: 30 students	-Control group: Students received traditional, classroom pressure ulcer training	-Knowledge acquisition was significantly greater in the experimental group compared to the control group.	-Single centre setting  Quality of study design: <b>Strong</b>

undergraduate nursing students.		<ul style="list-style-type: none"> <li>-Experimental group: received online pressure ulcer training</li> <li>-Pre and post-tests to evaluate pressure ulcer knowledge</li> </ul>	<ul style="list-style-type: none"> <li>-Control group overall score improvement: 8.23 versus 11.6.</li> <li>-Experimental group overall score improvement: 8.27 versus 15.83</li> </ul>	<p>Quality of study: <b>Medium</b></p>
<p>Powers &amp; Candela, 2016</p> <p>Objective; To determine the impact of online learning on critical care nurses perception and self-confidence in family presence during resuscitation.</p>	<ul style="list-style-type: none"> <li>-Cross-sectional descriptive</li> <li>-Perception findings: 40 nurses in the intervention group and 34 nurses in the control group</li> <li>-Self-confidence findings: 38 nurses in the intervention group and 34 nurses in the control group.</li> </ul>	<ul style="list-style-type: none"> <li>-Online training was provided to both groups. FPDR training was included in the intervention groups training.</li> <li>-Measured outcomes: FPDR perception and competence scores.</li> </ul>	<ul style="list-style-type: none"> <li>-Self-confidence in the intervention group's self-confidence in FPDR scores increased significantly (<math>p &lt; 0.001</math>)</li> </ul>	<ul style="list-style-type: none"> <li>-No control group</li> <li>-Single centre setting</li> </ul> <p>Quality of study design: <b>Weak</b></p> <p>Quality of study: <b>Moderate</b></p>

## **Appendix B**

### **Consultation Report for the Development of an Online Education Resource on Early Recognition and Treatment of Pediatric Sepsis**

The purpose of this practicum project is to develop an online education module on pediatric sepsis to teach nurses about recognizing and treating sepsis in pediatric patients. The rationale for choosing this topic is because sepsis is a serious medical condition that involves damage to the body's internal organs caused by a potentially life-threatening immune response to infection (Singer et al., 2016). Although all patients with sepsis are at risk of experiencing negative health outcomes, young children are especially vulnerable and are at greater risk of death than adults (Navaneelan, Alam, Peters, & Phillips, 2015). Recognizing sepsis in pediatric patients can be difficult as sepsis symptoms present differently in this population. Children's bodies have the ability to compensate for poor perfusion and, therefore, hypotension may not be present until the latent stages of septic shock (Goldstein et al., 2005). As a result children with sepsis may be diagnosed later, negatively impacting their chance of survival. Improved patient outcomes have been associated with early diagnosis and prompt, aggressive treatment with intravenous fluid and antimicrobial administration (Brierley et al., 2009; Castellanos-Ortega et al., 2008; Levy et al., 2014; Rhodes et al., 2017; Samransamruajkit et al., 2014; Weiss et al., 2014; Workman et al., 2016) Due to the severe adverse effects associated with sepsis, it is important for nurses to have a comprehensive understanding of sepsis symptoms and proper treatment to improve patient outcomes. Therefore, the purpose of this practicum project is to develop an education module that could improve the sepsis knowledge of nurses in Newfoundland and Labrador (NL) and, consequently, improve their care and

treatment of pediatric patients with sepsis.

After completing a literature review to support the development of and provide content for the online sepsis education module, the next component of the practicum project was to complete a learning needs assessment. Prior to developing and implementing an education project, it is important for educators to perform a learning needs assessment to determine the information required and the best education strategies to use (Pitcher, 2016). For this practicum project, a learning needs assessment was completed by asking key stakeholders to complete a survey and by completing an environmental scan of external sepsis education resources. The purpose of the consultations was to gain information about sepsis knowledge among nurses in NL and the best teaching strategies to use. To supplement the information obtained during the consultations, an environmental scan was also completed. The purpose of the environmental scan was to identify educational resources that are currently available to improve nurses' knowledge of sepsis. Professionals in other critical areas were consulted to determine the strategies they may have used improve the sepsis performance of their staff. The information obtained from the consultation and environmental scan will be used during the development of the education module.

The objectives for the consultations and environmental scan were:

1. Through the consultation process, I will solicit input from registered nurses, clinical educators, and physicians on the need for an online education module teaching nurses on pediatric sepsis in Newfoundland and Labrador
2. Through consultation with registered nurses working in the Pediatric Intensive Care Unit (PICU), I will determine the educational content required on sepsis-

related information.

3. Through consultation with registered nurses working in the PICU, I will determine the teaching strategies nurses preferred when using an online format.
4. By consulting with the PICU and emergency department nursing clinical educators, I will obtain expert opinion about the sepsis content required.
5. By consulting with the PICU and emergency department nursing clinical educators, I will obtain feedback about effective teaching and dissemination strategies to use when developing and implementing an online education module.
6. By consulting with a PICU intensivist and an infectious disease physician, I will obtain expert opinion about sepsis symptom and treatment information to include in the education module.
7. By consulting with the adult Intensive Care Unit (ICU) clinical educator, I will obtain feedback about what strategies, if any, other critical care areas within Eastern Health have utilized to educate their staff about sepsis.
8. By reviewing the Surviving Sepsis Campaign (SSC) website, I will determine if any sepsis education resources are available for the Registered Nurses of Newfoundland and Labrador to utilize to improve their sepsis knowledge and practice.
9. By consulting with the Pediatric Intensive Care Unit (PICU) clinical educator of the IWK Health Centre, I will obtain expert feedback about what strategies other pediatric hospitals have implemented to improve sepsis knowledge and treatment performance among nursing staff.

## **Methodology**

## **Consultation Setting and Sample**

The professionals approached for consultation for this practicum project were two Pediatric Intensive Care Unit (PICU) nurses (one senior and one novice), the PICU clinical educator, the emergency department clinical educator, a PICU Intensivist, and an infectious disease (ID) physician at the Janeway Children's Health and Rehabilitation Centre (JCHRC). These individuals were initially contacted by phone or email to obtain their verbal or written consent to participate. Letters of invitation were also emailed to provide a brief overview of the practicum project, details of their involvement, and contact information for the practicum project developer (see Appendix A). Interviews were conducted either in-person in private offices or by telephone.

Two PICU registered nurses were chosen as informants because of their representation of my education module target audience. PICU registered nurses have experiential knowledge caring for patients with sepsis, as well as have participated in various educational opportunities. These nurses were able to provide personal opinion about sepsis information they feel nurses lack knowledge in and which education strategies they feel have been successful in their past learning experiences. The nurses approached for consultation were selected based on their years of experience and level of motivation to improve their nursing practice through independent education opportunities. The PICU nurses that were consulted included a senior registered nurse certified in critical care pediatrics with 41 years of pediatric nursing experience. As well as, a novice nurse certified in critical care pediatrics with three years of experience in neonatal and pediatric nursing and current board member of the Canadian Association of Critical Care Nurses (CACCN) Newfoundland and Labrador Chapter. The role of these nurses include

providing bedside nursing care to the pediatric patients admitted to the PICU at the JCHRC.

The JCHRC's PICU and emergency department clinical educators were chosen due to their personal experience educating nurses on various topics, including pediatric sepsis. The purpose of these consultations was to receive feedback about the sepsis education information that is already available, the sepsis topics they feel are important for nurses to know, and the teaching strategies they feel are most effective when using an online education format. The PICU clinical educator has several years of previous experience as a PICU registered nurse and has been the PICU clinical educator for approximately four years. The emergency department clinical educator graduated with a Bachelor of Nursing in 2001, a Master's of Nursing in 2008, and has been a clinical educator since 2005. The roles of these clinical educators include providing orientation training to new nurses hired to their unit, providing continuing education to staff nurses, assisting with training healthcare professionals in Pediatric Advanced Life Support (PALS), and assisting with high-fidelity simulation training of staff at the JCHRC.

A PICU Intensivist and ID physician were chosen due to their involvement in caring for pediatric septic patients in NL. PICU intensivists are often consulted for treatment advice from rural healthcare institutions in NL and are personally responsible for the care of septic patients once these patients are transferred to the PICU for further management. ID physicians are often consulted by the PICU staff for further advice, such as antibiotic therapy, when a patient is diagnosed with sepsis. Their opinions about the sepsis information that is critical to know if caring for a pediatric patient with sepsis will influence the content of the sepsis education module. The participating PICU intensivist

began their pediatric critical care training in 2007 and has been a JCHRC staff intensivist since 2011. Several attempts were made to contact two ID physicians at the JCHRC through email or telephone. One physician did not respond and the other's schedule could not accommodate an interview prior to the completion of this practicum. As a result, no interview was conducted with an ID physician.

### **Environmental Scan Sample**

This environmental scan was meant to involve consultations with the clinical educators of the adult Intensive Care Unit (ICU) at the Health Sciences Centre (HSC) and the PICU at the IWK Health Centre, and review of the Surviving Sepsis Campaign (SSC) website. As a result of information gained through the consultations with JCHRC staff, the translating emergency knowledge for kids (TREKK) website was also reviewed for potential sepsis education resources. Attempts to contact the intended consultants were completed through phone or email, as well as letters of invitation were sent by email to provide the potential consultants with a brief overview of the consultation process and contact information of the practicum project developer (see Appendix B).

As another critical care area responsible for caring for septic patients within the same health authority as the JCHRC, it is important to determine what strategies other units are using to educate their staff and improve sepsis management. Therefore, the adult ICU clinical educator was to be consulted to determine what, if any, resources are used to educate their nurses about sepsis or assess for sepsis symptoms in their patients. Attempts have been made through email and phone to contact the ICU clinical educator, however, due to an extended leave of the educator no contact has been made at this time.

Alternative plan were made to consult with another adult ICU educator, however, an

extended leave of absence by this educator prior to the interview's completion prevented the interview from occurring. As a result, no interview with an adult ICU clinical educator was able to take place.

IWK Health Centre is a hospital, located in Atlantic Canada, and is responsible for women and children's health. They are often consulted by PICU intensivists at the JCHRC for treatment advice or to transfer patients for treatments that are beyond the Janeway's scope of practice. As a larger hospital, the IWK most likely has higher rates of pediatric sepsis than the hospitals of NL and, therefore, may have already attempted to improve sepsis management performance among their own staff. For this reason, the clinical educator of the IWK PICU was contacted for consultation to determine if they have any sepsis education resources available to their staff or have incorporated sepsis screening into their routine practices. The permanent IWK clinical educator had been approached through email but due to an extended leave of absence no contact has been made at this point. Attempts were made to contact the temporary educator, however, correspondence was not returned before the end of this practicum project.

### **Data Collection**

The consultations were conducted using pre-arranged in-person or telephone interviews with consenting participants. Interviews aimed to be completed within 30 minutes and, as of now, no interviews have exceeded this time limit. A pre-developed script of open-ended questions was used to conduct the interviews (see Appendix C). All consultants were asked an initial set of questions and then a specific set of questions based on their profession. Questions were modified if the consultants required clarification and at times the interviewer repeated the responses back to the consultants to

confirm the interviewer's understanding of the answer was correct. The interview data was recorded with the use of an audio recording device and components of these recordings were then transcribed to a word document to assist with the data analysis process. The interview responses were then transcribed and organized into a table (see Appendix F).

The SSC and TREKK websites were reviewed for sepsis information and education resources and any identified sepsis topics and education material was recorded and will be evaluated during the data discussion.

### **Data Analysis**

All the data collected during the completed consultations was analyzed by completing a content analysis. The purpose of the qualitative content analysis was to describe the phenomenon of pediatric sepsis education among healthcare professionals in NL by reviewing the open-ended question responses obtained during the consultation interviews (Hsieh & Shannon, 2005). The responses were categorized by question and reviewed for any common themes or ideas. Any differing or unique ideas were also noted.

### **Ethical Considerations**

Based on the results of the Health Research Ethics Authority screening tool (see Appendix E) this project did not require review by the Health Research Ethics Review Board. Written or verbal consent was obtained, from those being consulted, to record their responses and possibly include them any practicum assignments. The confidentiality of the responses was maintained by using initials as identifiers and the audio recordings are stored on a password protected technological device. Individuals that were consulted were informed of this information prior at the start of their interview and

reminded of their ability to withdraw their consent to participate at any opportunity. After the practicum project is complete and this data is no longer needed, all interview recordings and documents will be permanently deleted.

## **Results**

### **Consultation Results**

After completing the five of the six intended consultation interviews, there was 100% consensus supporting the development of an online education module on pediatric sepsis for nurses. The support of this module was based on the importance of early treatment on patient survival and the lack of sepsis education currently available to nurses. Consultant feedback also provided unanimous consensus that the incorporation of a sepsis screening tool for bedside nurses to incorporate into practice would be beneficial for at-risk patients. After performing a content analysis on the interview responses, common themes that were identified included:

- 1) Sepsis knowledge gaps: sepsis symptoms, timing of sepsis interventions, importance of first hour of care, antibiotic therapy and administration, delayed recognition, and evidenced-based guidelines.
- 2) Content: early pediatric sepsis symptoms, the Surviving Sepsis Campaign guidelines, the American College of Critical Care Medicine hemodynamic management guidelines, fluid resuscitation methods, antibiotic administration, early implementation of sepsis treatments, impact of treatment on morbidity and mortality rates, and nursing role in sepsis care.
- 3) Design: limited reading, interactive components, knowledge application activities, case-studies, instructional videos, limited theory, critical thinking questions, and

certificate of completion.

- 4) Dissemination; posters in high traffic areas, use of social media, easy accessibility, online accessibility, and nursing websites.
- 5) Sepsis education resources: the Surviving Sepsis Campaign website, the TREKK website, textbooks, journal articles, and limited knowledge of sepsis specific resources.

There were three ideas identified during the interviews and were highlighted in the content analysis. Firstly, designing the sepsis education module into multiple chapters that can be completed at different times to allow nurses to complete the module in short periods of time to promote participation. Secondly, the inclusion of patient experiences to emphasize the impact of sepsis and treatment on patient outcomes was also recommended. Thirdly, promoting the education module to nurses at peak times of the year, such as prior to the Association of Registered Nurses of Newfoundland and Labrador (ARNNL) licensing and the Nursing Union of NL (NUNL) nursing practice and leadership premium application deadlines to stimulate participation through external incentives.

The data collected from all these consultations will be used to influence the development, the content, the design, and the dissemination of the online education module on pediatric sepsis.

The Surviving Sepsis Campaign (SSC) is a collaboration initiative focused on reducing sepsis-associated mortality rates worldwide (Society of Critical Care Medicine, n.d.). The organization members, including researchers and clinicians, are responsible for the development of the SSC sepsis management guidelines and have a website dedicated

to their work. The website was reviewed to determine if there was any relevant resources available that would help improve the sepsis knowledge of nurses. The website contains links dedicated to the SSC guidelines for management of sepsis and septic shock and bundles of care. These pages contain printable materials that nurses can use in their practice to remember and implement the SSC management recommendations into their practice. The website also provides electronic tools and advice that healthcare authorities can use to implement and evaluate sepsis performance improvement measures that utilize the SSC guidelines. These electronic tools allow healthcare systems to electronically screen patients for sepsis and monitor staff compliance with the SSC guidelines when caring for patients with sepsis. In addition, the SSC website has various links to information about future sepsis and SSC associated events, education resources, sepsis-related literature, quality of care improvement initiatives, sepsis protocols and screening tools, and the SSC app. The educational resources available on the website include various PowerPoint presentations, webcasts, podcasts, online videos, and available sepsis education courses. The education topics vary but mainly include information about improving sepsis management on an organizational level by initiating a sepsis quality improvement program that evaluates the adherence of staff with SSC guidelines.

The TREKK website was developed to provide all emergency centres with pediatric health information to improve the emergency care provided to all children across Canada (Trek, 2013). It is available for anyone to access, including healthcare professionals, researchers, and patient families. Educational resources are organized based on medical conditions. The website's content includes a sepsis screening tool, pediatric vital sign guidelines, a guide to recognizing septic shock are available, a pediatric sepsis medical

directive, and a management algorithm to assist patient treatment. Other available resources include links to sepsis based research studies and evidence-based treatment guidelines.

Information about the SSC and TREKK websites will be included in the pediatric sepsis online educational module as additional resources for nurses to utilize to improve their sepsis knowledge.

## **Discussion**

### **Literature Review**

After consulting with nurses and key stakeholders about the desired sepsis education content, I considered the responses to be reflective of the information discovered during the literature review. This included the early symptoms of sepsis in pediatric patients, the criteria to receive a diagnosis of sepsis or septic shock, and evidenced based practice guidelines, such as the SSC guidelines for management of sepsis and septic shock and the American College of Critical Care Medicine guidelines for hemodynamic support of septic shock (Brierley et al., 2009; Goldstein et al., 2005; Rhodes et al., 2017; Singer et al., 2016). The interview responses particularly highlighted the importance of emphasizing the practice guidelines of early fluid resuscitation and antibiotic administration during sepsis education activities. The information collected from the literature review and the consultations will be used to determine the content of the pediatric sepsis education module.

### **Adult Learning Theory**

The responses collected about the desired and effective teaching strategies when using an online format were also reflective of Knowles' Adult Learning Theory. Knowles

characterizes adult learners as self-directed, goal oriented learners with prior knowledge from personal experiences (Lieb, 1991). Knowles describes adult learners as choosing education opportunities based on their practicality and relevancy to their education needs and personal goals. As well, adult learners require educators to demonstrate respect for their knowledge and possible contribution to education opportunities. Many of these characteristics were demonstrated in the consultation responses through the requests for easily accessible material that focused on application of nursing knowledge rather than the reading of theoretical material. This information will be used to determine the teaching strategies that will be utilized throughout the sepsis education module.

### **Environmental Scan**

There were very limited educational resources found during the consultation process and environmental scan, with the SSC and TREKK websites being the most commonly identified. Although both these website contain sepsis education resources accessible to nurses, improvements can be made improve nurse participation in their sepsis education opportunities.

Overall, the SSC website contains numerous educational resources that would be beneficial to improving the sepsis knowledge and performance of nurses. However, after reviewing this material there are many concerns that may prevent nurses from utilizing these education resources. Although there are podcasts about pediatric sepsis and nurses' role in sepsis, there is an abundance of material that is not relevant to nursing practice, As well, the website's material is organized based on format, such as podcasts, rather than topic. This may make it difficult for nurses to find relevant information or navigate the website easily. As well, most of the education material available involves reading or

listening to the presenting material rather than interactive activities which may not appeal to adult learners.

Similarly, the TREKK website's educational material consist mostly of journal articles rather than developed educational presentations. This type of format may not appeal to nurses as there is little opportunity to apply their nursing knowledge and they may not be familiar with critically analyzing research studies. Although the website contains several printable tools that nurses can use to improve sepsis care, disadvantages of the website include a lack of educational content about the septic progress and rationale for evidence-based treatments.

Although these websites will be included in the sepsis education module as available additional sepsis education resources, the sepsis module will aim to improve upon the teaching strategies used by these websites by incorporating more simplified, interactive education material.

### **Conclusion**

At this time the majority of the consultation objectives have been met, however, because all the intended consultations have not been completed the environmental scan objectives have not been fully achieved. Overall there was a consensus among the consultants that sepsis care within NL could be improved and that developing an online sepsis education module for nurses would be help to accomplish this. The data collected though the consultation interviews will be used to influence the content of the education module as common content themes included sepsis symptoms, evidenced-based guidelines, fluid resuscitation, and antibiotic therapy.

This data will also be used to determine the teaching and dissemination strategies

that will be utilized during the development and the implementation of the online education module. A content analysis determined that registered nurses and clinical educators consider interactive teaching strategies that incorporate application and critical thinking questions to be the best methods to promote nurse participation and learning when utilizing an online education format. Additionally, easy and convenient accessibility to education material are important motivators for nurse participation. As such, the sepsis education module will utilize interactive and problem-solving based strategies to teach the content and an online, easily accessible format.

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## Appendix B1

### Invitation Letter for Consultations

Dear (name),

I am contacting you with an invitation to participate in a consultation to assist in the development of online education module on the recognition and treatment of pediatric sepsis for the nurses of Newfoundland and Labrador. The development of this education module is a practicum project in partial fulfilment of my master in nursing degree at Memorial University of Newfoundland and Labrador. One of the requirements of this practicum project is to complete consultations with key stakeholders and, therefore, I am requesting approximately 30 minutes of your time to participate in an interview to obtain your expert opinion on the topic of pediatric sepsis. The purpose of this education module is to educate nurses about the symptoms and proper treatment of sepsis in pediatric patients with the intention of improving sepsis recognition and management among nursing personnel to improve patient outcomes.

The information collected during these consultations will be analyzed to identify common themes about current sepsis care issues, sepsis education content, and education strategies. This information will be used to facilitate in the development the sepsis education module. Information collected during this interview will be kept confidential through use of initials as identifiers and storage in a secure location. Once the practicum project is complete the data will be destroyed. Participation in this interview is completely voluntary and participants can refuse to answer any questions or withdraw consent at any time. The information obtained in this interview will only be viewed by myself and my practicum supervisor, Donna Best.

If at any time you have any questions I can be contacted by phone at (709) 763-5287 or by email at [d64dcr@mun.ca](mailto:d64dcr@mun.ca). You are welcome to keep this letter for your personal records. Your agreeing to participate in an interview will indicate that you understand the contents of this letter and are agreeing to participate as a consultant.

Thank you for your time.

Sincerely,

Danielle Ryder

## Appendix B2

### Invitation Letter for Environmental Scan Consultations

Dear (name),

I am contacting you with an invitation to participate in a consultation to assist in the development of online education module on the recognition and treatment of pediatric sepsis for the nurses of Newfoundland and Labrador. The development of this education module is my practicum project in partial fulfilment of my master in nursing degree at Memorial University of Newfoundland and Labrador. One of the requirements of this practicum project is to complete consultations with key stakeholders and, therefore, I am requesting approximately 30 minutes of your time to participate in an interview to obtain your expert opinion on the topic of pediatric sepsis. The purpose of this education module is to educate nurses about the symptoms and proper treatment of sepsis in pediatric patients with the intention of improving sepsis recognition and management among nursing personnel to improve patient outcomes.

The information gathered during this interview will be used to evaluate how other nursing units facilitate sepsis education and management among nursing staff. This information will be used as a comparative for the current practices utilized by the PICU at the Janeway Hospital and to identify any relevant resources that, with permission, could be included in the sepsis education module. Once the practicum project is complete the data will be destroyed. Participation in this interview is completely voluntary and participants can refuse to answer any questions or withdraw consent at any times. The information obtained in this interview will only be viewed by myself and my practicum supervisor, Donna Best.

If at any time you have any questions I can be contacted by phone at (709) 763-5287 or by email at [d64dcr@mun.ca](mailto:d64dcr@mun.ca). You are welcome to keep this letter for your personal records. Your agreeing to participate in an interview will indicate that you understand the contents of this letter and are agreeing to participate as a consult.

Thank you for your time.

Sincerely,

Danielle Ryder

## **Appendix B3**

### **Consultation Interview Question Script**

Questions for all consultations:

- 1) Do you feel that early sepsis recognition or proper sepsis treatment is a concern among healthcare professionals in Newfoundland and Labrador? Please explain.
- 2) Do you feel an education module for focusing on early recognition and treatment of sepsis among children would be beneficial for nurses in NL?
- 3) Do you feel a specific sepsis assessment should be part of routine nursing patient assessments? Please explain.
- 4) Part of this project is to complete an environmental scan for other educational resources about sepsis available to NL nurses. To your knowledge, are there any sepsis resources available that you feel would be beneficial for nurses to explore?

Questions for PICU Registered Nurses:

- 1) What sepsis topics would you like to learn about?
- 2) Based on your personal education experiences, what teaching strategies do you feel are most effective when completing an online education module? Case-studies, animations, or videos, etc.
- 3) What would motivate you to complete an online education module?

Questions for Clinical Educators:

- 1) If you were teaching nurses about sepsis in pediatric patients what are 3 things you would include in your presentation?
- 2) What do you think would be the best ways to design and disseminate an online education module to educate nurses?

- 3) In your expert opinion, what types of teaching strategies do you feel are most effective when developing an online education module? Case-studies, animations, or videos, etc.

#### Questions for PICU and ID physicians

- 1) What sepsis treatments do believe are most important for healthcare professionals responsible for caring for pediatric patients to know?
- 2) What do you think are the most common errors healthcare professionals make when providing care to septic children?
- 3) What sepsis symptoms do you feel are commonly overlooked when pediatric patients are being assessed for sepsis?
- 4) Do you feel the Surviving Sepsis Campaign guidelines are effective evidenced-based guidelines that healthcare professionals should incorporated into practice when caring for pediatric patients with sepsis?

## **Appendix B4**

### **Environmental Scan Consultation Interview Script**

- 1) As an educator, do you consider sepsis to be an important education topic among nurses?
- 2) How does your organization currently address educating its nurses about the topic of sepsis recognition and treatment?
- 3) Do you feel an education module for focusing on early recognition and treatment of sepsis among children would be beneficial for nurses?
- 4) Has your organization developed or use any sepsis education resources that may be available to outside personnel?
- 5) Does your organization utilize a sepsis screening process into nursing practice?  
Do you have a sepsis management protocol in place for when sepsis is suspected?
- 6) As an educator, what do you feel would be effective teaching strategies to consider when developing an online education module?

## Appendix B5

### Health Research Ethics Authority Screening Tool

	<b>Question</b>	<b>Yes</b>	<b>No</b>
<b>1.</b>	Is the project funded by, or being submitted to, a research funding agency for a research grant or award that requires research ethics review		<input checked="" type="checkbox"/>
<b>2.</b>	Are there any local policies which require this project to undergo review by a Research Ethics Board?		<input checked="" type="checkbox"/>
	<b>IF YES</b> to either of the above, the project should be submitted to a Research Ethics Board. <b>IF NO</b> to both questions, continue to complete the checklist.	<input type="checkbox"/>	<input type="checkbox"/>
<b>3.</b>	Is the primary purpose of the project to contribute to the growing body of knowledge regarding health and/or health systems that are generally accessible through academic literature?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>4.</b>	Is the project designed to answer a specific research question or to test an explicit hypothesis?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>5.</b>	Does the project involve a comparison of multiple sites, control sites, and/or control groups?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>6.</b>	Is the project design and methodology adequate to support generalizations that go beyond the particular population the sample is being drawn from?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>7.</b>	Does the project impose any additional burdens on participants beyond what would be expected through a typically expected course of care or role expectations?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>LINE A: SUBTOTAL Questions 3 through 7 = (Count the # of Yes responses)</b>		<b>1</b>	
<b>8.</b>	Are many of the participants in the project also likely to be among those who might potentially benefit from the result of the project as it proceeds?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>9.</b>	Is the project intended to define a best practice within your organization or practice?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>10.</b>	Would the project still be done at your site, even if there were no opportunity to publish the results or if the results might not be applicable anywhere else?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>11.</b>	Does the statement of purpose of the project refer explicitly to the features of a particular program, Organization, or region, rather than using more general terminology such as rural vs. urban populations?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<b>12.</b>	Is the current project part of a continuous process of gathering or monitoring data within an organization?		<input checked="" type="checkbox"/>
<b>LINE B: SUBTOTAL Questions 8 through 12 = (Count the # of Yes responses)</b>		<b>3</b>	

<b>SUMMARY</b> <b>See Interpretation Below</b>		
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**Interpretation:**

- If the sum of Line A is greater than Line B, the most probable purpose is **research**. The project should be submitted to an REB.
- If the sum of Line B is greater than Line A, the most probable purpose is **quality/evaluation**. Proceed with locally relevant process for ethics review (may not necessarily involve an REB).
- If the sums are equal, seek a second opinion to further explore whether the project should be classified as Research or as Quality and Evaluation.

**These guidelines are used at Memorial University of Newfoundland and were adapted from ALBERTA RESEARCH ETHICS COMMUNITY CONSENSUS INITIATIVE (ARECCI). Further information can be found at:**

**<http://www.hrea.ca/Ethics-Review-Required.aspx>.**

## Appendix B6

### Summary of Consultation Interview Responses

Interview Question	Response
Do you feel that early sepsis recognition or proper sepsis treatment is a concern among healthcare professionals in Newfoundland and Labrador? Please explain.	<b>PICU registered nurse #1:</b> <ul style="list-style-type: none"> <li>- Yes; previous experiences with patient's dying from sepsis have been associated with delayed treatment and poor initial recognition</li> </ul>
	<b>PICU registered nurse #2:</b> <ul style="list-style-type: none"> <li>- Yes; PICU intensivists good at treating sepsis; staff in periphery have difficulty recognizing sepsis in children; delayed recognition; early symptoms are missed often</li> </ul>
	<b>PICU clinical educator:</b> <ul style="list-style-type: none"> <li>- Yes; proper care is being administered but often the timing is not fast enough; emphasis of the first hour of care is needed</li> </ul>
	<b>Emergency department clinical educator:</b> <ul style="list-style-type: none"> <li>- Yes; early recognition and intervention are important to improved patient outcomes; early antibiotic administration is important for staff to know</li> </ul>
	<b>PICU intensivist:</b> <ul style="list-style-type: none"> <li>- Yes; early recognition is often an issue; first hour of care is often delayed</li> </ul>
Do you feel an education module for focusing on early recognition and treatment of sepsis among children would be beneficial for nurses in NL?	<b>PICU registered nurse #1:</b> <ul style="list-style-type: none"> <li>- Yes; areas do not have a clinical educator to teach them; most places have a lack of pediatric experience</li> </ul>
	<b>PICU registered nurse #2:</b> <ul style="list-style-type: none"> <li>- Yes</li> </ul>
	<b>PICU clinical educator:</b> <ul style="list-style-type: none"> <li>- Yes; there is a lack of rural education about pediatric illness; lack of education available about</li> </ul>

	evidenced-based guidelines for sepsis
	<b>Emergency department clinical educator:</b> - Yes
	<b>PICU intensivist:</b> - Yes
Do you feel a specific sepsis assessment should be part of routine nursing patient assessments? Please explain.	<b>PICU registered nurse #1:</b> - Yes; help patients at risk for sepsis
	<b>PICU registered nurse #2:</b> - Yes
	<b>PICU clinical educator:</b> - Yes; unsure of any screening tools available
	<b>Emergency department clinical educator:</b> - Yes; benefit patients at risk for sepsis
	<b>PICU intensivist:</b> - Yes
Part of this project is to complete an environmental scan for other educational resources about sepsis available to NL nurses. To your knowledge, are there any sepsis resources available that you feel would be beneficial for nurses to explore?	<b>PICU registered nurse #1:</b> - Only the Surviving Sepsis Campaign website; learned about it recently from working with the Canadian Association of Critical Care Nurses
	<b>PICU registered nurse #2:</b> - Just textbooks like Mosby's; not aware of any nursing specific resources
	<b>PICU clinical educator:</b> - TREKK and Surviving Sepsis Campaign website; these are not well known; the SSC website has too much information so may be confusing; need a more streamlined and organized resource
	<b>Emergency department clinical educator:</b> - TREKK and Surviving Sepsis Campaign websites
	<b>PICU intensivist:</b> - Bedside education from physicians; journal articles

<b>Interview Questions for PICU Registered Nurses</b>	<b>PICU Registered Nurse Responses</b>
What sepsis topics would you like to learn about?	<ul style="list-style-type: none"> <li>- Criteria for sepsis; antibiotic therapy; which antibiotics to use; types of infection</li> <li>- Early recognition/ symptoms; how to interrupt the sepsis process with treatments</li> </ul>
Based on your personal education experiences, what teaching strategies do you feel are most effective when completing an online education module? Case-studies, animations, or videos, etc	<ul style="list-style-type: none"> <li>- Statistics (mortality and morbidity rates, types of infection), less reading; videos, application case studies; interactive activities</li> <li>- No charts or graphs; videos; case studies; application questions; interactive activities</li> </ul>
What would motivate you to complete an online education module?	<ul style="list-style-type: none"> <li>- Can be completed in short periods of free time; easily accessible; separated into smaller modules that can be completed at different times</li> <li>- Recognition of completion; certificate</li> </ul>

<b>Interview Questions for Clinical Educators</b>	<b>Clinical Educator Responses</b>
If you were teaching nurses about sepsis in pediatric patients what are 3 things you would include in your presentation?	<ul style="list-style-type: none"> <li>- Antimicrobial therapy (timing and what medications can be pushed by nurses); fluid resuscitation; early symptoms of sepsis</li> <li>- Signs and symptoms of sepsis; first hour of sepsis care; morbidity and mortality statistics and the impact of early recognition and treatment on these outcomes</li> </ul>
What do you think would be the best ways to design and disseminate an online education module to educate nurses?	<ul style="list-style-type: none"> <li>- Interactive activities; use of critical thinking skills; case studies; only a small amount of theory followed by a large amount of application questions; certificate of completion; activities that require the participant to click to continue to keep them interested; easily accessible</li> </ul>

	<ul style="list-style-type: none"> <li>- utilize e-based learning; easily accessible; people should be able to access it from home</li> </ul>
In your expert opinion, what types of teaching strategies do you feel are most effective when developing an online education module? Case-studies, animations, or videos, etc	<ul style="list-style-type: none"> <li>- Physicians seem to prefer more statistics and evidenced-based guidelines; nurses what to know what they have to do; practical knowledge (nursing actions); case studies; instructional videos (nursing skills)</li> <li>- Case-based learning; progressive case-studies; patient experiences (videos) to show impact of sepsis; decreased reading; interactive, application, and evaluation questions</li> </ul>

<b>Interview Questions for Physicians</b>	<b>Physician Responses</b>
What sepsis treatments do believe are most important for healthcare professionals responsible for caring for pediatric patients to know?	<ul style="list-style-type: none"> <li>- Fluid resuscitation; early antibiotic administration</li> </ul>
What do you think are the most common errors healthcare professionals make when providing care to septic children?	<ul style="list-style-type: none"> <li>- Late recognition of symptoms; delayed treatments</li> </ul>
What sepsis symptoms do you feel are commonly overlooked when pediatric patients are being assessed for sepsis?	<ul style="list-style-type: none"> <li>- Tachycardia as an early symptom; missed because children have normal blood pressure early in the illness; too much focus on blood pressure</li> </ul>
Do you feel the Surviving Sepsis Campaign guidelines are effective evidenced-based guidelines that healthcare professionals should incorporated into practice when caring for pediatric patients with sepsis?	<ul style="list-style-type: none"> <li>- Yes; the American College of Critical Care Medicine guidelines are also good to know</li> </ul>

## Appendix C

### Early Recognition and Treatment of Pediatric Sepsis Education Module

#### Introduction

#### Why should nurses that provide care to pediatric patients complete this learning module on pediatric sepsis?

Sepsis is a life-threatening condition that can affect anyone, including children (Singer et al., 2016). The pediatric population consists of varying age groups, with differing ranges of normal vital signs, and have a unique physiological response to the sepsis process (American Heart Association, 2016; Hazinski, 1999; Hockenberry & Wilson, 2011; Goldstein, Giroir, & Randolph, 2005) Therefore, sepsis can be more difficult to diagnose in children compared to their adult counterparts. Considering that patient outcomes and mortality rates associated with sepsis improve with early treatment, it is important for nurses to be able to recognize signs of sepsis early and help initiate the proper treatments (Brierley et al., 2009; Davis et al., 2017; Dellinger et al., 2012; Rhodes et al., 2017).

The Canadian Nurses Association [CNA] (n.d.) states that it is the responsibility of registered nurses to participate in education opportunities that are relevant to their patients and ensure their nursing knowledge remains current. By continuing their education, nurses are enhancing their ability to provide safe, ethical, quality care to their patients. As a result, by completing this pediatric sepsis education module you will be ensuring your knowledge of pediatric sepsis is up to date and improve your ability to provide effective nursing care to children with sepsis.

#### What is the purpose of this module?

The purpose of this module is to provide you with information to help you recognize and treat sepsis in children. By enhancing your sepsis knowledge and competency through sepsis education, pediatric patients with sepsis can receive earlier diagnoses and treatments, leading to improved patient outcomes. This module will also provide you with an overview of the current evidence-based practices for treating sepsis in children.

This module is divided into **three** separate sections:

**Unit 1** describes the impact of sepsis on the pediatric population and the relevance of nursing in sepsis care. This unit provides statistical information about how much sepsis affects children and its associated mortality rate. Information on the role of nurses in providing sepsis care and the impact of nurses' knowledge of sepsis on patient outcomes is also provided.

**Unit 2** details the pathophysiology of sepsis and the signs and symptoms of sepsis and septic shock. As well, the diagnostic criteria for systemic inflammatory response syndrome, sepsis, and septic shock are reviewed.

**Unit 3** provides information about how to treat pediatric patients for sepsis and septic shock. Specifically, this unit provides an overview of the Surviving Sepsis Campaign (SSC), the American College of Critical Care Medicine, and the American Heart Association's evidenced-based guidelines for initial treatment of sepsis and septic shock to children.

### Module Instructions

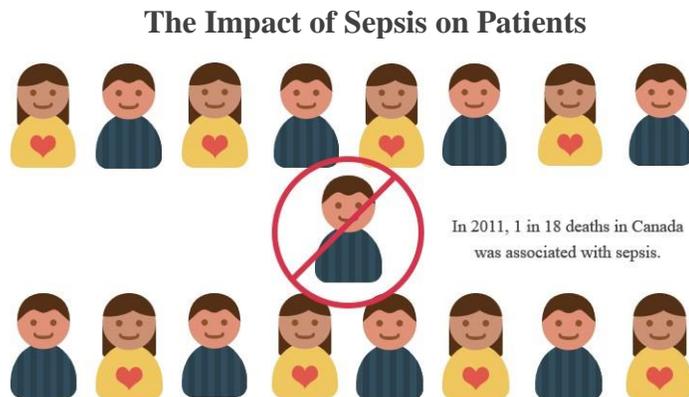
This module has been developed to be completed at your own pace and it is recommended that all units be completed. To be able to access all the material in this module, you will need to have access to [Google Drive](#). All sections of this module can be accessed through the menu bar at the top of the page. After completing units 2 and 3, participants should complete the corresponding review questions before completing the next unit. Also, there are case-study questions that should be completed after all units have been reviewed. Once the module has been completed, please complete the attached evaluation form.

## Unit 1: Sepsis and Nursing

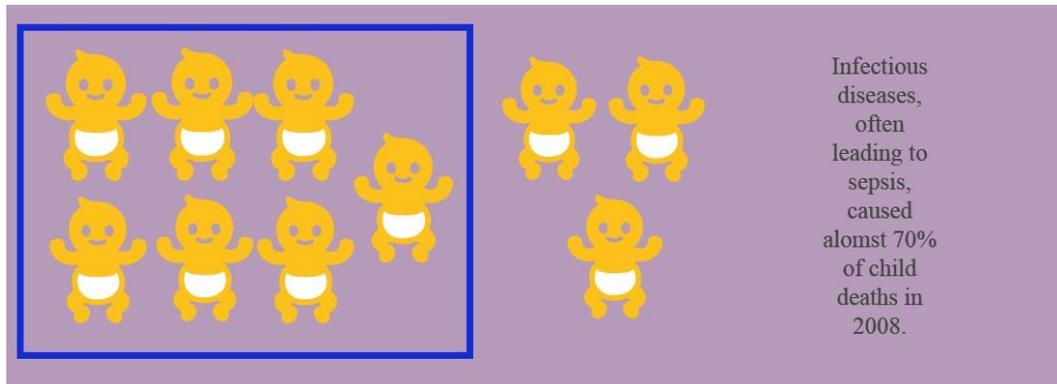
### Learning Objectives

After completing Unit 1, you should be able to:

- describe the recent impact of sepsis on pediatric mortality rates.
- identify the roles of nurses in caring for pediatric patients with sepsis.
- describe the effect of sepsis education on patient outcomes.



In 2011, almost 6% of all Canadian deaths were caused or associated with sepsis (Navaneelan, Alam, Peters, & Phillips, 2015). The most at-risk populations of a sepsis-associated death are the elderly and children, especially those under the age of one. In 2008 the World Health Organization determined that infectious disease, often associated with development of sepsis, was the cause of 68% of the deaths in children (Black et al., 2010). As a result, sepsis was a contributing factor in the death of approximately 6 million children and was considered one of the main causes of pediatric deaths in 2008.



Often children diagnosed with sepsis are transferred to the Pediatric Intensive Care Unit (PICU) after initial care has been provided, therefore, this is where most pediatric deaths associated with sepsis occur. Despite receiving critical care, it has been determined that as many as one quarter of children admitted to PICU with sepsis succumb to their illness (Weiss et al., 2015). Children diagnosed with sepsis often require more medical care, have longer hospital stays, and experience higher mortality rates than children with non-sepsis associated diagnoses (Wolfer, Silvani, Misicco, Antonelli, & Salvo, 2008).

Due to the high incidence of death associated with sepsis among children and the extensive medical care required by patients, it is important for you to have proper knowledge of how to recognize and treat sepsis among your patients to improve patient outcomes.

### **Role of Nurses in Sepsis Care**

Despite the development of evidence-based practice guidelines for treating sepsis and septic shock, sepsis associated complications and mortality rates continue to be an issue among pediatric patients (Launay et al., 2010; Pedro, Morcillo, & Baracat, 2015). These negative outcomes are often associated with healthcare professionals not adhering to evidence-based practices for sepsis treatment when caring for these patients. Insufficient sepsis knowledge among healthcare professionals continues to cause patient care issues, including: a) misdiagnosis of sepsis severity; b) delayed initiation of treatment; c) and insufficient measures to maintain hemodynamic stability, such as improper fluid

administration or use of vasoactive medications (Launay et al.,). Pediatric patients whose sepsis progressed to include signs of poor perfusion and organ dysfunction prior to receiving sepsis treatment, had higher rates of health complications and death (Pedro, Morcillo, & Baracat). Consequently, it is important for you to know how to recognize sepsis early, before it progresses to late stages, and help administer the proper treatments effectively to improve patient outcomes and chances of survival.

As a nurse, you play a critical role in sepsis care, including assessing for sepsis in your patients and assisting in the administration of interventions to combat sepsis symptoms and halt sepsis progression (Byrne, 2014). To perform your role effectively you must first have an understanding of sepsis symptoms and evidence-based sepsis treatment guidelines.



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The role of nurses in sepsis management includes (Byrne, 2014):

- Recognizing signs and symptoms of sepsis during your nursing assessment, which will assist in initiating early treatment efforts.
- Administering appropriate interventions to maintain the patient's airway and breathing, such as opening the patient's airway and administering supplemental oxygen.
- Obtaining adequate vascular access.

- Administering rapid fluid boluses.
- Administering antimicrobial medications.
- Collecting bodily fluid cultures and blood work.
- Providing care and support to the families of the patient's receiving treatment.

### **Nursing Education and Sepsis**

Research has shown that nurses are fairly familiar with symptoms of septic shock, however, comprehension of the early symptoms of the sepsis, such as those of systemic inflammatory response syndrome (SIRS), continue to be an issue (Jeffery et al., 2014; Robson et al., 2007; Stamataki et al., 2014). In addition, nurses have expressed a lack of knowledge regarding appropriate interventions to treat sepsis and septic shock.

So, as a nurse, what can you do to improve your understanding of sepsis and improve the outcomes of your patients with sepsis? Participating in sepsis education activities that focus on sepsis symptoms and evidence-based practices has been shown to not only improve nurses knowledge of sepsis, but also their confidence and competence in recognizing and treating it (Delaney, Friedman, Dolansky, & Fitzpatrick, 2015; Yousefi et al., 2012). Furthermore, nurses participating in formal sepsis education has been associated with improved compliance rates with evidence-based treatment practices and reduced mortality rates among patients with sepsis (Ferrer et al., 2008; Herràn-Monge et al., 2016). Therefore, furthering your education and ensuring your knowledge of sepsis treatments is up to date, will improve your nursing practice and the outcomes of your patients.

Finally, what is the future role of nurses in sepsis care? Many areas have begun to realize the importance of utilizing nurses in improving recognition and treatment of sepsis among patients (Gyang, Shieh, Forsey, & Maggio, 2015; Jones et al., 2015; Moore et al., 2009; Noritomi et al., 2014; Tromp et al., 2010). Recognition of sepsis has been shown to improve when formal screening tools are implemented that require nurses to assess for possible sepsis during their patient assessments (Gyang et al.; Jones et al.; Moore et al.). As well, facilities that have developed and implemented policies that guide the actions of nurses when sepsis is suspected in patients have been associated with earlier administration of treatments, better compliance rates with evidence-based practices, and improved mortality rates among patients (Jones et al.; Nortomi et al.; Tromp et al.). Subsequently, nurses can play an important role in measures aimed at improving the care and outcomes of patients with sepsis.

### **Unit 1 Conclusion**

Sepsis continues to be a significant cause of death among children and delayed recognition and improper administration of treatment by healthcare professionals have been contributing factors. As a nurse, it is your professional

responsibility to continue your nursing education and provide your patients with updated, high quality nursing care. Your role as a nurse in sepsis care includes recognizing sepsis symptoms among your patients and helping to administer the proper interventions to stop sepsis progression. By completing this sepsis education module, you will be improving your ability to recognize sepsis symptoms and provide proper sepsis care.

## Unit 2: Recognizing Sepsis

### Learning Objectives

After completing Unit 2: Recognizing Sepsis, you should be able to:

- describe the pathophysiology of sepsis.
- identify the differences in physiological response to sepsis between children and adults.
- define systemic inflammatory response syndrome, sepsis, severe sepsis, and septic shock.

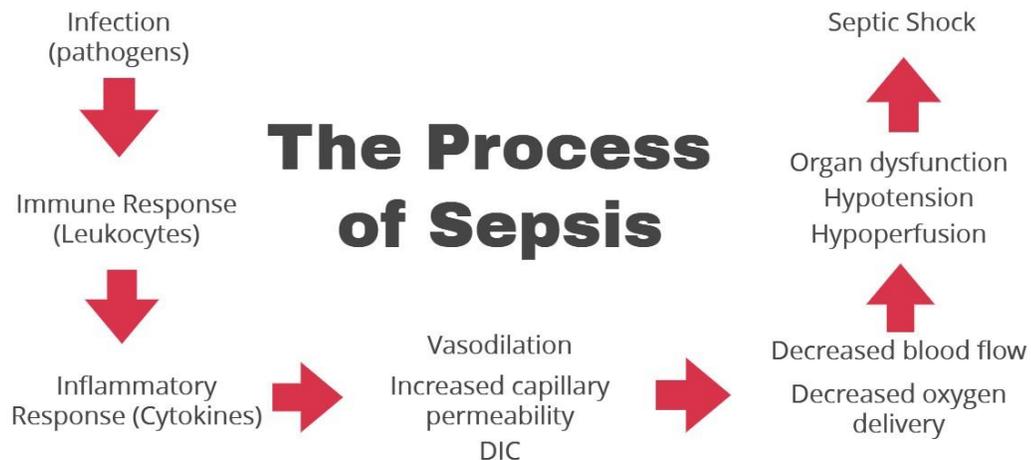
### Pathophysiology of Sepsis

Sepsis occurs in response to foreign microorganisms, or their by-products (e.g., endotoxins), being present in the body (American Heart Association, 2016). The presence of these foreign microorganisms often presents itself as an infection. When these microorganisms or their by-products are present, they can activate a systemic inflammatory response throughout the body (Hazinski, 1999).

Children can either acquire infections from the community or while in hospital, called nosocomial infections (Hasinski, 1999). Types of community acquired infections include pneumonia or meningitis. All children are at risk of acquiring an infection while in hospital, however, children receiving critical care are most at risk and should be closely monitored for signs of sepsis (Hazinski, 1999; Hockenberry & Wilson, 2011). These children are considered more susceptible to developing sepsis due to their higher risk of contracting infection by means of invasive devices or wounds and their inability to properly fight infection due to impaired immune systems and suboptimal nutrition.

The systemic inflammatory response is caused by the body's immune system releasing white blood cells, such as neutrophils monocytes, and macrophages, to fight the infection (American Heart Association, 2016). When these cells combine with the infectious microorganisms, the immune system releases inflammatory mediators (Hazinski, 1999). These mediators cause different reactions in the body leading to poor perfusion and organ dysfunction, including blood vessels to vasodilate, decreasing systemic vascular resistance (SVR), and fluid to leak from the capillaries. These reactions cause blood flow throughout the body to decrease (Hazinski, 1999; Hinshaw, 1996).

Disseminated intravascular coagulation (DIC) is another negative reaction that can occur and it causes blood clots in the capillaries, reducing blood flow to the body's organs (Hazinski; Hinshaw). This causes hypoperfusion and decreased oxygen delivery to the body's cells, leading to organ dysfunction.



### The Physiological Differences in Children in Response to Sepsis

In adults, when there is poor blood flow to the body's tissues due to sepsis, systemic vascular resistance decreases and cardiac output increases (Maloney, 2013). This causes hypotension with increased blood flow, resulting in warm extremities, bounding pulses, flushed colour, and brisk capillary refill (American Heart Association, 2016; Maloney, 2013). This is known as warm septic shock. Although this can occur in children, it occurs less frequently (Maloney, 2013).

Children will most often develop cold septic shock, as opposed to warm septic shock (Maloney, 2013). In response to hypoperfusion and hypotension, children's SVR will usually increase causing peripheral vasoconstriction. The purpose of this vasoconstriction is to shunt blood and oxygen to the more vital organs, such as the heart and brain (Hazinski, 1999; Hinshaw, 1996).

### Recognizing Pediatric Sepsis

Due to these physiological differences, the diagnostic criteria of illnesses used for adult population groups are not always suitable for use in pediatrics. For this reason, in 2002 a consensus conference consisting of numerous pediatric medical experts was organized (Goldstein, Brett, and Randolph, 2005). The purpose of this conference was to create definitions for systemic inflammatory response syndrome (SIRS), sepsis, severe sepsis, septic shock, and organ dysfunction appropriate for pediatric patients. In 2005, the International Pediatric Sepsis Consensus Conference (IPSCC) published these diagnostic criteria for these conditions.

To provide you with an overview of these definitions and the signs and symptoms of SIRS, sepsis, severe sepsis, and septic shock in pediatric patients, I created the following presentation. Sepsis is a progressive illness and this presentation illustrates the symptoms associated with each stage of the condition. I developed this presentation to help you recognize the signs and symptoms of sepsis in your patients and determine the severity of their illness.

## Signs and Symptoms of Sepsis Presentation

### Unit 2 Conclusion

Sepsis is a progressive condition, consisting of SIRS, sepsis, severe sepsis, and septic shock. Sepsis is caused by systemic inflammation in response to an infection. As the inflammation progresses the patient begins to experience vasodilation and decreased blood flow throughout the body. Left untreated, the patient will experience organ dysfunction, hypotension, and eventually death. Due to these significant consequences associated with sepsis, it is important for nurses to have a good understanding of sepsis in pediatric patients and to be able to recognize signs of this condition in their patients. Children considered at risk of developing sepsis, such as those in critical care, should be monitored closely. Knowing the signs and symptoms associated with all stages of sepsis progression will hopefully improve sepsis recognition among nurses and lead to earlier diagnosis and treatment in their patients.

## Unit 3: Treating Sepsis

### Learning Objectives

After completing Unit 3, you should be able to:

- describe the evidenced-based guidelines for sepsis treatment.
- identify what interventions should be administered within the first hour of the onset of severe sepsis symptoms.
- describe how to administer fluid boluses and antibiotics to septic patients.
- identify two methods of obtaining vascular access during the initial resuscitation of septic patients.

### Treating Sepsis

Patients exhibiting early signs and symptoms of sepsis should be cultured appropriately and empiric, broad spectrum antibiotic therapy started (Hockenberry & Wilson, 2011). These patients should be closely monitored for signs and symptoms of sepsis progression to severe sepsis or septic shock.

## Treating Severe Sepsis and Septic Shock

The goal of septic shock treatment is to implement appropriate measures early to interrupt the sepsis process and return the patient's perfusion to normal (Maloney, 2013). Septic shock treatments should focus on supporting the patient's respiratory and cardiovascular systems by improving ventilation, administering fluid, and improving cardiac output (Hockenberry & Wilson, 2011). When severe sepsis or septic shock is suspected, it is important to remember 3 important considerations when administering care Rhodes et al., 2017; Davis et al., 2017):

- **Urgency:** Septic shock can be **fatal** and, therefore, should always be considered a **medical emergency**, requiring immediate action.
- **Timing:** Providing treatment within the **first hour** of the onset of severe sepsis symptoms is important for improved patient outcomes.
- **The ABC's:** Patients with severe sepsis should receive **immediate** interventions to support and stabilize their respiratory and cardiovascular systems (**airway, breathing, circulation**)

### Evidence-Based Guidelines

Due to the severe negative outcomes associated with septic shock, such as death, extensive research has been completed to determine the most effective methods to treat this condition. Different organizations have used that research to develop evidence-based guidelines for healthcare professionals to utilize when caring for septic patients to improve patient outcomes. The Surviving Sepsis Campaign (SSC) and the American College of Critical Care Medicine (ACCCM) developed examples of well-known and widely used guidelines for treating severe sepsis and septic shock in children.

#### The Surviving Sepsis Campaign

The SSC sepsis and septic shock guidelines are evidenced-based recommendations for the management of care provided to patients diagnosed with, or suspected to have, sepsis (Rhodes, 2017). These recommendations are considered to be best practice for treating sepsis and septic shock. The purpose of these guidelines is to assist healthcare professionals when making medical decisions based on the patient's unique signs and symptoms. Although these guidelines were mainly intended for providing care to adult patients, they have been successful in treating pediatric patients and include pediatric specific considerations (Dellinger et al., 2013).



Anterior chest auscultation, child by Secom Bahia is licensed under CCAttributions 2.0 Generic license.

The SSC sepsis and septic shock guidelines provide recommendations about (Rhodes et al., 2017):

- Initial resuscitation
- Sepsis screening and performance improvement
- Diagnosing sepsis
- Antimicrobial therapy
- Infection source control
- Fluid therapy
- Vasoactive medications
- Corticosteroids
- Blood products
- Immunoglobulins
- Blood purification
- Anticoagulants
- Mechanical ventilation
- Sedation and analgesia
- Glucose control
- Renal replacement therapy
- Bicarbonate therapy

- Venous thromboembolism prophylaxis
- Stress ulcer prophylaxis
- Nutrition
- Setting goals of care

The SSC panel reviews new literature and updates their guidelines every four years. The latest guidelines were developed in 2016 (Rhodes et al., 2017). There are links included on the additional resources page if you wish to further review the SSC sepsis and septic shock guidelines or their website.

### **The American College of Critical Care Medicine**

The ACCCM completed a thorough literature review to develop evidence-based guidelines on how to provide hemodynamic support to pediatric and neonatal patients experiencing septic shock (Brierley et al., 2009; Davis et al., 2017). The ACCCM clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock provide evidence-based recommendations on the initial resuscitation during the first hour of septic shock and the continued stabilization of patients after this initial hour. The ACCCM used these guidelines to develop a treatment algorithm for healthcare professionals to standardize the management of hemodynamic support for infants and children in septic shock. These guidelines were also used by the American Heart Association (2016) to develop their pediatric septic shock algorithm included in their Pediatric Advanced Life Support (PALS) guidelines. A link to these guidelines, including the American College of Critical Care Medicine algorithm for time-sensitive, goal-directed stepwise management of hemodynamic support in infants and children can be found on the additional resources page.

### **Overview of Evidence-Based Guidelines on Sepsis and Septic Shock Treatment**

To provide you with a summary of these evidence-based guidelines, I created the following presentation to illustrate the initial resuscitation interventions that should be provided to patients within the first hour of severe sepsis symptom onset. The first hour of care is considered crucial to improving patient outcomes and improving the survival rate of patients.

This presentation is a summary of the recommendations for severe sepsis and septic shock treatment published by the SSC, ACCCM, and American Heart Association. However, it does not promote the use of any one set guidelines over another. Please refer to these sources for full descriptions of their recommendations and associated treatment algorithms. The information presented in this module should be used in combination with your unit's policies and procedures in providing resuscitation to children with sepsis and septic shock.

[Overview of Sepsis Treatment Presentation](#)



ICU nurse cares for infant by Bill Branson is licensed under [Public Domain](#)

### Unit 3 Conclusion

Patient outcomes and mortality rates improve significantly when proper sepsis treatment is administered early in the illness. Sepsis, either suspected or proven, should always be considered a priority and receive treatment. The first hour after severe sepsis symptom onset is considered crucial for administering fluid boluses and antibiotic treatment. There are evidence-based guidelines available to guide healthcare professionals when providing treatment to patients with sepsis. As a nurse, you should familiarize yourself with these guidelines.

## Additional Resources

Here is a list of resources, and links, that you can use to further your education on pediatric sepsis recognition and treatment.

### The Surviving Sepsis Campaign



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[The SSC International Guidelines for Management of Sepsis and Septic Shock: 2016](#)  
[The SSC International Guidelines for Management of Sepsis and Septic Shock: Pediatric Considerations](#)  
[The SSC Website](#)

### **The American College of Critical Care Medicine**

[The ACCCM Clinical Practice Parameters for Hemodynamic Support of Pediatric and Neonatal Septic Shock](#)

### **Intraosseous Needle Insertion**

The evidence-based guidelines for sepsis management recommend inserting an IO if IV access cannot be obtained quickly. Here is a link containing various education resources on how to properly landmark and insert an IO using a powered IO device.

[Intraosseous Needle Insertion](#)

### **Translating Emergency Knowledge for Kids (TREKK)**

The TREKK website provides various medical resources for healthcare professionals caring for pediatric patients. This is a link to their resources for caring for children with sepsis.

[PedsPacs: Point of Care Tools by TREKK](#)

### **Sepsis Related Apps**

Here is a link that will instruct you on how to download the Society of Critical Care Medicine's app. This app can be downloaded on your phone and will provide you with access to the SSC guidelines and sepsis screening tools.

[SCCM app](#)

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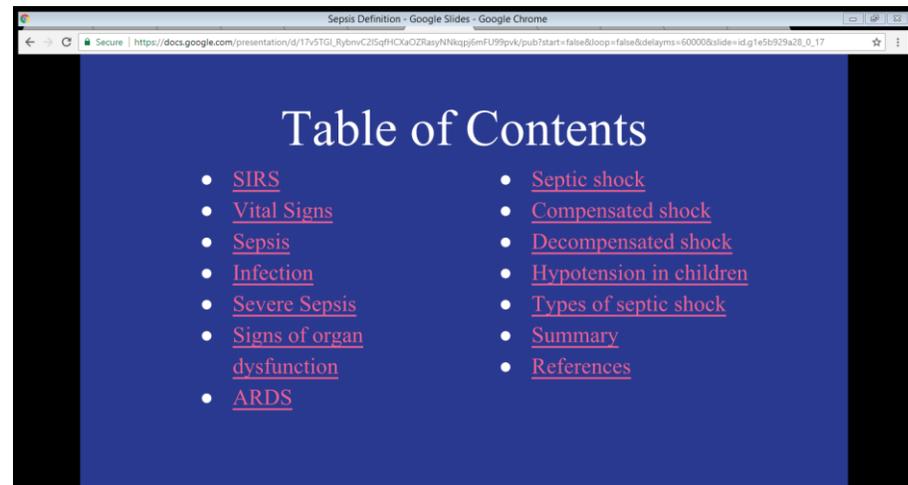
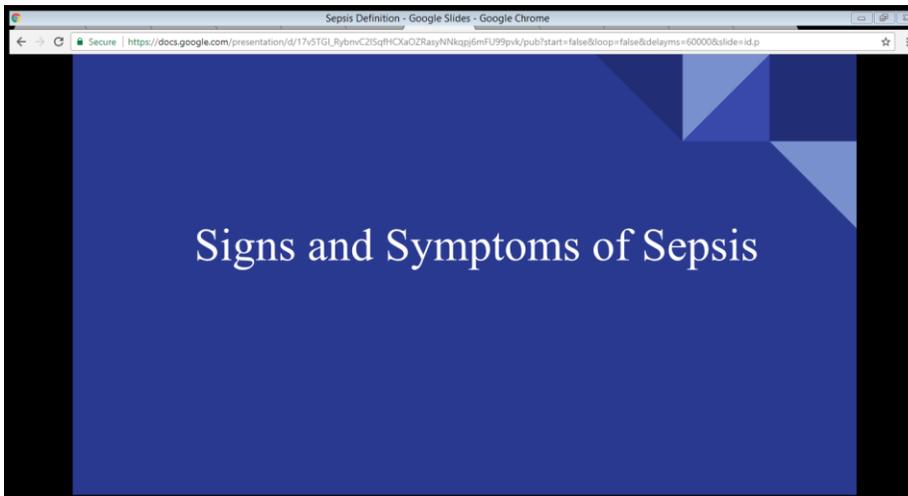
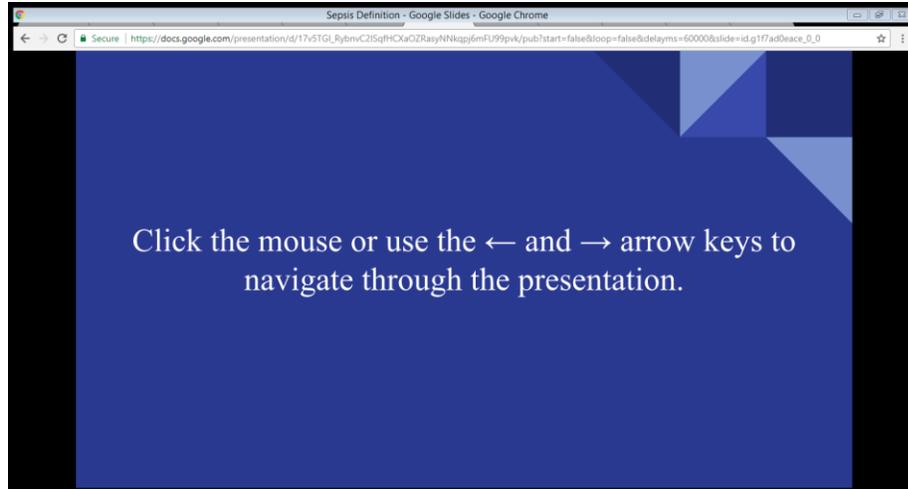
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Yousefi, H., Nahidian, M., & Sabouhi, F. (2012). Reviewing the effects of an educational program about sepsis care on knowledge, attitude, and practice of nurses in intensive care units. *Iranian Journal of Nursing and Midwifery Research*, *17*(2), S91- S95. Retrieved from: <http://www.ijnmr.mui.ac.ir/index.php/ijnmr/article/view/589>.

## Appendix C1

### Signs and Symptoms of Sepsis Presentation



Sepsis Definition - Google Slides - Google Chrome  
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The first stage of the sepsis process is called SIRS, and is defined as extensive inflammation throughout the body in response to various illnesses or medical conditions. SIRS stands for:

**S**ystemic **I**nflammatory **R**esponse **S**yndrome

(2.Goldstein, Giroir, & Randolph, 2005)

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The signs and symptoms of SIRS include:

- Hypothermia or hyperthermia
- Tachycardia (or bradycardia in infants < 1 year of age)
- Tachypnea
- Increased or decreased leukocyte count

(2.Goldstein et al., 2005)

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To receive a diagnosis of SIRS, a patient must have **at least 2 of these symptoms and 1 of them must include:**

- Hypothermia or hyperthermia
- Increased or decreased leukocyte count

(2.Goldstein et al., 2005)

**Vital Signs**

Due to the varying ranges of normal vital signs for different pediatric age groups, diagnosing SIRS may be difficult. Abnormal vital signs associated with SIRS based on age include: (1)

Age Group	0 days to 1 week	1 week to 1 month	1 month to 1 year	2-5 years	6-12 years	13 to 18 years
Tachycardia (beats/min)	>180	>180	>180	>140	>130	>110
Bradycardia (beats/min)	<100	<100	<90	NA	NA	NA
Tachypnea (breaths/min)	>50	>50	>50	>30	>25	>20

(1.American Heart Association, 2016; 2.Goldstein et al., 2005)

**Sepsis**



Pneumonia by James Hellman MD is licensed under CC Attribution-Share Alike 3.0 Unported

Patients are diagnosed with sepsis when they develop SIRS in response to an infectious pathogen. (2) The presence of an infection should be confirmed with diagnostic investigations. However, patients displaying symptoms of SIRS and a possible infection should be diagnosed with sepsis until this diagnosis is either confirmed or disproved by these investigations. (2)

(2.Goldstein et al., 2005)

**Infection**

Some infections may cause purpura or rashes in patients. (1) These patients should be assessed and monitored frequently for possible sepsis.

Purpura



Purpura on the Right Lower Leg of a Child by Okwikkim is licensed under Public Domain.

Rash



Erythema multiforme EM 01 appointment review note by Grook Da Ojar is licensed under CC Attribution-Share Alike 3.0 Unported.

(1.American Heart Association, 2016)

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## Severe Sepsis

Patients with sepsis are considered to have progressed to severe sepsis when they display signs and symptoms of organ dysfunction or acute respiratory distress syndrome (ARDS). (2)

Organ dysfunction associated with a diagnosis of severe sepsis can include signs and symptoms of cardiovascular dysfunction or dysfunction of at least two other organ systems. (2) This can include dysfunction of the lungs, brain, kidneys, liver, and the blood.

(2.Goldstein et al., 2005)

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## Signs of Organ Dysfunction

Signs of **cardiovascular dysfunction** include signs of continued poor blood flow throughout the body despite the administration of IV fluid boluses. These include: (2)

- Hypotension or
- At least 2 symptoms of poor perfusion:
  - Metabolic acidosis
  - Increase serum lactate
  - Decreased urine output
  - Delayed capillary refill
  - Cool extremities



Heart right anatomy by Patrick J. Lynch is licensed under CC Attribution 2.5 Generic license

(2.Goldstein et al., 2005)

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**Respiratory dysfunction** involves signs of oxygenation and ventilation issues, such as decreased oxygen levels or increased carbon dioxide levels on blood gases. (2) As well as, the need for high levels of supplemental oxygen or mechanical ventilation.



Lungs anatomy by Michael Haganovici is licensed under Public Domain



PSM V46 D167 Outer surface of the human brain by Sanger Brown M.D. is licensed under Public Domain

Signs of an altered mental status or decreased level of consciousness are signs of **neurological dysfunction**. (2)

(2.Goldstein et al., 2005)

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**Hematologic dysfunction** is often characterized by coagulation disorders. <sup>(2)</sup> Indicators include a decreased platelet count or an increased international normalized ratio (INR) level.



Ice-codblock-blood-bag sample by IC Sident is licensed under GNU Free Documentation License CC Attribution-Share Alike 3.0 Unported



Kidney by Shaidah is licensed under CC Attribution-Share Alike 4.0 International License

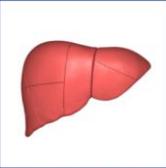
A high serum creatinine level is a sign of **renal dysfunction**. <sup>(2)</sup>

(2.Goldstein et al., 2005)

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Hepatic dysfunction can be diagnosed through blood work. Increased bilirubin and liver enzymes (i.e., alanine transaminase) are indicative of hepatic dysfunction. <sup>(2)</sup>



Liver 03 anterior view by Database Centre for Life Science is licensed under CC Attribution-Share Alike 2.1 Japan

(2.Goldstein et al., 2005)

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## ARDS

Acute respiratory distress syndrome (ARDS) occurs when an illness or traumatic event to the body causes increased capillary permeability in the lungs. <sup>(2)</sup> This results in pulmonary edema and oxygenation and ventilation issues, causing respiratory distress and hypoxemia.

Symptoms of ARDS include increased work of breathing, tachypnea, cyanosis, and decreased oxygen saturations. <sup>(2)</sup> ARDS can progress to respiratory failure and death.

(3.Hockenberry & Wilson, 2011)

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## Septic Shock

The final stage of sepsis progression is septic shock and it is associated with severe cardiovascular dysfunction. Although, unlike adults, hypotension is not a requirement of septic shock in children. (1,2) Children have compensatory mechanisms that can maintain a normal blood pressure for a short period of time in the presence of septic shock. (1,3,4) As a result, there are 3 stages of septic shock in children: 1) compensated; 2) decompensated; and 3) irreversible. (2)

The degree of a patient's shock is determined by their level of tachycardia, peripheral perfusion, mental status, and blood pressure. (2) Hypotension in children with septic shock is a latent sign and is associated with increased risk of mortality. (1,3)

(1. American Heart Association, 2016; 2. Goldstein et al., 2005; 3. Hockenberry & Wilson, 2011; 4. Kleinman et al., 2010)

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## Compensated Shock

Septic shock is classified as a form of distributive shock and is the result of organ dysfunction due to poor blood flow and oxygen delivery. (3) In the early stages of shock, compensatory mechanisms will cause an increase in heart rate and vasoconstriction to improve perfusion. This is called compensated shock.

Signs of compensated shock: (3,4)

- Tachycardia
- Cool hands and feet
- Prolonged cap refill (> 2 secs)
- Distal pulses < central pulses
- Normal systolic blood pressure
- Irritability
- Pallor



Checking blood pressure by Jency W licensed under CC Attribution 3.0 Generic

(3. Hockenberry & Wilson, 2011; 4. Kleinman et al., 2010)

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## Decompensated Shock

When these compensatory mechanisms become exhausted it causes hypotension, resulting in decompensated shock. (3,4) The result is poor perfusion and end organ dysfunction.



Child treated in ICU by National Cancer Institute is licensed under Public Domain

Signs and symptoms of decompensated shock: (3,4)

- Decreased level of consciousness, confusion
- Decreased urine output
- Metabolic acidosis
- Tachypnea
- Weak central pulses
- Deterioration in colour (cyanosis, mottling)
- Hypotension

(3. Hockenberry & Wilson, 2011; 4. Kleinman et al., 2010)

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# Hypotension in Children

Hypotension in children varies based on age group and can be defined as: (1,4)

**Systolic Blood Pressure**

Term Neonates (0-28 days old) = < 60mm Hg  
 Infants (1-12 months) = < 70mm Hg  
 Children (1- 10 years) = < 70mm Hg + (2 x years in age)  
 [example: 8 year old= 70 + (2 x 8)  
 = 70 + 16= 86]  
 Children ≥ 10 years = < 90mm Hg

(1.American Heart Association, 2016; 4.Kleinman et al., 2010)

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# Types of Septic Shock

There are 2 variations is how septic shock may present, known as warm or cold shock. The difference in these two types of septic shock include: (1,3)

Symptom	Warm Septic Shock	Cold Septic Shock
Peripheral Pulses	• Bounding	• Diminished
Capillary Refill	• Rapid (flash)	• Delayed
Colour/ Temp	• Flushed/ Warm extremities	• Pale/ Mottled/ Cool extremities
Blood pressure	• Hypotension (wide pulse pressure)	• Hypotension (narrow pulse pressure)

(1.American Heart Association, 2016; 3.Hockenberry & Wilson, 2011)

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# Summary

The definition of sepsis:

SIRS + infection = sepsis

The progression of sepsis:

SIRS → Sepsis → Severe Sepsis → Septic Shock → Death

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## Summary Continued

Signs and symptoms of poor perfusion due to septic shock include:

- Tachycardia
- Cold, pale, mottled skin
- Delayed capillary refill
- Diminished peripheral pulses
- Narrowed pulse pressure (increased diastolic pressure)
- Decreased urine output
- Altered mental status

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## Summary Continued

**\*\* Due to compensatory mechanisms, children can be in septic shock but still have a normal systolic blood pressure (i.e., compensated shock). Therefore, hypotension is a latent sign of shock in children and is associated with an increased risk of mortality.**

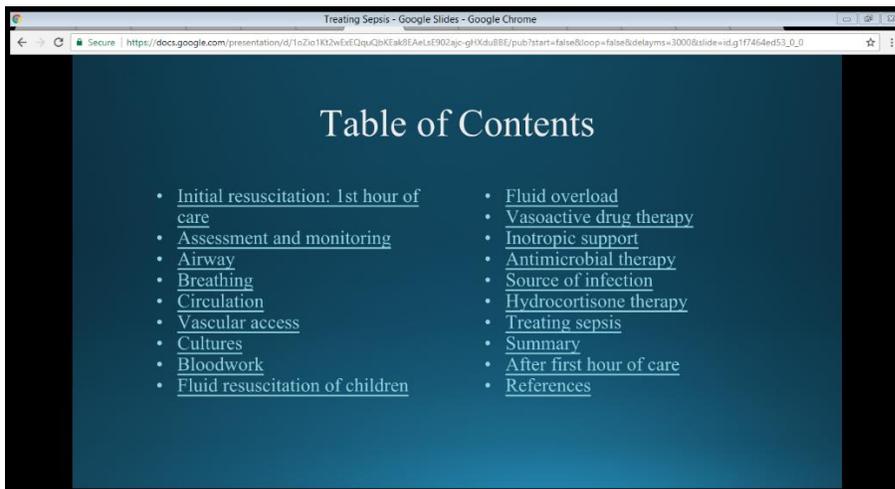
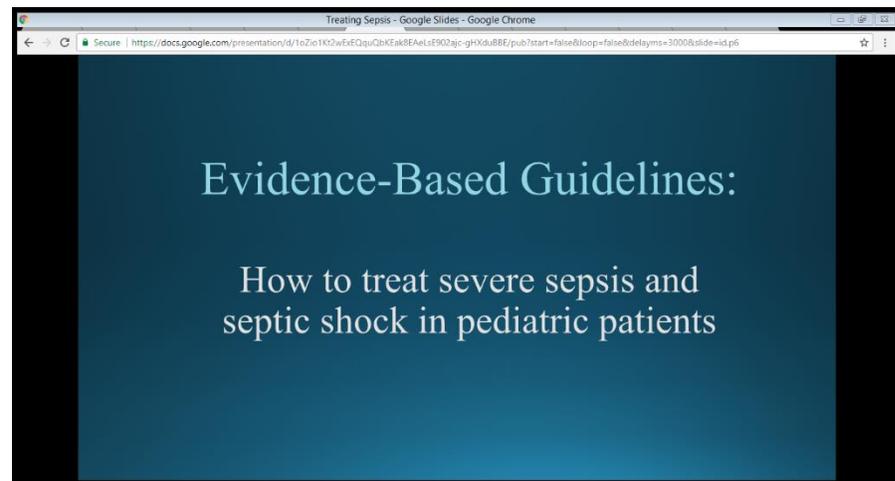
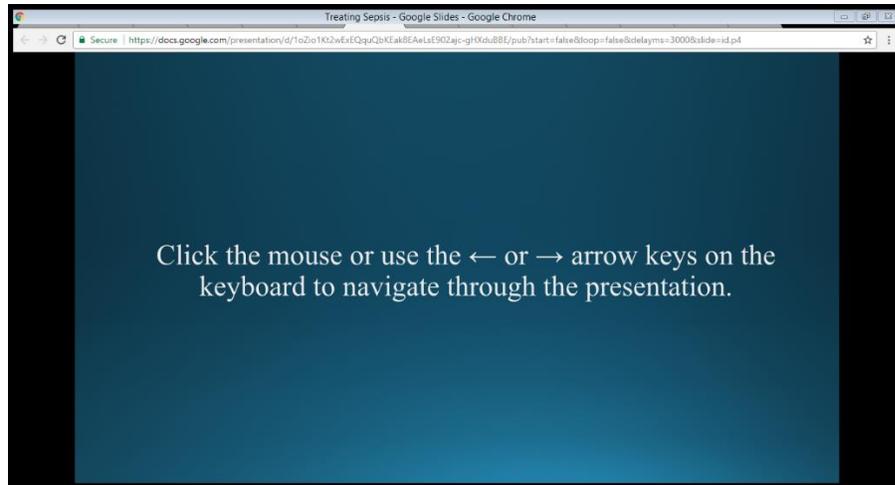
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1. American Heart Association. (2016). *Pediatric advanced life support: 2015 Canadian resuscitation & first aid guidelines*. Canada; Heart and Stroke Foundation.
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3. Hockenberry, M.J., & Wilson, D. (2011). *Wong's Nursing Care of Infants* (9th ed.). St. Louis, MI: Mosby
4. Kleinman, M.E., Chameides, L., Schexnayder, S.N., Samson, R.A., Hazinksi, M.F., Atkins, D.L.,.....Zaritsky, A.L. (2010). Part 14: Pediatric Advanced Life Support: 2010 American Heart Association Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*, 122(3), 876-908. doi: 10.1161/CIRCULATIONAHA.110.971101

## Appendix C2

### Overview of Sepsis Treatment Guidelines Presentation



Treating Sepsis - Google Slides - Google Chrome

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## Initial Resuscitation-1st Hour of Care

Administering care within the first hour septic shock onset is considered crucial to improving the patient's chance of survival. This is referred to as the initial resuscitation of the patient.<sup>[1,2,3]</sup> When administering resuscitation interventions to children with severe sepsis or septic shock, there are several therapeutic end-points these interventions aim to meet. The intent of resuscitation is to reverse hypoperfusion symptoms and achieve the following:<sup>[4]</sup>

- Cap refill  $\leq 2$  secs
- Urine output  $> 1$  ml/kg/hr
- Normal blood pressure
- Normal serum glucose
- Normal pulses (central pulses = peripheral pulses)
- Normal serum ionized calcium
- Normal mental status
- Warm extremities

(3.Davis et al. 2017; 4.Dellinger et al., 2013; 8.Rhodes et al., 2017)

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## Assessment and Monitoring

When a child is suspected, or proven, to have sepsis, it is important to assess and monitor the patient's vital signs.<sup>[1,2,4]</sup> These vital signs should be continuously monitored and reassessed throughout the resuscitation process.

Remember to assess the patient's: <sup>[1,2,4]</sup>	Remember to monitor the patient's: <sup>[4]</sup>
<ul style="list-style-type: none"> <li>• Airway</li> <li>• Breathing</li> <li>• Circulation</li> </ul>	<ul style="list-style-type: none"> <li>• Heart rate</li> <li>• Blood pressure</li> <li>• Pulse oximetry</li> </ul>

(1.American Heart Association, 2016; 3.Davis et al., 2017; 4.Dellinger et al., 2013)

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## Airway

When initiating resuscitation efforts to children with sepsis, it is important to administer aggressive interventions to stabilize the child's respiratory and cardiovascular systems.<sup>[1,2,3]</sup>

**Airway**  
When assessing the airway it is important to assess for:<sup>[1]</sup>

- Patency**
  - Is the child breathing?
  - Is there anything obstructing the airway (e.g., secretions)?
- Maintainability**
  - Can the child keep the airway open on their own or with simple maneuvers (e.g., repositioning)?
  - Are more advanced measures required to keep airway open (e.g, oral airway)?

(1.American Heart association, 2016; 8.Rhodes et al., 2017)

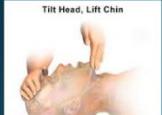
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## Airway

If the child is responsive and able to maintain their airway, interventions such as repositioning or suctioning may be sufficient to maintain patency. [1] However, if the child is unresponsive or otherwise unable to keep their airway open, then more advanced interventions will be required. These include:

Manual Repositioning  
(Jaw thrust or head tilt-chin lift)



CPA adult airway by BinsolBans is licensed under CC Attribution-Share Alike 4.0 International

Insertion of an advanced airway  
(Unconscious child)



Oropharyngeal airways by Hospital is licensed under CC Attribution-Share Alike 3.0 Unported

Intubation



Medical laryngoscope emergency medicine by Ann Platt is licensed under CC BY

(1. American Heart Association, 2016)

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## Breathing

When administering care to a child with severe sepsis, it is important to treat respiratory distress and hypoxemia with supplemental oxygen. [2] Several devices can be used to support the child's respiratory status, such as:

- Non-rebreather face mask
- High-flow nasal cannula
- Non-invasive continuous positive airway pressure (CPAP)
- Mechanical ventilation (intubated child)

(4. Dellinger et al., 2013)

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## Circulation

When resuscitating a child with severe sepsis or septic shock, it is important to administer intravenous (IV) crystalloid fluid, or albumin, to reverse hypoperfusion and shock symptoms. [3] Hypoperfusion due to sepsis in children presents as:

- Absent or weak peripheral pulses
- Cool extremities
- Prolonged capillary refill
- Narrowed pulse pressure

**Remember:** Hypotension is a latent symptom of poor perfusion in children and, therefore, fluid resuscitation should not be delayed because the child's blood pressure is normal

(1. American Heart Association, 2016; 3. Davis et al., 2017)

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## Vascular Access

Before administering fluid resuscitation, intravascular access must first be obtained. Timely treatment is essential to patient outcomes, therefore, if peripheral IV access cannot be obtained promptly, then intraosseous (IO) access should be acquired. [\[1,3\]](#)

Manual IO device



Service members conduct casualty resuscitation training on board USNS Comfort during Pacific Partnership 2015. 150637J-YW472-0623 by Senior Airman Peter Rich is licensed under Public Domain.

Powered IO device



Video: ezio (product name) by BW/Blinn/2699 is licensed under CC Attribution-Share Alike 3.0 Unported.

(1. American Heart Association, 2016; 3. Davis et al., 2017)

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## Cultures

After obtaining vascular access, attempts should be made to collect cultures and bloodwork. [\[1,3\]](#) Important points to remember when obtaining microbial cultures from children with sepsis are:

- Cultures should be collected from all possible sources of infection.
- Potential types of cultures to consider include:
  - Blood
  - Urine
  - Cerebrospinal fluid
  - Respiratory secretions
  - Wounds
- Both aerobic and anaerobic blood cultures should be collected.
- If the child has an intravascular catheter that has been in situ for more than 48 hours, then blood cultures should be collected from the catheter and another peripheral site to distinguish the source of infection (i.e., catheter or blood).

(1. American Heart association, 2016; 8. Rhodes et al., 2017)

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## Cultures



Blood culture bottles by Moxco, LLC, is licensed under GNU Free Documentation License and CC Attribution-Share Alike 3.0 Unported.

**\*\*** Cultures should be collected prior to administration of antimicrobial agents to improve the probability of identifying the infectious pathogen. However, if collecting cultures cannot be done quickly, than administering antimicrobial therapy within the first hour of sepsis symptoms should **always** take priority over collecting cultures. [\[1,3,4\]](#)

(1. American Heart Association, 2016,3. Davis et al., 2017; 4. Dellinger et al., 2013; 8. Rhodes et al., 2017)

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## Bloodwork

When collecting blood work to confirm a sepsis diagnosis and assess the patient's state of health, these laboratory studies should be completed. (4) (Remember that even though laboratory studies are important, resuscitation efforts are the priority and should not be delayed due to blood work collection.)

- **Blood gas (preferably arterial)**- monitor for acidosis and increased lactate levels associated with sepsis.
- **Complete Blood Count (CBC)**- elevated or decreased leukocytes or decreased platelets can be associated with sepsis.
- **Serum Electrolytes**- electrolytes levels, such as sodium, potassium, and chloride, may be affected due to sepsis and need correcting.
- **Serum glucose**- hypoglycemia is common with sepsis
- **Serum ionized calcium/ calcium**- sepsis may cause hypocalcemia that may impact myocardial function.
- **Serum creatinine**- sepsis may cause renal dysfunction.
- **Total bilirubin and alanine aminotransferase (ALT)**- sepsis may cause hepatic dysfunction.
- **Coagulation studies**- sepsis can affect coagulation processes and cause hemolytic dysfunction.



U.S. Navy 060105-N-3154G-010 A hospital computer with the Blood Doctor Team from Portsmouth Naval Hospital takes samples of blood from a donor for testing by Jeremy L. Graham is licensed under Public Domain.

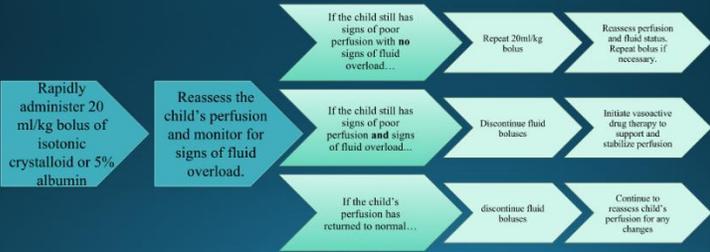
(6.Mendez & Lopus, 2015)

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## Fluid Resuscitation

IV fluid resuscitation should be administered in 20 ml/kg boluses, infused over 5-10 min intervals. Children with severe sepsis or septic shock usually require 40-60ml/kg in total during initial resuscitation to improve perfusion. (1,3,4)



(1. American Heart Association, 2016; 3.Davis et al., 2017; 4.Dellinger et al., 2013)

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## Fluid Resuscitation

When administering fluid resuscitation, it is important to administer the isotonic crystalloid or albumin (5%) **rapidly**. (4) This can be accomplished by administering the fluid by:

- IV Push
- Pressure bag
- Rapid infuser



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(4.Davis et al, 2017)

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## Fluid Overload

Following each fluid bolus, healthcare professionals should reassess the patient's hemodynamic status and monitor for signs of fluid overload.<sup>[1,3,4]</sup> If signs of fluid overload develop, then fluid boluses should be immediately stopped and vasoactive drugs should be used instead to improve perfusion.

Signs of  
fluid  
overload

**Rales (i.e., crackles)**

- Auscultate lungs for "wet" lung sounds
- May be associated with increased work of breathing
- [Click here to hear rales lung sounds](#)

**Hepatomegaly**

- Increase in the size of the liver
- May be assessed by palpation of liver

(1. American Heart Association, 2016; 3.Davis et al., 2017; 4.Dellinger et al, 2013)

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## Vasoactive Drug Therapy

If the child has fluid refractory shock (i.e., perfusion has not improved with fluid boluses) then continuous infusion of vasoactive medications (i.e., inotropes or vasodilators) will need to be started.<sup>[1]</sup>

If central access is unavailable, then inotropic support can be administered through peripheral access. However, it is important to frequently assess the PIV site for **ischemia** or **infiltration**.<sup>[1]</sup> Central access is ideal for inotrope infusions and should be obtained when possible.

The choice of inotropic medications to utilize is based on the child's type of septic shock and doses are titrated based on the child's perfusion in response to the inotrope infusions.<sup>[2,3]</sup>

(2.Brierley et al., 2009; 3.Davis et al., 2017; 4.Dellinger et al., 2013)

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## Inotropic Support

Different septic shock treatment algorithms recommend different procedures when initiating inotropic support, although there is no significant evidence that one algorithm is better than the other.<sup>[1]</sup> Dopamine, epinephrine, and norepinephrine are considered first-line inotropes when treating septic shock.<sup>[1,5]</sup> The PALS septic shock algorithm (American Heart Association, 2016) recommends:

Cold septic shock with normal blood pressure

Cold septic shock with hypotension

Warm septic shock

Dopamine

Epinephrine

Norepinephrine

(1.American Heart association; 3.Davis et al., 2017; 5.Maloney, 2013)

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## Antimicrobial Therapy

- Empiric, broad-spectrum antibiotics should be administered initially.<sup>[1,4,5]</sup>
- Choice of antibiotics should be based on:<sup>[4,7]</sup>
  - Suspected source of infection
  - Suspected pathogen
  - Community acquired or hospital acquired infection
  - Patient factors (e.g., immunosuppression, allergies, etc.)
- Antibiotic therapy should be reassessed daily and modified based on culture results, pathogen sensitivity, and clinical response to therapy.<sup>[1,3,8]</sup>
- Antifungals and antivirals may also need to be considered based on suspected pathogen or need for prophylaxis treatment.<sup>[5, 8]</sup>
- Consult a pediatric infectious disease physician about appropriate antimicrobial therapy. <sup>[3,8]</sup>

(1.American Heart Association, 2016; 4.Dellinger et al., 2013; 5.Maloney, 2013;7. Plunkett & Tong, 2015; 8.Rhodes et al., 2017)

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## Antimicrobial Therapy

Examples of what to consider when selecting antibiotics to treat sepsis and septic shock in children are: <sup>[4,5,7]</sup>

Suspected community acquired infection	3rd or 4th generation cephalosporin (e.g., cefotaxime or ceftriaxone)
Suspected hospital acquired infection	Extended spectrum penicillin (e.g., piperacillin with tazobactam) or carbapenem (e.g., meropenem)
Methicillin-resistant Staphylococcus aureus (MRSA) as suspected pathogen	Consider Vancomycin
Suspected toxic shock syndrome	Consider Clindamycin
Neonate patient	Acyclovir (herpes simplex virus) and Ampicillin (Listeria)

(4.Dellinger et al., 2013; 5.Maloney, 2013; 7.Plunkett & Tong, 2015)

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It is important to remember that the timing of administering antibiotics to children with sepsis and septic shock is crucial to the child's survival. With every hour antibiotics are delayed, the risk of mortality increases.<sup>[4]</sup> Therefore, is it important to remember:<sup>[4,6]</sup>

- Antibiotics need to be administered as soon as possible.
- Antibiotics should be administered within 1 hour of sepsis presentation.
- Never delay antibiotics because cultures have not been collected yet.
- Due to limited timing and, possibly, limited IV/IO access, antibiotics that can be administered over a shorter time period should be administered first.
- Antibiotics may need to be pushed to infuse them within the first hour of sepsis presentation. Consult proper resources on how to properly administer these medications by push.

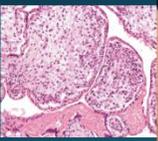
(4.Dellinger et al., 2013; 6.Mendez & Lapus, 2015)

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## Source of Infection

- When treating patients with sepsis or septic shock, it is important to identify the possible source of infection and implement appropriate measures to control the infection. [4,5]
- If the suspected source of infection is a site of intravascular access, then measures should be taken to remove the infected line as soon as possible if other IV access is available. [4,5]



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(4.Dellinger et al., 2013; 8.Rhodes et al., 2017)

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## Hydrocortisone Therapy

Corticosteroids should also be administered if the patient is displaying signs of: [1,4]



Fluid refractory shock

Catecholamine resistant shock

Adrenal insufficiency

(1.American Heart Association, 2016; 4.Dellinger et al., 2013)

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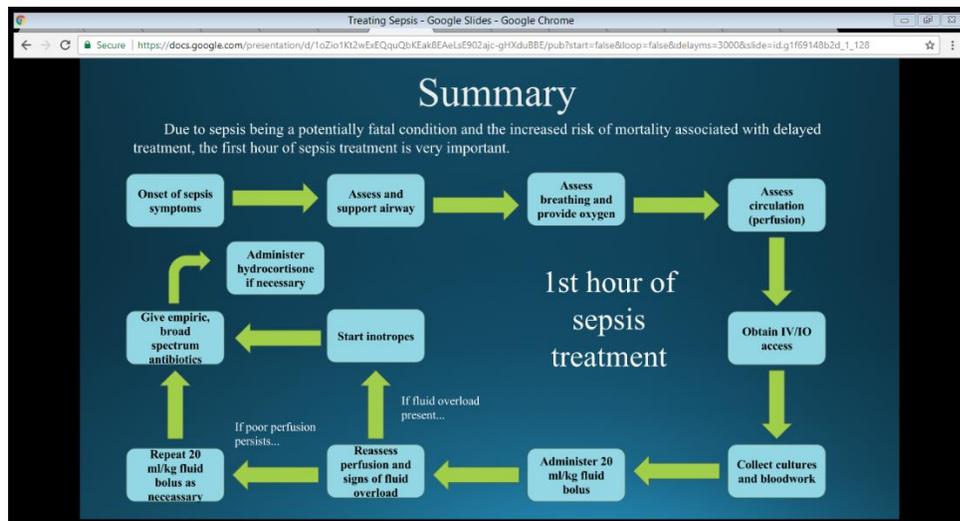
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ICU nurse caring for infant by Bill Branson is licensed under Public Domain

\*Due to the serious nature of sepsis and its time-sensitive treatment, if sepsis is suspected then proper treatment and diagnostic investigations should be implemented. [6] It is better to discontinue treatment once a possible sepsis diagnosis has been eliminated rather than delay treatment until sepsis has been confirmed if sepsis is present.

(7.Plunkett & Tong, 2015)



- ## After First Hour of Care...
- The child should be transferred to a Pediatric Intensive Care Unit for further treatment. <sup>[2,3]</sup>
  - Maintenance IV fluid should be administered to stabilize perfusion and provide electrolytes. <sup>[2]</sup>
  - The child should be closely monitored for fluid overload, and appropriate measures to remove excess fluid implemented if necessary. <sup>[4,7]</sup>
  - If necessary, inotropic therapy should be titrated based on child's perfusion. <sup>[2,3]</sup>
  - If the child is mechanically ventilated, then proper sedation should be administered and ventilator settings titrated based on the child's respiratory needs. <sup>[4,8]</sup>
  - Enteral or parenteral feeds should be initiated. <sup>[3,5]</sup>
- (2. Brierley et al., 2007; 3. Davis et al., 2017; 4. Dellinger et al., 2013; 7. Plunkett & Tong, 2015; 8. Rhodes et al., 2017)

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## Appendix C3

### Unit 2 Sepsis Recognition Review Questions and Answers

Question #1: A 15 month old patient has a temperature of 38.7°C rectally. Her heart rate is >180 bpm and her BP is 86/42 mmHg. The patient's extremities are warm to touch and capillary refill is < 2 seconds. The patient is sleeping but wakes easily with stimulation. The patient is tachypneic but her SpO<sub>2</sub> is 95% in room air. Chest auscultation reveals diminished breath sounds to the lower left lung. No blood work has been completed yet. Based on your nursing assessment, what diagnosis best fits your patient's symptoms?

- A) SIRS
- B) Sepsis
- C) Severe Sepsis
- D) Septic Shock

**Answer:** Sepsis. Based on her symptoms, sepsis is the best diagnosis to make until further investigations are completed. The patient's symptoms meet the criteria of SIRS (core temperature > 38.5°C and tachycardia) and they are showing signs of a possible infection (increased temperature and symptoms of a possible pneumonia). At this stage the patient is not showing signs of respiratory distress or poor perfusion, therefore the diagnostic criteria for severe sepsis has not been met. Further investigations, blood work, need to be completed to determine if there are any signs of organ dysfunction that would be cause with severe sepsis. However, it is still important to implement proper sepsis treatment once sepsis is suspected

Question #2: You are caring for a 5 year old with a Hickman central line that has become red at the insertion site. The patient's mom is worried that the site has become infected. The patient's heart rate is > 140 bpm but he is afebrile. The patient is tachypneic with a respiratory rate > 30 breaths/min. A CBC and blood gas are completed. The patient's WBC is increased from yesterday's level but is still within the normal range. True or false, this patient is showing signs of sepsis and should start receiving treatment?

- A) True
- B) False

**Answer:** False. Although this patient is exhibiting signs of a possible infection, they do not meet the diagnostic criteria for SIRS which is required for a diagnosis of sepsis. The patient does have 2 symptoms of SIRS (tachycardia and tachypnea), however, for children to receive a diagnosis of SIRS they must also have a core temperature < 36°C or > 38.5°C or a leukocyte count that is above or below normal levels for their age. Even though this patient does not meet the requirements to receive sepsis treatment, they warrant close monitoring for possible sepsis development in the future.

Question #3: A 10 year old girl is suspected of having sepsis. Based on the patient's age, which vital signs would meet the criteria for tachycardia and tachypnea?

- A) HR= 136 bpm, RR= 19 breaths/min
- B) HR= 125 bpm, RR= 24 breaths/min
- C) HR= 138 bpm, RR= 30 breaths/min
- D) HR= 130 bpm, RR= 20 breaths/min

**Answer:** HR= 138 bpm, RR= 30 breaths/min. For a 10 year old patient, a HR > 130bpm is considered tachycardic and a RR > 25 breaths/min is considered tachypneic.

Question #4: An 8 year old boy is tachycardic with a HR > 150 bpm and a blood pressure of 90/ 60 mmHg. He is being treated for suspected sepsis. He has received two 20 ml/kg normal saline IV boluses in the last 30 minutes. The patient weighs 25 kg and has voided 10 mls of urine in the last hour. The patient's extremities are cool to touch compared to his core and his capillary refill is > 5 secs in his feet. Is this patient displaying signs of cardiovascular dysfunction?

- A) Yes
- B) No

**Answer:** Yes. To meet the diagnostic criteria for cardiovascular dysfunction in children, despite the administration of IV fluid boluses a patient must be hypotensive, require vasoactive medications to maintain a normal blood pressure, or have 2 of the following symptoms: metabolic acidosis, increased serum lactate, oliguria (< 0.5 ml/kg/hr), prolonged capillary refill (>5 secs), or a core to peripheral temperature difference > 3°C. Even though this patient has received two fluid boluses he still has oliguria, delayed capillary refill, and a core to peripheral temperature difference. Therefore, he meets the diagnostic criteria for cardiovascular dysfunction.

Question #5: A 4 year old girl is brought to the emergency room by an ambulance. The patient has a decreased level of consciousness and is only responding to pain. The patient is febrile and tachycardic with a HR > 140 bpm. She is tachypneic and is requiring 100% oxygen by nonrebreather to keep her SpO<sub>2</sub> > 92%. Her extremities are warm to touch and her capillary refill is < 1 second. Peripheral pulses are bounding and she appears flushed. Her blood pressure is 72/35 mmHg. Based on her symptoms, is this patient exhibiting signs and symptoms of septic shock?

- A) Yes
- B) No

**Answer:** Yes. Based on the patient's symptoms (hypotension, bounding pulses, flash capillary refill, warm extremities, and respiratory distress) this patient is most likely experiencing warm septic shock. Although this patient does not display the typical

symptoms of shock, it is important to remember that warm septic shock can occur in children and to be familiar with its symptoms

Question #6: You are caring for a 16 year old, female patient. The patient's mother says her daughter feels warm to touch and she is having trouble waking her this morning. You complete a nursing assessment. While completing your nursing assessment you note that the patient has a temperature of 39°C orally and her HR= 130 bpm. Her blood pressure is 110/70 mmHg. The patient is only responding to touch, is confused when asked questions about where she is, and is displaying signs of weakness when asked to squeeze your hand. The patient's morning blood work shows that her creatinine level has doubled since her last level. The patient's mom says her daughter complained of pain when she peed last night. Based on your nursing assessment, what diagnosis best fits your patient's symptoms

- A) SIRS
- B) Sepsis
- C) Severe Sepsis
- D) Septic Shock

**Answer:** Severe sepsis. Based on their symptoms the patient has a suspected source of infection (urinary tract infection) and is displaying symptoms of at least 2 organ dysfunctions (neurological and renal). The patient's mental status has deteriorated and their serum creatinine has doubled. At this point further assessment and diagnostic investigations are needed to determine if the patient is exhibiting signs of septic shock, therefore, severe sepsis is the best diagnosis at this time. This patient should receive immediate treatment for their sepsis.

Question #7; A 1 year old patient is tachycardic with a HR > 180 bpm but afebrile. The patient's respiratory rate and blood pressure are normal. The patient's blood gas is normal but her WBC is decreased on her CBC. Based on these symptoms, what diagnosis best describes the patient's condition?

- A) This patient's symptoms appear not sepsis related
- B) SIRS
- C) Sepsis
- D) Severe Sepsis

**Answer:** SIRS. Based on their symptoms, the patient meets the diagnostic criteria for SIRS (tachycardia and decreased leukocytes). However, the patient not currently displaying any obvious signs of symptoms of an infection. Therefore, the best diagnosis for this patient would be SIRS, although further investigations should be completed to rule out a possible infection as the cause of the patient's SIRS.

## Appendix C4

### Unit 3 Sepsis Treatment Review Questions and Answers

Question #1: You are caring for an 8 year old boy suspected of being septic. He is febrile and tachycardic. His blood pressure is normal. He is tachypneic. The physician orders the patient to be receive 100% oxygen by nonrebreather, rectal acetaminophen to treat his temperature, a 20 ml/kg normal saline IV bolus, and to be connected to cardiorespiratory monitors. What is the best sequence of actions for these orders to be completed?

- A) Administer oxygen, administer IV bolus, administer acetaminophen, and then connect to monitors
- B) Connect monitors, administer oxygen, administer IV bolus, and administer acetaminophen
- C) Administer oxygen, connect to monitors, administer IV bolus, and administer acetaminophen
- D) Connect to monitors, administer IV bolus, administer oxygen, and administer acetaminophen

**Answer:** Administer oxygen, connect to monitors, administer IV bolus, and administer acetaminophen. The patient is showing signs of respiratory distress, therefore, supporting his breathing should be your first priority. If the patient can be connected to monitors quickly, then he should be connected prior to receiving an IV bolus to allow you to monitor his vital signs in response to the fluid bolus. The next priority is circulation, therefore the bolus should be administered rapidly. Once all the resuscitating interventions have been completed and the patient's condition has improved, the patient may receive acetaminophen to relieve his temperature.

Question #2: A 5 year old girl is being assessed in the emergency room. The patient arrived with her mom 40 minutes ago. The patient is connected to cardiorespiratory monitors and IV access has been obtained. She is tachycardic but blood pressure is normal. She is receiving 100% oxygen by nonrebreather. According to the evidence-based guidelines for treating sepsis, what would be the recommended care the patient receives next?

- A) Administer a 20 ml/kg normal saline bolus over 15 mins.
- B) Administer Cefotaxime over 15 mins and then Vancomycin over an hour.
- C) Obtain blood cultures and blood work, then administer antibiotics.
- D) Push a normal saline IV bolus and antibiotics.

**Answer:** Push a normal saline IV bolus and antibiotics. According to the evidence-based guidelines, it is important for patients to receive fluid boluses and antibiotics within the first hour of sepsis symptom onset. This patient has already been waiting in emerge for 40 mins, therefore, to improve this patient's chance of survival and outcome she needs to receive IV fluid and antibiotics as soon as possible.

Question #3: Your 1 year old patient is exhibiting signs and symptoms of sepsis. He is tachycardic, febrile, and lethargic. His blood pressure is normal but extremities are cool and pale. Oxygen has been administered but staff have been attempting to obtain IV access over 15 mins with no success. What should staff do next?

- A) Have a physician insert a central line at the bedside.
- B) Insert an intraosseous needle (IO).
- C) Call anesthesia to obtain an IV.
- D) Administer antibiotics by intramuscular (IM) injection.

**Answer:** Insert an intraosseous needle (IO). According to the evidence-based guidelines, obtaining vascular access should be obtained quickly so that fluid boluses and antibiotics can be administered. If IV access cannot be obtained promptly, then IO access should be attempted because it is quick method of obtaining vascular access. If IO access cannot be obtained then IM antibiotics should then be considered.

Question #4: You are caring for a 15 year old patient, newly diagnosed with sepsis. The patient is tachycardic and febrile. Her blood pressure is normal, although her extremities are cool and cap refill is delayed. The patient is receiving 100% oxygen by nonrebreather. The resident orders the patient to receive PO acetaminophen, a 15 ml/kg normal saline IV bolus, and Cefotaxime, Ampicillin, and Vancomycin. What suggestions should you make to the resident to make his orders more compliant with evidence-based practices?

- A) The patient should receive rectal acetaminophen instead of PO in case their breathing deteriorates and they require intubation.
- B) The IV bolus dose should be 20 ml/kg.
- C) Cultures should also be ordered and collected, quickly, before antibiotics administered.
- D) All of the above.

**Answer:** All of the above. Patients with sepsis are at risk of their respiratory status deteriorating, therefore, intubation may be necessary. Patients at risk of intubation should not receiving anything by mouth to keep the stomach empty. The recommended fluid bolus dosage for fluid resuscitation in patients with sepsis is 20 ml/kg. Cultures should always be attempted prior to antibiotic administration to help identify the infectious pathogen. If cultures cannot be obtained in a timely manner, then antibiotics should be administered prior to cultures being obtained

Question #5: You are caring for a 10 year old patient exhibiting symptoms of septic shock. The patient is tachycardic and tachypneic. The patient's extremities are cool to touch, capillary refill is delayed, and peripheral pulses are weaker than the central pulses. The patient is receiving 100% oxygen by nonrebreather. A 20 ml/kg normal saline IV bolus is ordered and administered. After the fluid bolus the patient's perfusion remains

poor and the patient is now showing signs of increased work of breathing. What should be the next step in providing treatment to this patient?

- A) Administer another 20 ml/kg NS IV bolus
- B) Auscultate the patient's lungs.
- C) Begin continuous inotropic infusions.
- D) Administer antibiotics.

**Answer:** Auscultate the patient's lungs. After administering a fluid bolus the evidence-based guidelines recommend reassessing the patient's perfusion and assessing for signs of fluid overload. This patient's perfusion remains poor, meaning further interventions are needed to return their perfusion to normal. However, the patient's respiratory status changed, which could mean the patient has developed rales due to fluid overload. The patient's lungs should be assessed to determine if the patient is fluid overloaded and will need inotropic support or if the patient's lungs sound clear and they can receive another fluid bolus.

Question #6: A 6 month old baby has been brought to the emergency room by his dad with symptoms of sepsis. You go to complete your nursing assessment on the patient. The baby is asleep in his car seat (see picture below). The baby is showing signs of respiratory distress with slightly dusky lips. The babe's arms are cool to touch but peripheral pulses are normal. What should you do first?



Free photo: Vehicle, infant, boy, transportation, people, young by PublicDomainPictures and licensed by Public Domain (Retrieved from: <https://pixabay.com/photo-69771/>)

- A) Place the babe in 100% oxygen by nonrebreather
- B) Obtain IV access.
- C) Connect the baby to cardiorespiratory monitors
- D) Remove the baby from the car seat and open the airway by repositioning the baby's head.

**Answer:** Remove the baby from the car seat and open the airway by repositioning the baby's head. Remember the ABC's (airway, breathing, circulation) when providing care to patients. Your first priority should always be to assess the airway. In this situation the child's airway patency may be compromised due to their position in the car seat. Therefore, the babe's airway should be opened with repositioning prior to implementing other interventions.

Question #7: A child is being treated for septic shock. The patient is exhibiting signs of poor perfusion (cool extremities, weak peripheral pulses, pale in colour, delayed capillary refill). The patient's blood pressure is normal but is widening. The patient has received 60 ml/kg total of IV normal saline with little improvement in perfusion. An epinephrine infusion has been started but perfusion has not improved. According to the evidenced-based guidelines, what is another intervention that may improve perfusion in this situation?

- A) Administer hydrocortisone.
- B) Administer antibiotics.
- C) Insert an arterial line to better measure blood pressure.
- D) Administer a ringer's lactate bolus.

**Answer:** Administer hydrocortisone. This patient is exhibiting signs of fluid-refractory shock and catecholamine resistant shock. According to the evidence-based guidelines, corticosteroids should be administered in these situations to improve vasoconstriction and perfusion.

## Appendix C5

### Sepsis Case Study Questions and Answers

Case Study 1, Question #1: A 5 year old boy has been diagnosed with sepsis. The patient's HR is >140 bpm), oral temperature is 38.7°C, RR is > 30 breaths/min, and BP= 95/50 mmHg. He is lethargic and his extremities are cool with a capillary refill of > 4 secs. Staff were able to obtain IV access after 15 mins and an IV normal saline bolus was started. During the bolus the IV infiltrated and new access was needed. What should staff do to obtain new vascular access?

- A) Attempt another peripheral IV
- B) Have a physician Insert a central line
- C) Call anesthesia to insert a peripheral IV
- D) Insert an IO

**Answer:** Insert an IO. Treating sepsis is time-sensitive and receiving the proper care within the first hour after severe sepsis symptom onset is crucial to improved patient outcomes. This patient's treatment has already been significantly delayed due to not being able to obtain IV access. The evidence-based sepsis management guidelines recommend inserting an IO if an IV cannot be obtained promptly.

Case study 1, Question #2: An IO was successfully inserted into the patient's leg. The patient was very scared and upset during the IO insertion and is now showing signs of decreased consciousness and is only responding to pain. He is lying in bed with the head of his bed increased. The patient's RR is now 50 and his SpO<sub>2</sub> is 87% in 100% oxygen by nonrebreather. His blood pressure has decreased to 90/45 mmHg. Another 20 ml/kg NS bolus and antibiotics have been ordered. What care should the patient receive next?

- A) Push the NS bolus over 5 minutes.
- B) Begin antibiotics
- C) Attempt to wake the patient up to increase his SpO<sub>2</sub>
- D) Reassess the patient's respiratory status and need for more advanced support.

**Answer:** Reassess the patient's respiratory status and need for more advanced respiratory support. Although this patient does require another fluid bolus and antibiotics, this patient's respiratory status has changed. This patient's symptoms show that the patient is having difficulty maintaining a normal SpO<sub>2</sub> and further intervention is required. According to the Pediatric Advanced Life Support guidelines, the priority of care is airway, then breathing, and then circulation. Therefore, caring for this patient's respiratory status is now the priority before administering the IV bolus and antibiotics.

Case Study 1, Question #3: It has been 50 mins since the patient first presented with sepsis symptoms. The patient is now intubated, has received two 20 ml/kg NS boluses,

and antibiotics have been given. The patient's BP is still decreasing and is now 79/40 mmHg. The patient still only has an IO for vascular access. The respiratory therapist informs the physician that the patient has developed crackles to his lung bases. The patient requires further intervention to improve his perfusion. What would be the best intervention to complete next to improve this patient's perfusion?

- A) Administer another 20 ml/kg NS bolus.
- B) Begin inotropic drug infusions.
- C) Administer hydrocortisone
- D) Administer a 5% Albumin bolus.

**Answer:** Begin inotropic drug infusions. This patient has developed rales (crackles), which is a sign of fluid overload. Therefore, administering more fluid would not be an appropriate to improve this patient's perfusion. This patient has not yet met the criteria of fluid-refractory or catecholamine resistant shock, therefore hydrocortisone is not yet recommended. Starting inotropic infusions to treat the patient's hypotension would be the best intervention in this situation.

Case Study 1, Question #4: The physician orders the patient to receive an epinephrine infusion to treat his hypotension. What should staff do next to begin an inotropic infusion?

- A) A physician should insert a central line to infuse the epinephrine infusion.
- B) A physician should insert an arterial line to better measure the patient's blood pressure in response to the epinephrine infusion.
- C) Administer the epinephrine infusion peripherally until central vascular access can be obtained.

**Answer:** Administer the epinephrine infusion peripherally until central vascular access can be obtained. This patient requires immediate intervention to treat his hypotension and improve his perfusion. It is recommended that in emergency situations inotropes should be administered peripherally until central access can be obtained. When administering inotropes peripherally remember to closely monitor the vascular site for signs of infiltration and ischemia.

Case Study 2, Question #1: You are caring for a 10 year old girl with a PICC line. When you check on your patient at 2300h you notice the patient has developed redness at the insertion site and the site has started to become warm to touch. The patient's HR is > 130 bpm and her oral temperature is 38.3°C. Her RR is >25 and blood pressure is 105/70 mmHg. You call the resident and inform him of your assessment findings. The resident comes to assess the patient. It has been 30 minutes since you first noticed your patient's symptoms and the resident is unsure if your patient is septic or not. What should staff do in this situation? Select all answers that apply.

- A) Call the physician on call to come and assess the patient.
- B) Draw a blood culture from the PICC line and remove the line.
- C) Order blood work to determine if the patient is septic (blood gas, CBC, serum electrolytes)
- D) Start antibiotic therapy.

**Answer:** Order blood work to determine if the patient is septic **and** start antibiotic therapy. Sepsis treatment is time sensitive and this patient has been exhibiting signs of possible sepsis for at least 30 mins. The proper procedure in this situation would be to begin sepsis treatment while performing further diagnostic testing to confirm or disprove the patient's suspected sepsis diagnosis. It is better to stop treatment if sepsis is eliminated than wait to provide treatment until sepsis has been confirmed. Although the PICC is the likely source of infection, it should not be removed until alternative vascular access has been obtained

Case Study 2, Question #2: Antibiotics have been ordered and a blood culture, blood gas, CBC, serum electrolytes, serum creatinine, liver function tests, and a coagulation panel have been drawn from the PICC line and sent to the lab. The patient's temp has now increased to 38.9°C orally. The patient's blood gas indicates a metabolic acidosis and the lactate is significantly increased. The patient is now very lethargic and difficult to arouse. The patient's extremities are cool to touch and her peripheral pulses are weaker than her central pulses. Capillary refill is > 5 seconds. Based on this patient's symptoms, what diagnosis best fits this patient's condition?

- A) SIRS
- B) Sepsis
- C) Severe sepsis
- D) Septic shock

**Answers:** Septic shock. This patient is exhibiting symptoms of SIRS (hyperthermia and tachycardia) and infection (PICC line) meaning they meet the diagnostic criteria for a sepsis diagnosis. This patient's condition has progressed to exhibiting signs of cardiovascular organ dysfunction (delayed capillary refill, metabolic acidosis, core to peripheral temperature difference, and diminished pulses) and neurological organ dysfunction (decreased level of consciousness). Due to all these symptoms, this patient has most likely progressed to septic shock.

Case Study 2, Question #3: An hour has now passed since the patient's symptoms were noticed. The patient has received three 20 ml/kg NS boluses by push, IV antibiotics by push, and is receiving 100% oxygen by high flow nasal cannula. An epinephrine infusion has just been started due to the patient's continued hypoperfusion after fluid boluses. The patient's extremities remain cool to touch and capillary refill is > 3 seconds. Peripheral pulses are still weaker than central pulses. What would be the appropriate plan of care for this patient? Select all possible answers.

- A) Consult the Pediatric Intensive Care Unit for patient transfer.
- B) Administer hydrocortisone.
- C) Increase the rate of the epinephrine infusion.
- D) Begin continuous maintenance IV fluid.

**Answer:** All answers are correct. All of these answers would be correct. Patients with septic shock should be transferred to the Pediatric Intensive Care Unit following initial resuscitation for further care and stabilization. Hydrocortisone should be administered when patients exhibit signs of fluid refractory and catecholamine resistant shock. Inotropic infusions may need to be titrated based on the patient's perfusion. Patients should receive continuous maintenance IV fluid to provide hydration and electrolytes.

## Appendix C6

### Sepsis Module Evaluation Form

The information in this module was relevant to my nursing practice

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

The information presented in this module was easy to follow and understand

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I learned something new after completing this module

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I enjoyed completing this education module

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I would recommend this education module to others

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

My favorite components of this module were... (Check all that apply)

- The online format
- The Google slide presentations
- The review questions/ Case Studies
- Accessibility
- Being able to complete the module at your own pace
- Other:

My least favorite component of this module was...

Additional Comments: