Nursing factors affecting the management of sepsis

A Literature Review

Hue Nguyen

Nhu Nguyen

Bachelor's thesis
December 2023
Degree Programme in Nursing

jamk | Jyväskylän ammattikorkeakoulu
University of Applied Sciences

jamk

Description

Authors: Hue Nguyen & Nhu Nguyen

Nursing factors affecting the management of sepsis

Jyväskylä: Jamk University of Applied Sciences, September 2023, 25 pages

Degree Programme in Nursing. Bachelor's thesis.

Permission for open access publication: Yes

Language of publication: English

Abstract

Background: Sepsis is a life-threatening condition caused by the response of the infected body towards the infection. Sepsis has been a serious problem which causes 30 million death per year globally, severe complications with post-sepsis syndrome such as organ damages, loss of limbs, increase of costs. Nurses have significant roles in sepsis management.

Objectives: Thus, the aim of this literature review is to summarize factors related to nurses that would affect the management of sepsis, and the purpose is to create an evidence base review supporting nurses in sepsis control.

Method: From database CINAHL Ultimate and PubMed, a literature review was conducted.

Results: There are direct and indirect nursing factors influencing control of sepsis/infection. In this study, direct nursing factors are nursing interventions such as hand hygiene, assessments, and response of nurses against sepsis/infection. Indirect factors are knowledge of nurses including nursing education and experience.

Conclusions: There are diverse nursing factors that would affect the management of sepsis. Although nurses' importance in controlling sepsis was acknowledged and many actions were taken, there is still more room for improvement.

Keywords: Nursing factors, sepsis management/sepsis control, nursing intervention, nursing knowledge

Miscellaneous (Confidential information)

None

Contents

Figure

Tables

1 Introduction

In a fact sheet published in 2020, WHO defined sepsis as a life-threatening dysfunctional organ, which is caused by a dysregulating of the host response to the infection. If it cannot be recognized or found out at the early stage and be managed on time, it may lead to diversity of life-threatening situations, such as: septic shock, failure of multiple organs or worse is death. Moreover, sepsis causes the serious infection's complication, which particularly represents a crucial factor causing maternal and neonatal morbidity and death rate in low- and middle-income countries. Furthermore, during care delivery, sepsis is present of the clinical deterioration of infections and is the result of health care setting's infections. Antimicrobial resistance is a major cause in clinical unresponsiveness to the treatment and rapid progression to sepsis and sepsis shock. Patients who carry sepsis-resistant pathogen have been found to have a greater risk of mortality in the hospital. In 2017, it was estimated by a scientific publication that there were over 48 million cases and 11 million sepsis-related-to deaths globally, which accounted for almost 20% of deaths all around the world (WHO, 2020).

A study conducted in Massachusetts hospitals stated that in United States, in every 20 seconds there will be one person who is diagnosed with sepsis, in which obviously is an increase in sepsis cases. In fact, 30 million people who have died because of sepsis globally per year, meanwhile death rate of sepsis in U.S is about 270 000 deaths, which is the major cause of death in U.S hospitals. It is undeniable that sepsis's survival rate is really poor (at only 30%). For those who survive, the sepsis's lingering effects are often devastating, an estimated 50% of survivors who have suffered from serious complications consistent with post-sepsis syndrome, including the damage of organs, loss of limb and limbs (Flanagan et al., 2020).

According to Karlsson et al., in Finland, sepsis in severe case and sepsis shock is always challenging in the intensive care unit because it is commonly happened, is high cost for treatment and significant mortality rate which is from 30% to 50% in different studies. According to international estimates of incidence, it is estimated that there are 3500 patients to 15000 patients per year in Finland who has had severe sepsis. The target of international surviving sepsis campaign (SSC) is to apply the treatment recommendation for use in many different countries and also to make the mortality rate go down by 25% in the next 5 years in severe sepsis cases (Karlsson et al., 2007).

Based on Duodecim (2014), it is showed, however, that the severe sepsis rate in Finland was 0,38/1000/year in 2004 and 2005. In 2012, the incidence of severe sepsis increased to 0,6/1000/year, which means the mortality rate of severe sepsis and sepsis shock is still high (24,1%, presented by FINNAKI in 2012) despite the improved prognosis. Although the hospital mortality in 2005 was 28,3% by FINNSEPSIS, the rate was decreased to 24,1% in 2012 by FINNAKI. In other words, the hospital treatment for severe sepsis had been improved in order to reduce the rate of mortality in the hospital setting. Although mortality rate of sepsis was still high, there is no recent statistic that mentions about sepsis rate in Finland over the past decade.

The aim of this literature review is to synthesize nursing factors that would affect management of sepsis. The purpose is to create an evidence-based review supporting nurses in sepsis control.

2 Sepsis – Medical problem

2.1 Causes of sepsis

NICE reported that it is mentioned that the fluid from the bowel that contains bacteria spilled inside of abdominal area which can multiply and be present even though it has been washed with sterile fluid during the surgery, leading to severe infection and later causing sepsis. Another cause is that the body itself produces warm fluid following the surgery which may be the ideal environment for the bacteria so that they can grow and spread through the body. Other infections which are not related to the recent surgery may be developed as well. Because of a long period of being ill before the surgery, the general health status can be affected, resulting in having poor recovery after the surgery, for instance, poor healing in post-operative phase which may lead to vulnerable infection. For those who need immediate surgery while the bacteria are already present inside of the body, which might be a possible cause of having infection after the surgery if they become ill again. For those who must be monitored and accessed via tubes, they might increase the risk of getting infection if they break the skin even though they are inserted in sterile technique. The immune system plays an important role for those who have an impaired immune system, which means they are at higher risk of getting sepsis compared to others when they have surgery (NICE, 2016).

2.2 Symptoms and signs of sepsis

Sepsis-identification criteria are applied to identify patients with sepsis when there is an abnormality in vital signs, which include primary vital signs, such as: temperature, heart rate and blood pressure. In addition, clinical criteria considered also the systolic value, GCS (glasgow coma scale), oxygen saturation, blood glucose level, lactate in-hospital, or abnormal in white blood cell counting (Lane et al., 2016).

According to Romero et al. (2017), sepsis guidelines were introduced across the New South Wales department in order to reduce the rate of sepsis mortality and morbidity in the hospital by recognizing, assessing and managing sepsis-presenting in patients. The patients must have the risk factor and additionally have at least two signs of yellow zone criteria or one sign in the red zone criteria:

NICE (2017) stated that risk factors are depended on age (under 1 year-old, over 75 years-old or frail people); trauma, small or invasive surgery (recently in 6 weeks); impaired immune system; having indwelling lines, inserting catheter, receiving intravenous drugs; and having any problem with skin integrity. Other risk factors include any signs of infection; immunocompromise; history of fever or rigors.

Following the mentioned statement of Romero et al., yellow zone criteria is described that respiratory rate is less than 10 breaths or greater than 25 breaths per minute, oxygen saturation is lower than 95%, systolic blood pressure is lower than 100 mmHg, pulse is lower than 50 beats or higher than 120 beats per minute, temperature is less than 35,5 C or greater than 38,5 C, altered level of consciousness or change in recognition status. Red zone criteria is included that systolic blood pressure is less than 90 mmHg, lactate is greater than 4 mmol/L, base excess is lower than –5.0, immunocompromised, age is over 65 years old (Romero et al., 2017).

2.3 Pathophysiology of sepsis

A study reported that sepsis-causing bacteria first enters the host tissues and if the tissue is injured and there is bleeding, infection will confront the blood clot and complement as the host's first line of defense. Then, macrophages are activated by the microbial products, and will acquire

anti-microbial competence which is leading to the effectiveness of immunity. Sepsis-causing bacteria, however, have been evolving mechanisms that inhibit the macrophages and response of host immune system. When the bacteria penetrate the barrier of tissues, they enter the bloodstream and move with the blood flow and become charged electrically. Triboelectrically charged bacteria interact with any electric nearby which is strong enough. The charged erythrocyte membrane which has very strong electric charge, will attract and attack immediately nearby the floating bacteria. Microbial proteases and pathogen-associated molecular patterns will irritate the erythrocyte membrane and provoke the releasing of reactive oxygen species transferred to the surface of erythrocyte by hemoglobin. The bacteria are sensitive to oxidation and being killed by the oxidation on the surface of erythrocyte. The bacteria causing sepsis has been evolving multiple antioxidative mechanisms that help them survive in the blood. These mechanisms are strongly effective and even supplemental saturation of arterial blood with hyperbaric oxygen does not help to kill sepsis-causing bacteria in the bloodstream (Minasyan, 2019).

2.4 Complications of sepsis

Sepsis impairs the wound healing process after the surgery, causing oxygen hypoperfusion in the cells while the metabolic phase is increased and thus leading to organ dysfunction progression. Moreover, hypoxia also decreases the function of leukocyte in order to kill bacteria, angiogenesis, synthesis of collagen which prolongs the process of healing. Therefore, it is important to maintain the blood flow (which is rich in oxygen) to the vital organs such as viscera, skeletal muscle and skin tissue (Efron et al., 2001).

Severe sepsis is contained sepsis and dysfunction of organs. The patients who are developing sepsis shock may experience severe sepsis symptoms such as altered mental condition, oliguria or anuria, hypoxia, cyanosis and ileus accompanied by hypotension. The early “compensated” stage of sepsis shock is known as warm shock when the blood pressure level is maintained and others distributive signs to shock might be present such as warm extremities, fast refilling the capillary in less than a second and bounding pulses. If the sepsis shock progresses into the uncompensated stage while hypotension still ensures, this is known as cold shock in which the patient might present cool extremities, delaying in refilling capillary in more than three seconds and a thready heart rate. Thereafter, continuing tissue’s hypoperfusion may ensue shock irreversibly and progress greatly into multiple organ dysfunction syndrome. Sepsis shock is the most complication of sepsis

caused mortality (Sidharth & Alan, 2023). Moreover, it is described that sepsis shock may cause multiple system and organ injuries such as injury of central nervous system, respiration, heart, kidney, liver, and blood (Lu et al., 2022).

2.5 Sepsis management

Survival rate from sepsis has been improving for over 40 years. The most focus is to use the antimicrobial therapy to treat sepsis and how to manage sepsis immediately. For those who are critically ill because of sepsis, should receive resuscitation when needed and given adequate oxygen in order to maintain the saturation level above 95%. Giving saline intravenously is considered as standard for all patients. 500mL of saline should be administered for over 15 minutes for patients with low blood pressure. Despite receiving enough fluid resuscitation, patients with persistent hypotension are hospitalized and administered vasopressor therapy. Antimicrobial therapy should be applied within an hour of hospitalization as quickly as possible. Blood culture should be taken before an antibiotic is administered because it is important to find out the sensitivity of antibiotic of cultural pathogens and thus it is beneficial in making further treatment in the future. Fluid balance is crucial and needs to be accurate. The urine output will be recorded as well as the fluid will be administered. The blood sugar level should be controlled, and insulin should be administered intravenously in order to keep the blood glucose under 10mM for hyperglycaemia. Moreover, identification and management of the source causing sepsis is also crucial as well as the change in physiological parameters by doing full examination (Evans, 2018).

2.6 Roles of nurses in taking care of hospitalized patients

Nurses have a significant role in the care of surgical patients. They work independently and their competences heavily impact the outcomes of patients undergoing surgical procedures (Nestler, 2019). In postoperative care, patients need to be monitored, according to WHO Postoperatve care, the process of monitoring should include medical and wound care, nursing observations, controlling complications, any changes in treatment should be paid attention. Nurses participate throughout the postoperative care besides observations to provide holistic care to the patient. Nurses play a significant role in wound care, preventing surgery site infection (SSI) (Gairhe, 2022). Nurses perform pain management by observing signs, symptoms (sweating, anxiety, high heart

beat, etc) and applying measuring tools such as NRS, VAS, VDS to assess the pain; providing pharmacological, non-pharmacological interventions (Gedara et al., 2015) To shorten the hospitalized time of patients, enhanced recovery after surgery (ERAS) protocols are now used in many units with nurses as central carriers (Nelson, 2022).

Nurses not only play an important role in post operative care, but also have an essential role in patient care during the hospitalized period, presented in responding timely to the patient and patient's family requests or needs (within five minutes), following patient's emotional and physical support, and supervising fully about delegated tasks. Nurses also educate patients and their family for discharge, assist patient's necessary traveling and have conversations with team workers. The least activities performed by nurses were administration of enteral or parenteral nutrition, and medication administration (Zeleníková et al., 2023).

3 Study aims, purposes, and research question

The aim of this study is summarizing nursing factors that would affect the management of sepsis.

The purpose of this study is to create an evidence-based review supporting nurses in sepsis control.

The research question of this study is what are nursing factors affecting sepsis control?

4 Methodology

4.1 Literature review

Aveyard (2023) described a literature review as a process of finding, evaluating, and analyzing other literature to answer a research question. By reviewing different relevant research, new findings could be found. Literature review is an approachable research method and well, commonly employed among nursing students. The method is considered "shortcuts in the evidence-based process" using available literatures that share the same topic to answer other research questions. (Bettany-Saltikov, 2012, p.11).

Table 1. Steps in a systematic literature review (Bettany-Saltikov, 2012, p.34)
1. Develop review a question 2. Write background of the review 3. Write objectives 4. Specify criteria 5. Conduct search strategy 6. Select, appraise, and extract the relevant information from found research papers to answer the research question

After the research question had been created, based on it, the aim and purpose of this literature review were developed and fundamental knowledge of sepsis, especially at post operative stage, was briefly introduced in the background part. The authors of this review then established search terms based on the research question. Following this, search terms were applied to seek relevant literature from accessible sources with filters as criteria. Papers which are used in this review were found from CINAHL Ultimate and PubMed with the right of access provided by JAMK (Jyvaskyla University of Applied Sciences). Results of the search were assessed. Finally, data answering the research question was extracted from selected, evaluated papers.

4.2 Literature search

The original research question of this literature review was “What are nursing interventions to prevent sepsis in post-operative care?”. Search terms were “post operative or post-operative or postoperative or post-surgery” AND “nursing interventions or nursing care or nursing support or nurse’s role or nursing or nurse” AND “sepsis or septic or severe sepsis or septic shock”. Criteria for the search included factors of language, time, accessibility, and research papers. In other words, books, protocols, guidelines, and other published works besides research would be excluded. Based on the advanced search system of each database, the criteria introduced were implemented. On CINAHL Ultimate, limiters including full text, English language, research article were applied; expanders were applied equivalent subjects with Boolean/Phrase as search modes, time was limited within 10 years. On PubMed, filters utilized were free full text, clinical trial, meta-analysis, randomized controlled trial, review, systematic review within 10 years of time, and English language. From CINAHL Ultimate, there were a total of 12 results returned from the search

and from PubMed, 9 results were returned. Both authors read 21 papers separately then evaluated abstract of these papers together and reduced the number of most relevant literatures down to 9 and then to 6. After reading deeply into the results of 6 chosen papers, there were not enough findings that answer the research question (Figure 1). Thus, the authors decided to widen the research question into “What are nursing factors affecting sepsis control?”.

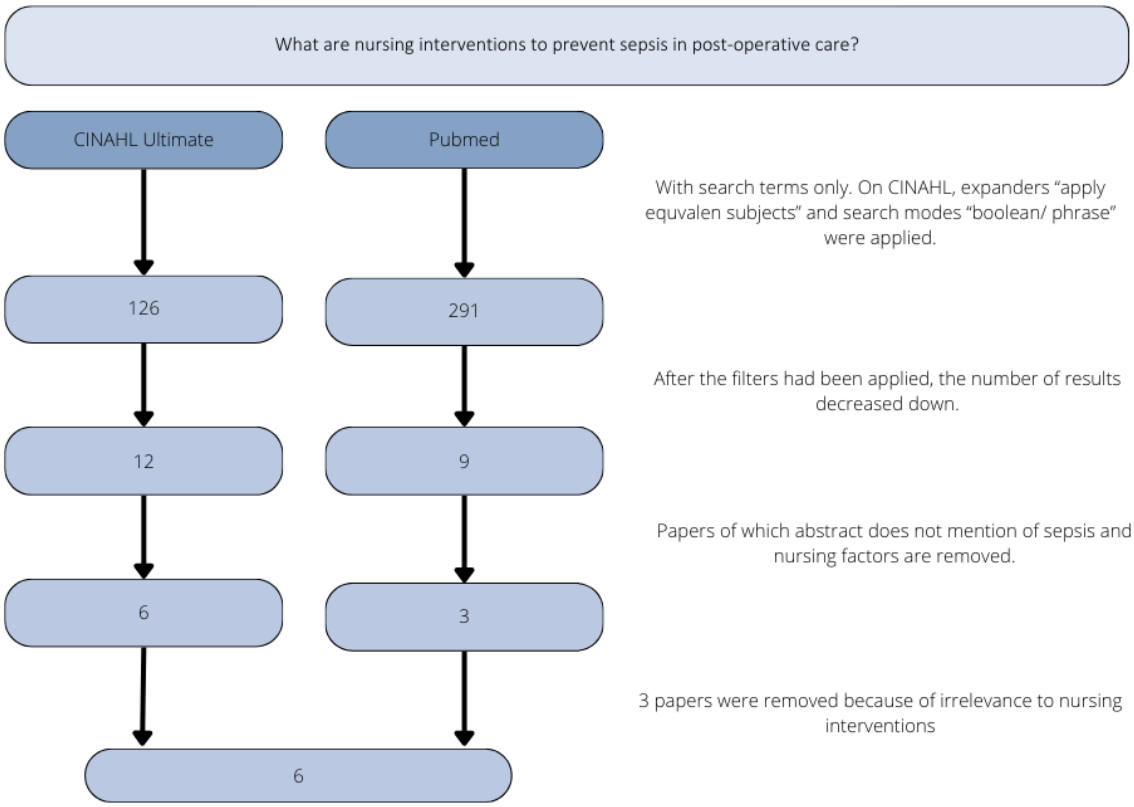

Figure 1: The original research question and the first literature search

Search terms “nursing factors or nursing interventions or nursing care” AND “influence or im-pact or effect or affect” AND “sepsis rate” were made and employed. On CINAHL Ultimate, limiters, expanders, and search modes remained the same. On PubMed, the original filters were used at first, but then the filter “books and documents” was added. However, there were no changes in the number of results returned by PubMed. The total number of literatures given by CINAHL Ultimate was 4 and by PubMed was 32 (Figure 2). The process that was reported earlier was implemented.

In this present literature search, blood stream infections and all factors that impact the management of sepsis including prevention, recognition, response, treatment, were also taken into consideration.

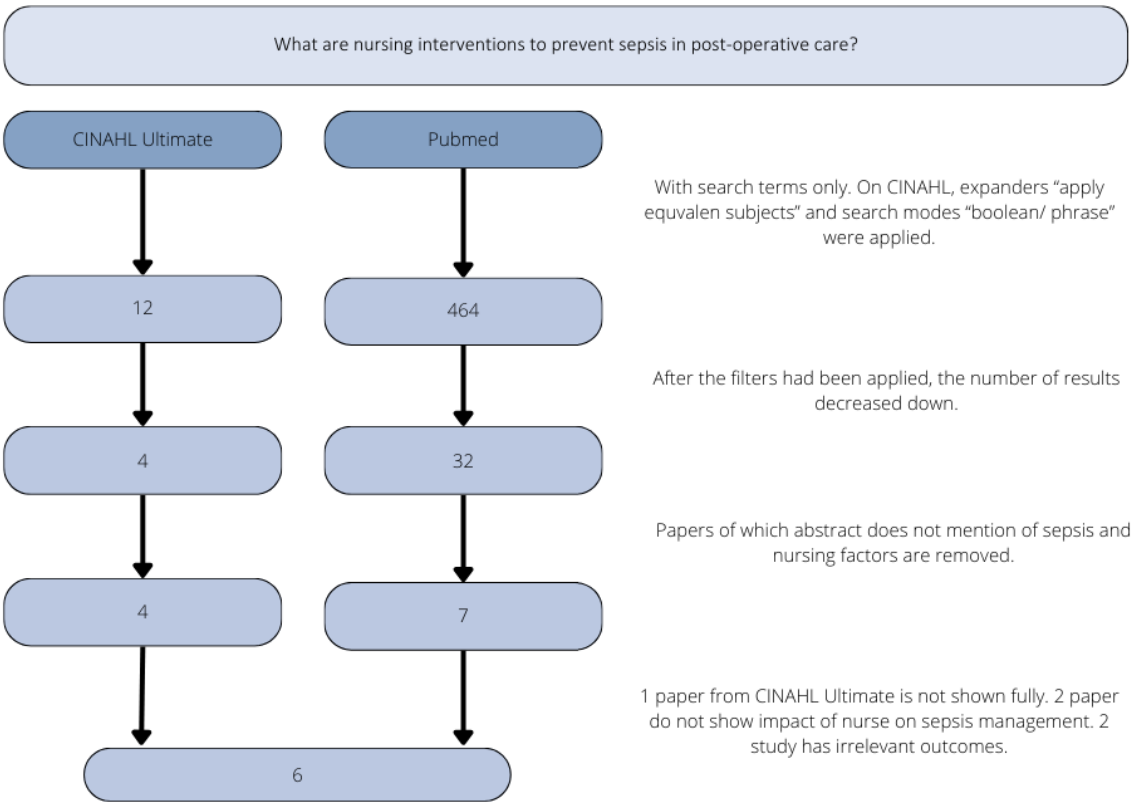

Figure 2: The widened research question and the second literature search

4.3 Data extraction and analysis

Averill (2014) recommended that the analysis process starts with organizing and managing data, then information is read throughout and coded. After that, sequential coding should be done to synthesize and integrate previous codes then presented as complementary information. The information should be analyzed thematically and interpreted (Averill & Chesnay, 2015). A similar structure was explained in a book of nursing research process, which includes using constant comparative method to find analogous points/ findings, coding, reducing codes and developing categories, finding the main category, and finally discovering or building the theory based on discovered findings (Holloway & Wheeler, 2010). Following the theories above, authors of this review searched

and selected needed literature in compliance with the process of literature search explained earlier, then findings of selected papers were put onto a table. Writers of this review read through information together, highlighted, and coded relevant points that answered the research question (Figure 3). Then the codes formed in the previous step were reduced and divided into subcategories and subcategories were integrated into main categories as presented in Table 2.

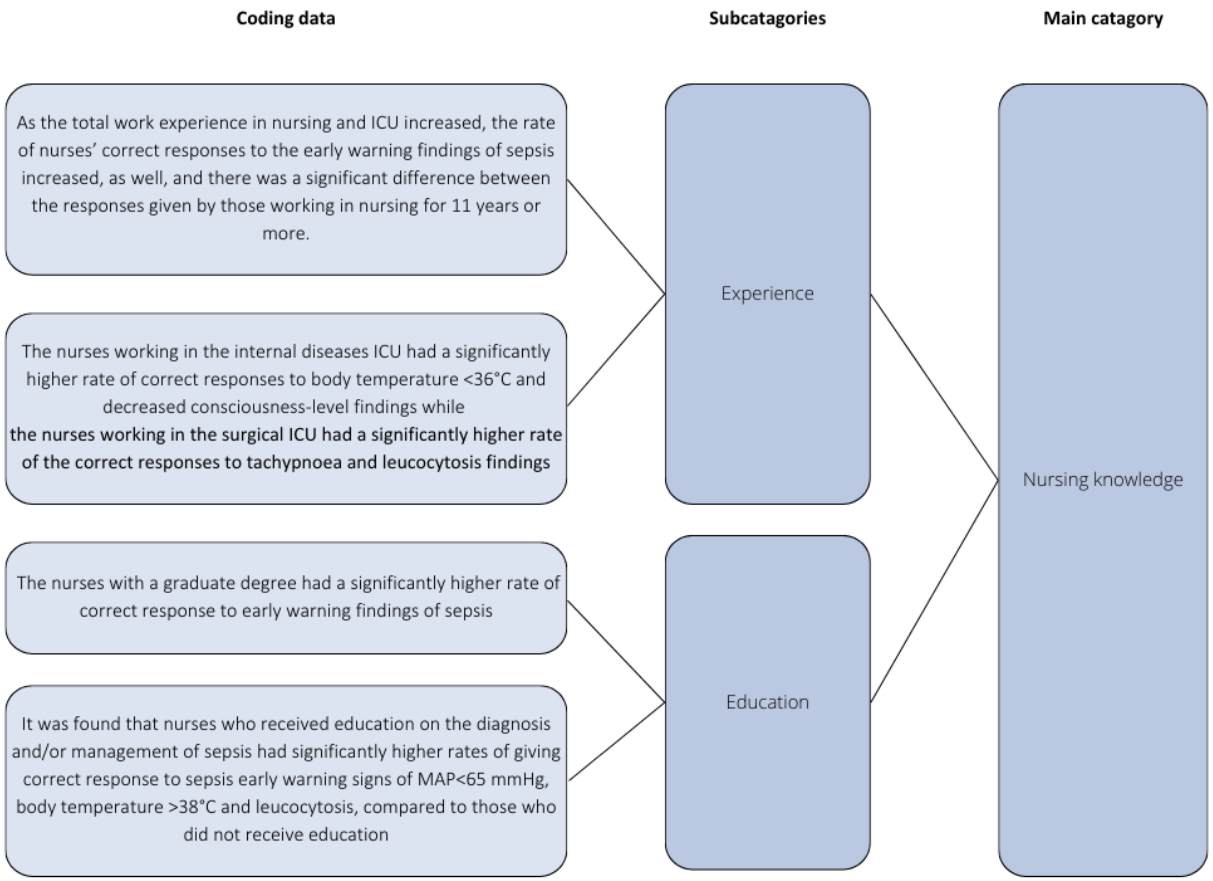

Figure 3: Process of data analysis

5 Results

Table 2. Summary of main categories and subcategories identified from the appraised articles		
Research question	**Subcategories**	**Main categories**
What are nursing factors affecting sepsis control?	Preventing sepsis Sepsis recognition Response to sepsis	Nursing interventions
	Education Experience	Nursing knowledge

5.1 Nursing interventions

Preventing sepsis

A study of an educational intervention on hand hygiene compliance and infection rate conducted in an intensive care unit showed remarkable influence of hand hygiene on infection's management. Compliance of health-care workers to five indications of hand hygiene was described as hand washing before entering to the neonatal intensive care unit (NICU), before contacting with the patient, in between contacting with the patient, leaving the patient and after removing the gloves. The compliance was significantly improved by increasing from 45% in the first phase to 74% in the third phase. However, the compliance of hand hygiene after removing the gloves did not improve compared to all other indications of hand hygiene. In general, compliance of health-care workers for all kinds of hand hygiene opportunities was significantly improved from 46% before the intervention into 69% after the intervention. Furthermore, the infection rate was decreased significantly from 96 per 1000 patient-days before the intervention to only 47 per 1000 patient-days after the intervention (Chhapola & Brar, 2015). Another study evaluating effectiveness of antimicrobial dressings and securement devices in reducing catheter-related bloodstream infections (CRBSI) indicated that different wound dressings have different effects on CRBSI rate per 1000 catheter-days. According to this paper, transparent dressing showed best result of reduc-

ing CRBSI among types of dressing included in this study with probability of reduction of incidences of CRBSI (SUCRA=92.5%) while biguanide disc dressing had lowest probability (SUCRA=7.3%). It is also stated in the paper that the transparent dressing can also be beneficial when applying on arterial catheters (Dang, Li & Tian, 2019).

Sepsis recognition

Sepsis can be recognized by nurses with support from measurements and tools. Oh and his colleagues (2016) conducted a study of temporal changes in systemic inflammatory response syndrome (SIRS) criteria scores measuring vital signs relating to this syndrome (temperature, hear rate, respiratory rate, and blood pressure). The study indicated that SIRS criteria are more useful for identifying SIRS patients in the early stage which has shown a significant increase in SIRS criteria score in the case group compared to the control group. Additionally, the proportion of aged patients, diabetes mellitus, hypertensive and wound patients had significantly higher SIRS criteria scores in the case group compared to the control group. Another study mentioned of nurses' role in sepsis recognition said that for the early warning of sepsis assessment, nurses who received education on the sepsis's diagnose and/or sepsis's management had used sepsis-related organ failure assessment score (SOFA) and quick sepsis-related organ failure assessment score (q-SOFA); blood find; vital signs and blood findings; or blood culture results as a screening toll in order to diagnose sepsis (Öztürk, Karabag & Köroğlu, 2022).

Response to sepsis

Nurses play an essential role in control of sepsis, which includes response to sepsis. According to Oh and his colleagues (2016), the direct-goal therapy for treating sepsis or SIRS is including maintaining the central venous pressure at the level of 8 to 12 mmHg and the mean arterial blood pressure at 65 mmHg or above by administering fluids intravenously; monitoring continuously heart rate, respiration rate, urine output, central venous saturation and arterial oxygen saturation; administering dobutamine hydrochloride in case central venous oxygen saturation (ScvO2) is dropping below 70% in order to maintain the heart function; administering spectrum antibiotics; and monitoring the level of serum lactate. According to Drewry and his colleagues (2017), antipyretic

therapy was applied by using different terms of antipyretic interventions, such as: NSAIDs, acetaminophen and physical cooling; and the antipyretic treatment's duration, in which showed that antipyretic interventions has impacted on fever control which could affect patient's outcome potentially. Although antipyretic therapy has an impact on decreasing the body temperature, heart rate and minute ventilation, it does not have any effect on improving mortality in the subgroup of septic shock patients. In other words, antipyretic could be used to control the fever in sepsis patients. In the intensive care unit (ICU), it is recommended to apply pulse-induced contour cardiac out-put (PiCCO) technology in order to monitor the hemodynamic condition of those who have septic shock. PiCCO technology is applied by inserting a catheter into the large arterial (femoral, brachial or axillary) and via central vein. This technique continuously monitors cardiac output, intrathoracic blood volume index (ITBVI), the end-diastolic volume, extravascular lung water index (EVLWI) and left systolic index in order to reflect the changes in cardiac preload as well as the function of systolic and diastolic and better predict the response of the patient to the fluid resuscitation, fluid management and clinical application. Thus, the mortality rate in the group of PICCO was significantly lower compared to the control group. Moreover, the PICCO monitoring was connected to a shorter duration of invasive mechanical ventilation, staying duration in the ICU and hospital and ventilator time in comparing with the control group. Besides that, the acute physiology, chronic health condition and the post-operative complication phase of incidence rate had lower effect on the PICCO group than the control group, which means using PICCO monitoring as post-treatment improve the patient's prognosis and promote the rehabilitation. (Lu et al. 2022).

5.2 Nursing knowledge

Influence of nurses' education and experience showed from different aspects in the study of Öztürk, Karabag & Köroğlu (2022). In this study, it is shown that nurses who graduated had a higher rate of correct response to early warning findings of sepsis. Nurses of internal diseases ICU had higher rate of correct response to body temperature below 36 Celsius degrees and symptoms related to level of consciousness while nurses from surgical ICU had higher rate of correct response to body tachypnoea and leucocytosis findings. It was indicated by 11 years-experienced nurses that early sepsis warning signs are easier to get recognized using measurement tool for the diagnosis of sepsis (Öztürk, Karabag & Köroğlu, 2022). Through the study of Chhapola & Brar (2015) mentioned earlier, after the educational intervention was done, the compliance of hand hygiene was increase leading to decline of infection rate (Chhapola & Brar, 2015).

6 Discussion

6.1 Discussion of results

There was a limitation in selecting articles answering directly to nursing intervention in sepsis management. By contrast, after correcting the key words and advanced search, it was found that there were a variety of assessment tools which support nurses in recognition of sepsis and sepsis management, such as systemic inflammatory response syndrome (SIRS) criteria scores for screening sepsis in order to recognize sepsis early and apply intervention quickly (Oh et al., 2016), sepsis-related organ failure assessment score (SOFA) and quick sepsis-related organ failure as-assessment score (q-SOFA) for managing reliably and effectively as well as applying infection prevention and control measures to prevent sepsis (Öztürk et al., 2022) and pulse-induced contour cardiac out-put (PiCCO) technology to improve the nursing outcomes, prognosis and patient's survival rate (Lu et al. 2022).

The most frequently used tools for identifying the early signs of sepsis were SOFA, q-SOFA, vital signs, blood finding and blood culture which is considered as a gold standard for diagnosing sepsis. SOFA is used to estimate the hospital mortality rate in the ICU which is assessing the six-organ system dysfunction's severity for critical patients and the score was calculated during the ICU administration and every 48 hours in the future and an increase in the baseline of at least 2 points from the SOFA score indicating organ dysfunction acutely with the possibility of having sepsis diagnosis. Also, SOFA criteria shows that the blood lactate level is a crucial biomarker for assessing sepsis (lactate is higher than 2 mmol/L) because the lactate level is increased when there is a tissue hypoperfusion which is normally observed in sepsis patients. Hence, it is important to monitor the lactate level in the identification of sepsis and in sepsis treatment's response. Other biomarkers used to identify sepsis were C-reactive protein level (CRP) and procalcitonin level (PCT). Because of the late onset of infection, it is recommended to monitor CRP and PCT in order to observe the response to the treatment and consider the discontinuation of administrating antibiotic. If sepsis is identified and the start of fluid resuscitation has begun within 30 minutes after medical diagnosis, it helps to decrease the mortality rate. In addition, nurses should be aware of patients those are at risk of having sepsis, follow up the infected signs, monitor the organ dysfunction and observe the biomarkers (Öztürk et al., 2022). By Oh and his colleagues (2016), systemic inflammatory response syndrome (SIRS) criteria scores were used in order to identify sepsis in the three-day period which

includes: maintaining the pressure of central venous at 8-12 mmHg and of arterial blood pressure at or above 65 mmHg by adjusting the fluid given intravenously responding to heart rate, respiration rate, urine output, central venous and arterial oxygen saturation level; early administrating antibiotic; applying steroid therapy; controlling the blood sugar level; providing protective ventilation for the lung; and monitoring the C-active protein treatment. To boost the sepsis monitoring, PICCO monitoring was suggested by Lu and his colleagues (2022) which is known as an alternative tool for observing the cardiac output and reflected the full changes in the hemodynamic parameters along with systolic and dystolic function, leading to the benefit of fluid resuscitation, fluid management as well as clinical application. Additionally, PICCO monitoring group had a significantly greater level of hemodynamic parameters compared to the control group at six hours after the intervention was implemented (Lu et al. 2022).

There are areas for further completement and development in education of sepsis management to health care professionals in general, and to nurses in specific. Efforts had been made to improve knowledge and ability of health care professionals against sepsis with support from organizations and practices (Walters, 2018). But it seems that there is insufficiency in education of sepsis management towards health care professional. A study conducted in Lausanne University Hospital (Switzerland) during 2020 with 1116 participants (Regina et al., 2023) showed that there were “a deficit of sepsis awareness and knowledge reflecting a lack of sepsis-specific continuing education requiring immediate corrective measures.” The study also reported about lack of specific continuing education of sepsis, “Only 18.5% of participants reported having attended sepsis-specific training in the previous three years”. The matter of fact is that the study was done recently in a university hospital of a developed country. It is also shown from findings of this literature review that nurses with different work environment and time experience have different knowledge and response against sepsis. Considering nurses’ importance in management of sepsis, a study showed that (Torsvik et al., 2016) with nursing interventions, there is higher rate of positive outcome, rates of compliance and knowledge discussed above are truly concerning.

6.2 Ethical considerations, validity and reliability, strengths and limitations

The internal validity of research is referred to no errors of methodology in the research (Patino & Ferreira, 2018). This literature review was done by following recommended theories as detailly ex-

plained in the part of methodology. Despite of difficulties happened during the process of conducting this literature review, which led to a decision of changing the topic and redoing, reconsidering each steps done earlier, authors had been discussing between each other and with supervisor to maintain the objectivity and validity of this research. Authors had been open and honest while presenting the procedure of data collection, analysis, and results. The quality of the selected papers was also evaluated according to an appraisal tool developed by Hawker et al. (2002). The appraisal tool assesses nine factors of a paper, which are abstract and title, introduction and aims, method and data, sampling, data analysis, ethics and bias, results, transferability or generalizability. Each factor would be scored from 1 to 4 with 1 as very poor, 2 as poor, 3 as fair, and 4 as good. Authors implement the tool together and results of the evaluation are presented in table x. All literature used in this review was scored at least 29 points.

While assessing the chosen articles, ethical appraisal was taken into account by utilizing Hawker tool as a quality appraisal tool which included evaluating the ethical consideration in each article (Hawker et al, 2002). Moreover, the primary prerequisite for Finnish scientific writing is the responsible conducting of research (RCR) that is complying with RCR criteria. One of the most critical aspects of study that fulfills ethical perspectives and evaluations related to science and research is ethics. Honesty and integrity in research are crucial factors that should be prioritized. Thus, to maintain the values of honesty and integrity while doing further study, it was essential to continue and advance in a responsible manner. According to Finnish Advisory Board on Research Integrity (2023) the thesis's research integrity can be achieved through precise execution and careful assessment, ethical and scientific methods, reporting and analysis in accordance with scientific understanding, scientific planning, scientific respecting and properly citing other researchers. Besides that, to make sure the authors are adhering to JAMK thesis reporting criteria, the thesis supervisor evaluated and consulted this work regularly. In addition, our study will be sent to Turnitin, which is known as detective software for academic writing, to detect the possibility of plagiarism. Also, writers got the ideas of avoiding plagiarism and citating properly to show respect to other author's effort (Masic, 2014).

The process of selecting articles, the search results might be affected because all the chosen articles were presented in English which is not writer's mother language leaded to affect the reliability

of the study. The study's validity was continuously ensured in the process of inclusion and exclusion of selecting articles that included peer-reviewed articles publishing from 2013 to 2023. From a different point of view, there could be quality studies that had been excluded due to criteria of time and language. In addition, sources of information are limited to accessible databases provided by JAMK.

6.3 Conclusion and recommendations

There are diverse nursing factors that would affect the management of sepsis. Although nurses' importance in controlling sepsis was acknowledged and many actions were taken, there is still more possibility and expectations for improvement. This literature review leads to recommendation of studying specific nursing interventions against sepsis in different settings and stages. Additionally, methods of education should also be taken into consideration to ensure the sufficiency of educational interventions.

References

Chesnay, D. M., & Averill, J. (2015). Qualitative Data Analysis. In *Nursing research using data analysis* (pp. 3–8). essay, Springer Publishing Company, LLC.

Chhapola, V., & Brar, R. (2014). Impact of an educational intervention on hand hygiene compliance and infection rate in a developing country Neonatal Intensive Care Unit. *International Journal of Nursing Practice*, *21*(5), 486–492. https://doi.org/10.1111/ijn.12283

Dang, F.-P., Li, H.-J., & Tian, J.-H. (2019). Comparative efficacy of 13 antimicrobial dressings and different securement devices in reducing catheter-related bloodstream infections. *Medicine*, *98*(14). https://doi.org/10.1097/md.0000000000014940

Drewry, A. M., Ablordeppey, E. A., Murray, E. T., Stoll, C. R., Izadi, S. R., Dalton, C. M., Hardi, A. C., Fowler, S. A., Fuller, B. M., & Colditz, G. A. (2017). Antipyretic therapy in critically ill septic patients: A systematic review and meta-analysis. *Critical Care Medicine*, *45*(5), 806–813. https://doi.org/10.1097/ccm.0000000000002285

Efron, D., & Barbul, A. (2001). Wounds in infection and sepsis - role of growth factors and mediators. In H. Rene & M. John (Eds.), *Surgical treatment - evidence-based and problem-oriented*. essay, W Zuckschwerdt Verlag.

Evans, T. (2018). Diagnosis and management of sepsis. *Clinical Medicine*, *18*(2), 146–149. https://doi.org/10.7861/clinmedicine.18-2-146

FINNISH NATIONAL BOARD ON RESEARCH INTEGRITY TENK. (2023, March). *Responsible conduct of research and procedures for handling allegations of misconduct in Finland*. Finnish National Board on Research Integrity TENK. https://tenk.fi/en/advice-and-materials/RCR-Guidelines-2012

Flanagan, J. M., Read, C., & Shindul-Rothschild, J. (2020). Factors associated with the rate of sepsis after surgery. *Critical Care Nurse*, *40*(5). https://doi.org/10.4037/ccn2020171

Gairhe, S. (2022, September). (thesis). *NURSE'S ROLES IN WOUND CARE AND INFECTION CONTROL Surgical Wound Infection in Elderly*. Theseus. Retrieved 2023, from https://www.theseus.fi/bitstream/handle/10024/781192/Gairhe_Sarita.pdf?sequence=2.

Gedara, G. P. S., Kauppinen, R.-M., & Louarn, S. L. (2015, November). (thesis). *Post-operative pain management methods and nursing role in the relief of pain of total knee replacement patients*. Theseus. Retrieved 2023, from https://www.theseus.fi/bitstream/handle/10024/104715/THESIS%2027.11.docx%20modified.pdf?sequence=1&isAllowed=y.

Hawker, S., Payne, S., Kerr, C., Hardey, M., & Powell, J. (2002). Appraising the evidence: Reviewing disparate data systematically. *Qualitative Health Research*, *12*(9), 1284–1299. https://doi.org/10.1177/1049732302238251

Holloway, I., & Wheeler, S. (2010). Part Four: Data Analysis and Completion. In *Qualitative research in nursing and Healthcare* (3rd Edition, pp. 281–282). essay, Wiley-Blackwell.

Karlsson, S., Varpula, M., Ruokonen, E., Pettilä, V., Parviainen, I., Ala-Kokko, T. I., Kolho, E., & Rintala, E. M. (2007). Incidence, treatment, and outcome of severe sepsis in ICU-treated adults in Finland: The finnsepsis study. *Intensive Care Medicine*, *33*(3), 435–443. https://doi.org/10.1007/s00134-006-0504-z

Lane, D., Ichelson, R. I., Drennan, I. R., & Scales, D. C. (2016). Prehospital management and identification of sepsis by Emergency Medical Services: A systematic review. *Emergency Medicine Journal*, *33*(6), 408–413. https://doi.org/10.1136/emermed-2015-205261

Lu, X., Zhai, H., Dong, Y., Su, F., Xie, Y., Wang, Y., Wang, L., Li, J., & Xu, P. (2022). Therapeutic effect and prognosis of Picco in the treatment of myocardial injury complicated with Septic Shock. *Computational and Mathematical Methods in Medicine*, *2022*, 1–7. https://doi.org/10.1155/2022/2910849

Masic, I. (2014). Plagiarism in scientific research and publications and how to prevent it. *Materia Socio Medica*, *26*(2), 141. https://doi.org/10.5455/msm.2014.26.141-146

Minasyan, H. (2019). Sepsis: Mechanisms of bacterial injury to the patient. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *27*(1). https://doi.org/10.1186/s13049-019-0596-4

Nelson, G. (2022). Nursing role central to successful implementation of enhanced recovery after surgery. *Asia-Pacific Journal of Oncology Nursing*, *9*(7), 100112. https://doi.org/10.1016/j.apjon.2022.100112

Nestler, N. (2019). Nursing care and outcome in surgical patients – why do we have to care? *Innovative Surgical Sciences*, *4*(4), 139–143. https://doi.org/10.1515/iss-2019-0010

NICE. (2016, July 13). *Sepsis: Recognition, diagnosis and early management: Guidance*. NICE. https://www.nice.org.uk/guidance/NG51/chapter/Recommendations#risk-factors-for-sepsis

NICE. (2017, September 13). *Overview: Sepsis: Recognition, diagnosis and early management: Guidance*. https://www.nice.org.uk/guidance/ng51

Oh, H., Bae, E., Lim, S., Oh, J., Han, S., & Seo, W. (2016). Temporal changes in physiological parameters of systemic inflammatory response syndrome during the three days prior to a diagnosis of sepsis: A case–control study. *Journal of Clinical Nursing*, *25*(21–22), 3176–3188. https://doi.org/10.1111/jocn.13327

Patino, C. M., & Ferreira, J. C. (2018). Internal and external validity: Can you apply research study results to your patients? *Jornal Brasileiro de Pneumologia*, *44*(3), 183–183. https://doi.org/10.1590/s1806-37562018000000164

Ray-Barruel, G., Xu, H., Marsh, N., Cooke, M., & Rickard, C. M. (2019). Effectiveness of insertion and maintenance bundles in preventing peripheral intravenous catheter-related complications and bloodstream infection in hospital patients: A systematic review. *Infection, Disease & Health*, *24*(3), 152–168. https://doi.org/10.1016/j.idh.2019.03.001

Regina, J., Le Pogam, M.-A., Niemi, T., Akrour, R., Pepe, S., Lehn, I., Wasserfallen, J.-B., Calandra, T., & Meylan, S. (2023). Sepsis awareness and knowledge amongst nurses, physicians and paramedics of a tertiary care center in Switzerland: A survey-based cross-sectional study. *PLOS ONE*, *18*(6). https://doi.org/10.1371/journal.pone.0285151

Romero, B., Fry, M., & Roche, M. (2017). The impact of evidence-based Sepsis guidelines on emergency department clinical practice: A pre-post medical record audit. *Journal of Clinical Nursing*, *26*(21–22), 3588–3596. https://doi.org/10.1111/jocn.13728

Sepsis (adults). Duodecim. (2014). https://www.duodecimlehti.fi/lehti/2014/5/duo11520?keyword=verenmyrkytys+https%3A%2F%2Fwww.duodecimlehti.fi%2Fxmedia%2Fduo%2Fduo11520.pdf

Sidharth, M., & Alan, H. (2023, June). Septic shock. *StatPearls [Internet]*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK430939/.

Torsvik, M., Gustad, L. T., Mehl, A., Bangstad, I. L., Vinje, L. J., Damås, J. K., & Solligård, E. (2016). Early identification of sepsis in hospital inpatients by Ward nurses increases 30-day survival. *Critical Care*, *20*(1). https://doi.org/10.1186/s13054-016-1423-1

Walters, E. (2018). Raising awareness for sepsis, sepsis screening, early recognition, and treatment in the emergency department. *Journal of Emergency Nursing*, *44*(3), 224–227. https://doi.org/10.1016/j.jen.2017.10.008

World Health Organization. (2020). *Sepsis*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/sepsis

Zeleníková, R., Jarošová, D., Polanská, A., & Mynaříková, E. (2023). Implicit rationing of nursing care reported by nurses from different types of hospitals and hospital units. *Journal of Clinical Nursing*, *32*(15–16), 4962–4971. https://doi.org/10.1111/jocn.16695

Öztürk Birge, A., Karabag Aydin, A., & Köroğlu Çamdeviren, E. (2021). Intensive Care Nurses' awareness of identification of early sepsis findings. *Journal of Clinical Nursing*, *31*(19–20), 2886–2899. https://doi.org/10.1111/jocn.16116

Appendices

Appendix 1. Table of chosen articles

Authors	Published year	Title	Methods	Results
Öztürk Birge, Ayşegül; Karabag Aydin, Arzu; Köroğlu Çamdeviren, Esra	2022	Intensive care nurses' awareness of identification of early sepsis findings	A cross-sectional design	The nurses who had been working for 11 years or more, had worked with a patient diagnosed with sepsis in the last month and used a measurement tool in the diagnosis thought that it was significantly easier to determine the early warning findings of sepsis. In the study, the majority of nurses correctly identified the early findings of sepsis, but the rates of the correct responses to the variables of lactate >2 mM, leucopenia and hypothermia were low. Female gender, having a graduate degree, unit type, total work experience, having received training on sepsis and working with a patient diagnosed with sepsis in the last month made a significant difference in determining the early warning findings of sepsis accurately. Conclusions: Nurses had a good rate of identifying early sepsis findings. Yet, they could not distinguish between early sepsis and late sepsis findings.
Chhapola, Viswas; Brar, Rekha	2015	Impact of an educational intervention on hand hygiene compliance and infection rate in a developing country neonatal intensive care unit.	Continuous surveillance	Compliance of HCWs for all HH opportunities combined was 46% before intervention and improved significantly to 69% after intervention. The improvement was statistically significant ($P < 0.0001$). For nurses, the overall compliance was 45% in the first phase and 74% in the third phase of study, and the improvement was statistically significant. Infection rate was 46 per 100 neonatal admissions in the first phase compared with 21 per 100 neonatal admissions in the third phase. The decrease was statistically significant. Infection rate per 1000 patient-days also showed a statistically significant decline from 96 per 1000 patient-days in pre-intervention to 47 per 1000 patient-days in postintervention phase
Oh HyunSoo, Bae EunKyoung, Lim SeonYoung, Oh JiHye, Han SunYoung, Seo WhaSook	2016	Temporal changes in physiological parameters of systemic inflammatory response syndrome during the three days prior to a diagnosis of sepsis: a case-control study	A retrospective case-control study	Homogeneity test revealed greater proportions of the aged and subjects with diabetes mellitus, hypertension and wound in the case group. Analysis also showed significant intergroup differences in systemic inflammatory response syndrome criteria score, heart rates, platelet counts and blood glucose levels, but no intergroup differences in body temperatures, blood pressures, respiratory rates, urine outputs or serum creatinine levels. A larger proportion of case subjects were fitted with a central venous or Foley catheter. Conclusions The presence of a wound, hypertension or diabetes mellitus, and the use of an invasive medical device may increase the risk of systemic inflammatory response syndrome. Of the physiological parameters examined, heart rate, platelet counts, and blood glucose

				levels might serve as significant early signs of systemic inflammatory response syndrome.
Drewry AM, Ablordeppey EA, Murray ET, Stoll CRT, Izadi SR, Dalton CM, Hardi AC, Fowler SA, Fuller BM, Colditz GA	2017	Antipyretic Therapy in Critically Ill Septic Patients: A Systematic Review and Meta-Analysis	A systematic review and meta-analysis	Antipyretic treatment does not significantly improve 28-day/hospital mortality in adult patients with sepsis.
Dang FP, Li HJ, Tian JH	2019	Comparative efficacy of 13 antimicrobial dressings and different securement devices in reducing catheter-related bloodstream infections: A Bayesian network meta-analysis	Literature review	Results: Finally, 35 RCTs involving 8494 patients and evaluating 13 dressings were included. Network meta-analysis showed that transparent dressing may be the best way to prevent CRBSI. Suture and bordered polyurethane dressing might have the lowest risk of CRBSI rate per 1000 catheter-days, and sutureless securement device might lead to the lowest incidence of catheter failure. Conclusions: This network meta-analysis indicated that transparent dressings may be selected for the prevention of CRBSI in patients with central venous catheters, which is of importance in future research. Although evidence is scant, more attention should be paid to head-to-head comparisons of the most commonly used dressings in this field.
Lu X, Zhai H, Dong Y, Su F, Xie Y, Wang Y, Wang L, Li J, Xu P.	2022	Therapeutic Effect and Prognosis of PiCCO in the Treatment of Myocardial Injury Complicated with Septic Shock	Qualitative study	At 6 h after monitoring intervention, the hemodynamic parameters of the patients in the PiCCO group were significantly increased. Additionally, compared with the control group, the ScvO2 level was higher while the lactate level was lower in the PiCCO group. An intergroup comparison on inflammation also showed that WBC and CPR levels recovered better in the PiCCO group than in the control group. Moreover, patients with PiCCO monitoring showed better performance in outcome measures such as mortality, duration of invasive mechanical ventilation, length of hospital stay, duration of ventilator use, acute physiology and chronic health scores, and postoperative complications. Conclusion: With the monitoring and guidance of the PiCCO technique, the nursing outcomes, survival rate, and prognosis of patients with myocardial injury and septic shock can be improved.

Appendix 2. Table of Hawker appraisal (Hawker et al., 2002)

Article	Abstract	Introduction and aims	Method and Sampling	Sampling	Data analysis	Ethics and bias	Results	Transferability or generalizability	Implications and usefulness	Total score
Intensive care nurses' awareness of identification of early sepsis findings	4	3	4	4	4	3	4	3	2	31/36
Impact of an educational intervention on hand hygiene compliance and infection rate in a developing country neonatal intensive care unit.	3	4	4	4	4	4	4	4	2	33/36
Temporal changes in physiological parameters of systemic inflammatory response syndrome during the three days prior to a diagnosis of sepsis: a case-control study	4	4	4	3	4	3	4	3	4	33/36
Antipyretic Therapy in Critically Ill Septic Patients: A Systematic Review and Meta-Analysis	4	4	3	4	4	4	4	4	4	35/36
Comparative efficacy of 13 antimicrobial dressings and different securement devices in reducing catheter-related bloodstream infections: A Bayesian network meta-analysis	4	4	4	3	3	3	4	4	2	31/36
Therapeutic Effect and Prognosis of PiCCO in the Treatment of Myocardial Injury Complicated with Septic Shock	4	4	4	4	4	3	4	3	3	33/36