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Hemodialysis Access Sites (HAS) and infection prevention

A literature review of infection risk factors and its prevention for hemodialysis patient

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Abstract:

Hemodialysis access sites are essential for the end stage renal disease patients for their treatment either long-term or short-term basis. These patients are in tremendous risk of infections due to invasive procedures on a regular basis and immunocompromised state of life. Infectious complications continue to be a major cause of morbidity and mortality among hemodialysis (HD) patients. The objective of this literature review is to explore about the risks of infection associated with the HD patients due to their vascular access sites and infection preventions from the nursing perspective. Research questions guiding this study is to understand the risk factors of infections through hemodialysis access sites, and the nursing interventions to improve infection preventions. The theoretical framework has been formed from the fusion of Joanne Duffy's Quality Care Model, Germ theory of disease by Louis Pasteur and Evidence Based Practices. The data for this study are collected using the academic guidelines and are analyzed by using qualitative data analysis with inductive approach. The major findings in risk factors of infections include patient himself/herself, environment, health care providers and equipment's in hemodialysis. Similarly, the nursing interventions for improving infection preventions are proper hand hygiene, use of personal protective equipment, cleaning and disinfection of environmental surfaces and equipment's, safe injection practices, routines serologic testing and patient placement during dialysis, proper use of skin antiseptics, immunization of patients and health care workers, taking part in continuous quality improvement programs, proper use of antimicrobial solutions, using needleless catheter hub, managing the waste products and education of patient as well as staff. Finally, aseptic/sterile techniques for execution of all dialysis procedures are central aspects for infection preventions for nurses. In addition, continuous quality improvement through staff and patient education in a multidimensional health care environment is essential. This research has the limitations such as inclusion of only 20 articles which are freely available and written in English language but can be useful to the nurses and concerned people.

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Foreword

We would like to express our sincere thanks to Arcada University of Applied Science for providing us an excellent learning environment and our supervisor Pauleen Mannevaara and reviewer Pamela Gray, for assisting and providing the opportunity to write this thesis independently making remarkable learning experience to us.

We extend our gratitude to honourable lecturers who are our source of inspiration to become strong believer in learning and growing. We thank to health care department administration for providing the study place adding new dimension of learning journey.

The memorable days with classmates learning community in multicultural group of friends NS16 was awesome experiences to us. It's our pleasure to be a member of this care, share and grow together group. In addition, learning from different simulation experiences with lecturers and environments were inspiring to us for further development in the nursing career.

Lastly, we express the deep respect for our family members for their strong support in completion of this thesis in time.

Krishna Adhikari
Aryan Attaulhaq
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1. Introduction

Nurses are the frontline defense for applying daily infection control practices to prevent infection transmission from one source to another. They have different opportunities to reduce the risk of infections through properly following and practicing standard procedures. Hemodialysis patients are at high risk of getting infections due to the regular use of catheters and needles to access the bloodstream and their weakened immune systems (Centers for Disease Control and Prevention 2012). The CDC (2012) estimates that each year about 37,000 bloodstream infections occur among hemodialysis central line patients. [CDC, 2012]

Most healthcare infections are transmitted by health care workers and patients themselves without knowing from the various activities or clinical procedures like changing the gloves between client contacts and hand washing. On the other side, healthcare provider's direct contact to the patients, execution of clinical and nonclinical procedures, utilizing equipment inside healthcare settings and recapping of needles and other sharp instruments also exposes concerned individuals to blood born infections such as hepatitis B, C and HIV viruses. National and international health organizations need to support the infection control guidelines for reducing the incidence of health care infections in all health care settings. (Salem, 2019)

The Code of Ethics for nurses specify the four major responsibilities of nurses as health promotion, disease prevention, restoring health and easing suffering therefore, the authors believe that it is important to search for sources that could help the nurses in fulfilling these responsibilities in order to improve the quality of healthcare delivery for hemodialysis patients in infection prevention perspective of hemodialysis access sites. (ICN Code, 2012)

In hemodialysis treatment, most procedures are considered invasive such as, hemodialysis machine set up, patient connection or disconnection from the machine, patient cannulation, accessing vascular catheters or permanent catheters, removal of needles and IV medication administration. It is not uncommon to see and ignore that dialysis nurses connecting or disconnecting patients while at the same time they are operating the dialysis machine knobs with the same gloves. (Kluwer, 2010).

Unlike the conditions in general hospital wards due to the typical lay-out and associated conditions in most hemodialysis units, stricter measures are specifically recommended, wherein multiple patients receive extracorporeal treatment with prolonged blood exposures in the same area and usually with one nurse caring for more than one patient at the same time, are potential factors that may increase the transmission of infections. (Karkar et al., 2014)

While discussing this important subject of infection control of haemodialysis access sites or reducing dialysis-related infections due to inconsideration of aseptic techniques, a question needs to be answered if nurses or other health care providers are following and practicing infection control guidelines properly to prevent dialysis-related infections? In order to answer this question, the authors have decided to study and to determine infection prevention interventions for nurses while working in haemodialysis units.

To answer the questions, the authors have written the contents in the following order. In background, basic relevant information about end stage renal disease and haemodialysis is provided. Similarly, methodology, content analysis, ethical considerations and findings followed by discussion and conclusion. In addition, due to the requirement of deep knowledge for haemodialysis nursing staff some content of this thesis may sound more medical. Researchers have simplified the content to the extent of possibility and minimum level of requirements for the understanding is maintained.

2. Background

Background provides relevant basic information about the topics of end stage renal disease, aseptic techniques, hemodialysis and its complications, nosocomial infections and associated risks.

Infection Prevention

According to Salem, O.A. (2019), a well-functioning healthcare system can be established through well practiced infection prevention and control strategies during patient caring procedures. In health care settings the nurses can play a crucial role to avoid the transmission of infections since health care related infections have a serious impact on population's morbidity and mortality rates which is both time and const effective. All nurses in all professional related roles can establish a management and supervision of infection control and prevention by using their knowledge, skills and judgment. Likewise, World Health Organization (2011) defined infection control as infection prevention and control measures that concentrates on the protection of those patients who are vulnerable to acquire infection both inside health care setting and outside while receiving treatment due to health problems. The Joint Commission on Accreditation of Health care Organization and the Centers for Disease control and Prevention (CDC) have recognized that health care providers must follow the recommended infection prevention guidelines while making contact to the patients. (Salem, 2019)

Asepsis and aseptic techniques

The presence of micro-organism does not mean that an infection will start but the spread and development of an infection happens in a cyclical way that depends on the following six basics. A pathogen or agent, a reservoir (a source for micro-organism's development), a portal of exit, a mode of transmission, a portal of entry into the host and a susceptible host.

An infection develops if the chain of theses six elements remains intact. Health care providers are supposed to break down an element of this chain by practicing infection control strategies so the infection will not spread and develop. The nurse's efforts to minimize the onset and spread of infection are based on the principles of prevention guidelines. Asepsis is the absence of disease-causing germs and pathogens. Aseptic technique is the effort taken to keep the patient as free from hospital micro-organisms as possible. (Potter et al., 1994)
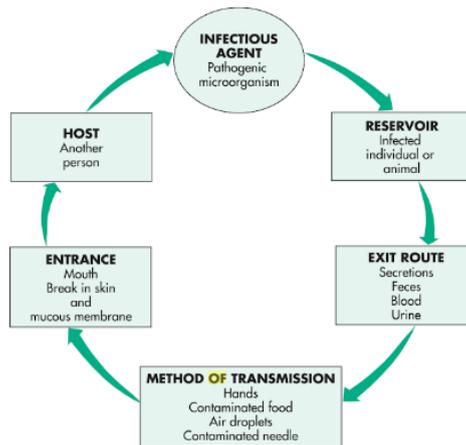
Figure 1, An example of chain of infection (Potter et al., 2007)

Along with, there are Medical and Surgical basic types of asepsis. In medical asepsis the objects are taken as Clean or Dirty. Clean means the absence of almost all micro-organisms and Dirty means soiled, contaminated or to have micro-organisms that some of them can cause infection. It includes all practices that can confine a specific micro-organism to a specific area by reducing its number, growth and transmission. Surgical asepsis is considered as a sterile technique and it includes the practices that destroy micro-organisms and spores to change the area or object free of all types of micro-organisms. (Kozier et al., 2008)

Chronic kidney disease and patient care

World Kidney Day (WKD) team defines chronic kidney disease (CKD) as the progressive loss of kidney function during a period of months or years. Each kidney contains a million of nephrons. Nephrons stop working if are damaged and makes the healthy nephrons to do extra work. But if the damage of nephrons continues then more nephrons shut down and after a certain point, the remaining healthy nephrons will not be able to filter the blood well enough to maintain healthy status of body. Eventually it ends with kidney failure, the toxins will accumulate inside the body which is life-threatening. (World Kidney Day, 2019)

In such emergency cases, the immediate care for the patient is dialysis or kidney transplant. If kidney transplant was not possible from suitable donor or the patient is not well enough to have a major

operation, then the next available option is dialysis. (NHS, 2018)

Dialysis – hemodialysis

According to U.S national library of medicine the current treatments available for kidney failure patients are hemodialysis, peritoneal dialysis and kidney transplant. Dialysis removes waste products from the blood when the kidneys can no longer filter them out. It removes spare salt, water, and waste products from body, maintains the level of vitamins and minerals and keeps the blood pressure in normal range. (Medline Plus, 2018)

As well as, during hemodialysis, the blood passes from patient to an artificial kidney or filter through a tube. The filter is called a dialyzer and a thin wall has divided it into 2 parts. When the blood passes through the first part of the filter, the special fluid in the other part of it draws out the waste products from blood. The blood then goes back into the patient through another tube. The dialysis access sites are decided and done by doctors which depends on patient's health status. (Medline Plus, 2018)

How Does Hemodialysis Work?

A hemodialysis patient will need minor surgery so a direct access to the bloodstream can be created and it can be done in three ways, Fistula, Graft and CVC. (WebMD, 2018)

Fistula or Arteriovenous Fistula is made through a minor surgery as the surgeon joins an artery and a vein together under the skin in patient's arm. Most of the time, it is created in the non-dominant hand of the patient. A-V fistula can be used for many years but at beginning it needs about 6 weeks to heal before it can be used for hemodialysis. (WebMD, 2018)

Graft or Arteriovenous graft or AVG is a plastic tube used under the skin to join an artery and a vein. It heals in two weeks. Arteriovenous graft lasts for shorter time than a fistula and the patient will likely need another one after few years. Graft patients will need to see the doctor more often than fistula since the risk of infection is higher. (WebMD, 2018)

Central Venous Catheter or CVC is another way of making hemodialysis happen for the patients specially in emergency cases. A flexible tube (catheter) is placed into a vein in neck, below the collarbone (clavicular bone), or next to groin. Due to higher risk of infection CVC is suggested to be used for short period of times only. (WebMD, 2018)

Complications of Hemodialysis

According to Advanced Renal Education Program thrombosis, infections, aneurysms, venous hypertension, hematomas, heart failure, and prolonged bleeding are the chronic hemodialysis access complications. Infectious complications of vascular access among hemodialysis patients is considered a major source of morbidity and mortality. Previous studies have reported that 9.5-36% of deaths in hemodialysis patients is due to infection. Vascular access sites infections (mostly in patients with CVC) are reported to be the source of all bacteremia in hemodialysis patients in up to 48 to 73%. The average risk of bacteremia with tunnel cuffed catheters is 2.3/1000 catheter days and it indicates approximately 20 to 25% bacteremia risk over the average duration of use. The risk of infection in AV grafts is 10%, and 5% in AV fistula. (Advanced Renal Education Program, 2009)

Nosocomial infection or Hospital Acquired Infections (HAIs)

The effort of health care professionals for the prevention of hospital acquired infections can not be underestimated, but still a challenge for them to make it to happen in healthcare environments. Hospital acquired infections are classified as infections that associated with the delivery of healthcare services in a healthcare setting. Nosocomial infections can either develop during a patient's stay in a clinical area or manifest after discharge. HAIs have received increasing attention in recent years and each year affect significant patient numbers. The most common environment where nosocomial infections develop are hospital's surgical or medical intensive care units. The most common human body spots for HAIs are the urinary tract, the respiratory tract, bloodstream and wounds. The source for micro-organisms that causes nosocomial infections can be different, the ones that originate from the patient themselves is a endogenous source and the ones that originate from hospital environment and hospital personnel is a exogenous source. Most nosocomial infections appear to have endogenous source. E coli, Staphylococcus aureus and enterococci are the most common infecting micro-organisms. (Kozier et al., 2008)

There are several factors that contribute to nosocomial infections. Iatrogenic infections originate directly from diagnostic or therapeutic procedures. One example of an iatrogenic infection is bacteremia that results from an intravascular line such as hemodialysis. All nosocomial infections are not iatrogenic and not all nosocomial infections are preventable. The host itself can be a contributing

factor to the development of nosocomial infections, such as the patient with lower immunity system or immunocompromised patients due whose normal defenses have been lowered by surgery or illness like patients with chronic renal disease. (Kozier et al., 2008)

Nosocomial bloodstream infections (BSIs) is not only a major cause of morbidity but also it increases the length of stay in hospital, produce extra costs, and increase mortality. Also, the increase in antibiotic resistance has been a significant concern among causative organisms because this may lead to wrong selection of empiric antimicrobials in patients with suspected sepsis or blood stream infections. Regarding the prevention of nosocomial infections, the surveillance and active reporting of nosocomial blood stream infection are crucial elements. Hospital admitted patients are often harmed by preventable medical errors during their in-patient stay. (Huttunen et al., 2015)

According to Stephanie Taylor (2017) "Conservative studies report that 33 out of every 100 patients experience some type of medical error during their hospitalization. Of these, 18% will get a new infection from their hospital experience this means that at least 9% of patients acquire a health care-associated infection (HAI), while in the hospital. The full cost of HAIs on the American society, not just the incremental cost to hospitals, is estimated to be $96-$147 billion alone. Globally, HAIs kill more people than AIDS, breast cancer, and auto accidents combined. (Stephanie, 2016)

Risk of infections associated with hemodialysis

APIC Guide (2010) states that patients receiving hemodialysis treatment are at high risk of infections for many different reasons, such as depressed immunity state due to end stage renal disease (ESRD), the high prevalence of diabetes, frequent hospital visits and exposure to other patients in the hemodialysis setting and the invasiveness of the hemodialysis procedure. Many of the acute bacterial infections in hemodialysis patients are caused by Staphylococcus aureus and are related mostly to central venous catheter. These infections can lead to sepsis and bacterial seeding / infection of implants such as total hip/knee and cardiac valves which is a serious complication causing significant additional morbidity and may require removal/replacement of implants. Bacterial infection of compression spine fractures has also been reported due to long-term antibiotic therapy in hemodialysis patients. (APIC, 2010)

Apart of Staphylococcus aureus, pneumococcal pneumonia is the next common associated infection in hemodialysis patients. Pneumovax immunization is indicated for hemodialysis patients which is helpful in preventing pneumonia and bloodstream bacteria invasion. One of the reasons that hemodialysis patients are prescribed antibiotics is Pneumonia which in turn increases the risk of infection colonization with multidrug resistant organisms as MRSA (methicillin-resistant Staphylococcus aureus) and Clostridium difficile development. Another serious concern for hemodialysis patients is seasonal influenza, which can be transmitted by both unvaccinated dialysis health care providers and patients. (APIC, 2010)

Nursing process in Action

From patient caring perspectives it is important to understand the caring process conducted by health care providers in health care settings. Nursing care process is a systematic, rational method of planning and providing care. Identifying patient's health status and actual or potential health problems is the aim of this process in order to establish plans to encounter the identified needs and to deliver specific nursing interventions so the desires of patient's can be addressed. The nursing process has five element or phases to follow in a logical sequence, but more than one element can be involved in a situation. Maybe at the end of first or second phase, care process may be concluded if the goals or needs achieved or the process may continue or modified with reassessment of the situation. The nursing process is a patient-centered process. The nurse arranges the plan of care according to patient's health related problems rather than nursing goals. The five components are described as follow. (Kozier et al, 2008)

Assessment, as it initiates the process the nurse collects information to identify about patient's habits, routines and needs enabling the nurse to incorporate patient routines into the care plan as much as possible. And to establish a database of baseline information about the patient response to health-related concerns or illness and the ability to achieve healthcare needs. Diagnosing phase which also called the phase of data analyzing and synthesizing is about to identify patient's strengths and health problems that can be prevented or resolved by cooperative and independent nursing interventions. Planning, at this stage of the process the health care provider determines how to prevent, reduce or resolve the identified patient problems or how to support patient strengths and how to implement nursing interventions in an organized, individualized and goal directed way. Implementing phase is

about carrying out the planned nursing interventions to assist the patient to meet desired goals, promote wellness, to prevent illness, to restore health and facilitate coping with altered functioning. Evaluating, as the last phase of nursing process it is about measuring the degree to which goals have been achieved and identifying factors that positively or negatively influence goal achievement in order to determine whether to continue, modify or terminate the plan of care. (Kozier et al, 2008)

3. Theoretical Framework

Theoretical framework describes the nursing theory of Joanne Duffy's Quality-Caring Model and evidenced based practices for this research. Joanne Duffy's Quality-Caring Model, an ideal model for nursing care of the patient and evidenced based practices provide the foundation for the best available nursing interventions. In addition, the germ theory is also considered by the authors which provides the solid concept of contamination or infection risks due to microorganisms in health care settings as well as outside environment.

Joanne Duffy's Quality-Caring Model and evidenced based practices are relevant to prevention of infections in health care settings. When viewed together, they provide an effective framework either by making decisions through best available evidence-based sources such as Asking, Acquiring, Appraising, Aggregating, Applying and Assessing or by identifying or eliminating the hazards, modifying risk behavior and adopting safer strategies to achieve the goal of infection prevention so the best available health care will be provided. (Smith, 2015)

In patient care aspects the authors believe that health care providers must not rely only on evidence-based nursing practices but rather need to have critical thinking skills founded on a nursing theory since the application of theory in nursing process aims to assess patient's health situation by different methods explained in theory, to find out about the need of patient, to demonstrate a healthy and useful interaction and relationship between health care provider and the patient, to identify and solve health related problems of patient and to evaluate the quality of health care services available for the patients. (Smith, 2015)

Joanne Duffy's Quality-Caring Model

This study uses the quality-care model proposed by Joanne R. Duffy. According to Joanne, caring relationship is the core concept of the model and is believed to be integrated, although often hidden in the daily work of nursing. Quality care is not an endpoint but a continuous process of learning and improving in which patients are taken as full partners including fully integrated work of health professionals. In addition she focused on professional nurse caring which requires specialized

knowledge, attitudes, and behaviors that are specifically directed toward health and healing such that recipients feel 'cared for' for being positive, feeling safe, learning new healthy behavior, or participating effectively in decision making based on evidence. Major assumption in her model states professional nursing work is done in the context of human relationships which leads to self-advancing system for quality-care to provider as well as receiver providing a foundation for patient-centered care. (Smith, 2015)
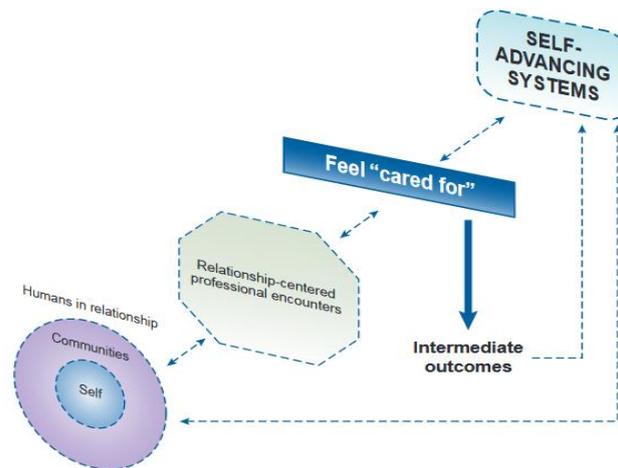
Figure 2, Nursing Theories and Nursing Practice 2015 (Smith, 2015)

Evidence Based Practices

"Evidence-based practice (EBP) is receiving considerable attention within the general field of human services and within the disciplinary literatures of specific professions, such as medicine, psychiatry, psychology, social work, marital and family therapy, chiropractic, and nursing, among others.". (Bruce, 2014)

In another words, the basic idea of evidence-based practice is that good quality decisions should be made based on a combination of critical thinking and the best available evidence. Evidence-based practice seeks to improve the way decisions are made. It is an approach to decision-making and day-today work practice that helps practitioners to critically evaluate the extent to which they can trust the evidence they have at hand. It also helps practitioners to identify, find and evaluate additional evidence relevant to the decisions they make. (Barends et al., 2014)

According to Barends E. et.al, 2014, "Mostly decisions are not based on the best available evidence. Instead but practitioners often prefer to make decisions rooted solely in their personal experience. However, personal judgment alone is not a very reliable source of evidence because it is highly susceptible to systematic errors – cognitive and information-processing limits make us prone to biases that have negative effects on the quality of the decisions we make". (Barends et al., 2014)

Germs theory of disease

Germ theory of disease is also called the pathogenic theory of medicine, it leads into the development of antibiotics and hygienic practices. The major concepts of Germs theory can be explained mainly as the phenomenon of disease transmission, prevention, decision making and to understand the unknown phenomenon of germ transmission. (Nursing theories, 2012)

Scientists have contributed to the germ theory over the past 150 years. Although some may argue that the origin of this theory links with Girolamo Fracas Toro in 1546 or Bassi in 1835 but the most closely name associated with the idea that germs causes the diseases is Louis Pasteur. Pasteur was constantly insisting that the germs that makes the individuals sick are originated from other germs not in a result of spontaneous generation. His idea was revolutionary accepted and established the basis of sterilization, asepsis and the germ theory of disease. (Gillen et al., 2009)

Today, the term germ is well known and refers to pathogens or disease-causing microbes or "rapidly growing cells". The **germ theory** of disease is considered as one of the central themes of biology science and the most important concepts to understand about deadly infectious diseases. From centuries, the perception of germs and the cause of infectious or contagious diseases was almost unknown. The mysterious miasmas and their spontaneous generation were believed as the causes of sickness. Miasma was thought to be a poisonous gas or vapor-filled particles of decaying miasmas that caused many sickness and disease. (Gillen et al., 2009)

The authors believe that the germ theory of disease is still one of the most important concepts in our age in respect to infection prevention either inside health care settings or outside, as Joseph Lister (1827–1912) applied the germ theory of disease to promote the concept of cleanliness and hygiene in public through governments and different institutions around the world to reduce infectious diseases.

(Gillen et al., 2009)

The reason behind the fusion of three different concepts in theoretical framework is that they are complementing each other to create the ideal solution in nursing care specifically understanding the infection risks and infection prevention interventions. Joanne Duffy's Quality care model is focusing on caring through professional human relationships by the health care workers for the creation of feeling cared for being positive, safe and learning new behaviour through active participation of patient. This core idea is supplemented by the conscientious use of current EBP (Evidence Based Practice) in making decisions about patient care. In addition, germ theory of Louis Pasteur adds the awareness among patients and nursing professionals practicing clinical as well as non-clinical procedures about the possibility of pathogens transmission.

4. Aim of the study and research questions

The skin is the body's first line of defense against germs. A person is vulnerable to infection as soon as there is a break in their skin, regardless of whether it occurs as a result of an accidental injury or a surgical incision. A Healthcare Center Acquired Infection is an infection that a person acquires as a result of treatment from a healthcare professional. According to the Centers for Disease Control and Prevention (CDC), one in every 31 hospital patients will have at least one HCAI. (Eske, 2018)

With a view toward, the authors believe that hemodialysis patients can be more vulnerable to HCAIs due to their frequent visits in HD center and vascular access sites. Thus, understanding risk factors and finding nursing interventions or recommendations to reduce these infections are the main purposes of this task. The research questions guiding this study are formulated as,

What are the risk factors of infections in Hemodialysis access sites?
What are the Nursing interventions to improve infection preventions?

The reason behind this study and its aim is the mistakes identified by health care providers in haemodialysis centre during treatment procedure. In this context, the authors believe and take the matter sensitive and the prevention of such mistakes must be the priority of all health care providers.

5. Methodology

Writing methodology for this study will help readers to understand the validity of this data. As it is a qualitative study, the research methodology that will be used includes literature review and content analysis. For data analysis process the inductive content approach will be conducted. Twenty peer reviewed articles will be used in this context which were all systemically searched and selected from search engines of Arcada Libguides platform.

In qualitative research non-statistical methods are used to achieve deep understanding about an event, human groups data, and broad patterns behind events and people. Or, in other words qualitative research does not deal with the numbers as in quantitative research. (Stephanie, 2016). Qualitative research can produce information that can help nurses updating clinical decisions and it focuses on patients' and/or health care professionals' experiences. (Ingham-Broomfield, 2015)

In a qualitative research, at the start of the work the scholar uses a limited amount of literature to let the participant's views instead from the literature, that play a key role in the study. And at the end of work, the literature is cited again to compare and relate the findings with previous written work, but in quantitative research it is different as the literature at the end compare the results with previous predictions that have been made at the beginning of the research. (John, 2008)

According to Creswell J.W 2008, "A literature review is a written summary of articles, books, and other documents that describes the past and current state of knowledge about a topic, organizes the literature into topics, and documents a need for a proposed study". Through his review the readers can understand that the researcher has already information about related topics to the chosen study and provides the need for study to verify that other studies have not included the same topics in the same way. (John, 2008)

The literature review consists of two parts the Process and the Product. The process is the literature search. A literature search is "a systematic and through search of all types of published literature in order to identify as many items as possible that are relevant to a particular topic" (Gash, 2000, p.1). The product is the written document that is a coherent argument that leads to a proposed study written from your perspective. It is a written synthesis of the literature arranged around themes from your

critical perspective. (Rockinson-Szapkiw et al., 2012)

The literature review is important because it has both practical and scientific advantages. One of the practical advantages is that it demonstrates about the investigator who is knowledgeable about the field, including its vocabulary, theories, key terms, phenomena, methods, and its history. Another practical advantage is that, this review with some modification is "legitimate and publishable scholarly document" (LeCompte & colleagues, 2003). Similarly, it allows the researcher to find out about the influential researchers and research groups relevant to study. Another reason for writing a literature review is that it provides a framework for relating new findings to previous findings in the discussion section of a study. If the state of the previous research is not established, then it is impossible to establish or show that how the new research advances the previous one. (Randolph, 2009)

Beside practical reasoning, there are many scientific advantages for conducting a literature review. Gall, Borg, and Gall (1996) state that the literature review also plays a role in delimitating the research problems, seeking updates of inquiry, avoiding unnecessary approaches, achieving methodological insights, recommendations for future research and seeking support for ground theory. (Randolph, 2009)

There are five stages to conduct literature review, problem formulation, data collection, data evaluation, analysis and interpretation and public presentation. At the first stage, after identifying the proper type of review the focus moves to problem formulation. The investigator thinks to decide about the research question which will be answered by the literature and about the inclusion and exclusion criteria of the articles included in the study. Also, at this point it is important for the author to differentiate between the literature review question and empirical research question. The two main steps in problem formulation stage is the determination of the questions that will guide the literature review and to clearly determine the inclusion and exclusion criteria for collecting articles. (Randolph, 2009)

In data collecting stage the goal is to collect relevant set of scientific articles. The process of data collection usually starts with an electronic search of academic databases and the Internet. After conducting the searches, the searched databases, the key words, key words combinations and the

number of records resulting from each search is recorded carefully. The data collection process can be stopped when the reviewer has enough relevant evidence and when the point of saturation is reached. Now from the collected articles the potentially relevant articles need to be separated from obviously irrelevant articles and the reviewer is advised that whichever method has been used the process needs to be documented accurately. (Randolph, 2009)

The next step is about the evaluation of collected data. The reviewer extract and evaluate the information from the chosen articles which met the inclusion criteria. The type of extracted information is determined by the focus and goal of the review for example the focus can be research outcomes and goal will be the integration of those outcomes. After evaluation, once again the author is advised to document the data extracting procedure accurately with extensively in details such as what type of data were extracted, and which process was used. The documentation could be either included in the body of the study or in a separate coding book such as an electronic document, a spreadsheet, or a physical form on which data are recorded for each article. (Randolph, 2009)

According to Justus J, (2009), after data evaluation stage the reviewer needs to analyse, interpret and understand the extracted data. A short summary of each article that include the main idea will be written in reviewer's own words that can demonstrate or facilitate the understanding level of researcher. Finally, the reviewer will be publicly presenting the study. At this stage the author will decide to present the information which is more important and less important information will be left behind. (Randolph, 2009)

Data collection

In respect to data collection process, Arcada's Libguides platform has been used to search for relevant data for this study. The academic search engines on this platform which are used are Academic Search Elite (EBSCO), Cinahl (EBSCO), PubMed, Science Direct, Cochrane Library, WebMD and SAGE journals. The first step of this process was a general article searching coordinated by using keywords such as risk factors AND hemodialysis access sites, hemodialysis access sites AND infection prevention, hemodialysis access sites AND infection, hemodialysis patients AND infections, Hemodialysis access, Risk factors in hemodialysis access sites, Prevention and management of

catheter related infections in hemodialysis patients, Hemodialysis Infection Prevention, Vascular access complications and risk and vascular access sites infection prevention AND nursing. The hits from Academic Search (EBSCO) were 348 articles, CINAHL (EBSCO) with 67 articles, 122 articles in PubMed, 60 from Science Direct and nothing from Cochrane Library.

The search characteristics for the mentioned outcome of this task were as free full text, 2009 – 2019 and English language. From total hits of 763 articles only 93 were assessed for inclusion and exclusion criteria. In selection process all repeated and similar articles were excluded. The remaining articles were all read by the investigators and were divided into more important and less important categories. More important articles were 30 and the rest were remained in less important category of articles. Afterwards, the titles, abstracts and conclusions of last 30 important articles were studied again by the researchers, and finally 20 scholarly articles were selected as the most important and most relevant articles for analysis to answer the research questions of this study.

The exclusion and inclusion criteria for this study is presented as follow in table 1.

Table 1

Inclusion criteria	Exclusion criteria
Relevant to the subject "hemodialysis access points nursing care from infection prevention perspective"	Articles without the nursing perspective were eliminate such as from 'doctors' perspective'
Studies published in English	Publication in any other languages were excluded
Considered articles were published from year 2009 - 2019	Articles were published before 2009 were excluded
Free access and Full text articles were included	Extra permission and pay needed articles were excluded
Scientific articles academic databases with peer reviewed	Articles from non-academic databases were excluded such as google,
Articles with clear, relevant and informative conclusions were included to the study	Articles with biased and irrelevant summaries were excluded
Articles were chosen and included to study	Irrelevant articles found from searching key

found by searching key words of risk factors AND hemodialysis access sites, hemodialysis access sites AND infection prevention, hemodialysis access sites AND infection, hemodialysis patients AND infections, Hemodialysis access, Risk factors in hemodialysis access sites, Prevention and management of catheter related infections in hemodialysis patients, Hemodialysis Infection Prevention, Vascular access complications and risk and vascular access sites infection prevention AND nursing..	words were excluded such as related to peritoneal dialysis and dialysis for children.

Content analysis

According to Elo & Kyngäs (2007), "content analysis is a method that can be used either with qualitative or quantitative data and in an inductive or deductive way". The aim of content analysis to establish a model to describe the event in a conceptual form. It describes and quantify the phenomenon in a systematic and objective manner (Krippendorff 1980, Downe-Wamboldt 1992, Sandelowski 1995). As well, it helps to enhance investigators' data understanding by testing the theoretical issues and to classify the data into fewer content related categories (Cavanagh, 1997).

Furthermore, Krippendorff (1980) describes the content analysis as a research method for creating replicable and valid interpretations from data to their context in order to provide and present facts, updated information and practical guides in a conceptual way. In addition, content analysis plays an important role in nursing research as it provides many advantages for the researchers such as, it is a content-sensitive method (Krippendorff 1980) and offers the chance of flexibility in terms of research design (Harwood & Garry, 2003). [Elo & Kyngäs, 2007]

Regarding choosing either the inductive or deductive methods of data analysis, it depends on the purpose of task. If there is not enough previous information about the event or if the relevant knowledge or information is found in fragmented manner, then the inductive method is recommended (Lauri & Kyngäs, 2005). Both deductive and inductive approaches are represented as three main phases of preparation, organizing and reporting. The preparation phase is same for both methods and begins with selecting the title or unite of analysis (McCain 1988, Cavanagh 1997, Guthrie et al., 2004). The title can be a word, a sentence or a piece of writing (Polit & Beck, 2004) depending on what to analyse in what details, thoughts and factors are needed before selecting the unit of analysis (Cavanagh, 1997). However, the investigator needs to read the chosen materials several times in order to become well familiar to the data and chose a proper and representative picture and unite analysis (Burnard 1991, Polit & Beck 2004). Afterwards, the analysis process is started using an inductive or deductive approach (Kyngäs & Vanhanen, 1999). The next step is to organize the qualitative data which includes open coding, creating categories and abstraction. [Elo et al., 2007]

The author for this study has chosen the inductive content analysis of Elo & Kyngäs, (2007). Each unit of this process was read and implemented carefully as it shows in following table 2.

Table 2.

Open coding	The chosen text was read through for several times, during reading the notes and headings were written in the text as many times as needed and the relevant texts were highlighted. The headings were written on the sides of the text so it can describe the aspects of the content. After reviewing the highlighted text for several times, together with headings were written on a separate page.
Creating categories	The headings were categorized based on similarities and dissimilarities. Creating categories was not only bringing together the similar and related observations instead the data was classified based on its relevance to a topic or heading and separated from the observations and data which do not belong to the same category.
Abstraction	By generating categories, a general description of study was formulated. Each one of generated categories are named with the words representing the contents and in the same way the subcategories as it is described in following table.

Table 3. the Categories and Subcategories of findings

Catagories	Subcatagories
Ris factors	Risk factors associated to Patient, Risk factors associated to health care provider and Risk factors associated to envoirnment and equipment
Nursing interventions	Hand hygiene Personal Protective Equipment (PPE) Cleaning and disinfection environmental surfaces and equipment Safe injection practices Screening/routine serologic testing and patient placement Immunization of patients and health-care personnel Continuous quality improvement through tracking the failures in infection Needleless Connectors/Catheter hub devices Skin antiseptics Catheter exit site care and dressing Prophylactic Antimicrobial locking solutions (ALSs or AML) Educational activities for staff and patients Waste product management in hemodialysis center

6. Ethical considerations

This research work is mainly concerned in acquiring more knowledge in the topic from the nursing perspective which can be beneficial for the concerned professionals as well as to the general public who wants to know about the topic.

According to the European Code of Conduct for Research Integrity (2017) the fundamental principles of research integrity guide researchers to remain practical, ethical and intellectual challenges inherent in the research. These principles are reliability ensuring the quality of the research, honesty in the developing, respect for colleagues and accountability from the idea to publication. (Astedt-Kurki, 2018)

According to Nordic college of caring science (2018) ethical considerations are needed to guarantee the quality of scientific work. And so ethical norms are strictly followed from the very start of data collection to the whole finishing of the thesis. Furthermore, the authors are well aware of the undesirable effect to the nursing science world and the patient's community due to the fraudulent data and plagiarism. It has utilized the Arcada library's guidelines for collecting the academic articles form the recognized academic databases. All the references are given as per the rules. Notably researchers have not conducted any interviews and field visits for compiling and making the results on the topics. The sole legitimacy of this result is dependent on the considered articles, academic writings and Arcada's reviewers' feedback. In the writing process the background contains some reliable internet sources and academic books. Some terminologies used in this paper are defined by some well-known dictionaries such that it could be easier to understand for all. The unbiased and transparent way of writing is the major part of concern. The result was written through careful study of all the articles collected from the Academic databases. Further researchers have equally valued for the colleagues, fellow researchers, respondents, public and academic communities. So far methodologies used for the research is chosen for the best suited according to topic. (Astedt-Kurki, 2018)

This research paper is written to fulfil the university degree requirements under the supervision of Arcada's University lecturer without unjust influence just as supporting role and so not for the further other publications and dissemination. In addition, the authors are in the initial phase of professional career and not specialized in the concerned field of research topic though the used methodology has

the strong adherence with the topic. Certainly, approval of the topics from the university was first for this thesis writing process and known to ethics committee and board at University. Introduction and abstract provide the initial decisive information about the paper and its process which plays the important role to draw the attention of the reader.

Though university has offered the possibilities of doing the projects with funding from some organization or without funding, authors could not find any funding organizations. Researchers are independent in completion of writing process with absolute responsibility. This paper is passed through the central authority and final version will be publicly stored in the database which can be accessed through www. thesus.fi. Researchers believe that enough attempts are made to draw the conclusive outcomes for the readers even- though it has its own limitations.

7. Findings/Outcomes

After the analysis of chosen 20 relevant articles, the authors have categorized the outcomes into two main categories and respective subcategories namely, understanding the risk factors and nursing interventions. The relevant information for the relevant categories is collected, subcategorized and analyzed to make the findings. For more details about used articles for this findings the reader can refer to table 3 of appendices.

7.1 Risk factors

Due to high risk of Catheter related exit site and blood stream infection the morbidity and mortality rate in haemodialysis patients with Tunnelled central venous catheter is high. (Article, 18)

In general, the causes that increases the risk of hospital acquired infection among haemodialysis patients are indicated by authors in article 10 as, low level of immunity in patients, frequent and prolonged contact to blood, more patients in a small treatment space, frequent contact to health care providers, frequent visits to health care settings and improper implementation of recommended preventive practices. Similarly, article 1 summarises the sources of infection into four categories the patient, the healthcare provider, the equipment and the environment.

Risk factors associated to patient

Research in articles (1, 7, 8, 12, 13, 14) show that great risk factors related to patient are poor hygiene, perspiration under dressing, nasal carriage of staph aureus, catheter's exit site manipulation, removing the dressing at home, showers and wet dressing, sneezing on exposed HD access sites and unintentional removal of dressing during activities or sleep. Also, articles (8 & 13) indicates Diabetes, iron overload and longer duration of CVC (more than 10 days) as the significant associated risk factors of CVC-RIs. Old age, serum low level of haemoglobin and albumin were also mentioned as risk factors for CVC patients. Though, unite (3) reports the risk factors for BSI (Blood Stream Infections) in Tunnelled Cuffed Catheter patients as, the duration of the catheter, past catheter-related bacteraemia, catheters in left-sided internal jugular vein, hypoalbuminemia, and immunosuppression.

Most of the chosen unites accept that Arteriovenous fistula and grafts are considered to have a low infectious risk than CVC and it is very important for HD healthcare provider to understand the clinical feature for infection sites so they can take the action on time. AVF infections are generally leads to perivascular cellulitis, showing the classic signs of localized erythema, swelling, and tenderness. (8, 3, 12, 15, 18, 20)

Bacterial colonization of buttonhole cannulation tract may be asymptomatic and difficult to identify which increases the chance of more severe infectious problems such as endocarditis. In dialysis units the more the buttonhole cannulation technique is used the higher will be the risk of infection. Buttonhole technique at home dialysis has three times higher risk of infection then the haemodialysis in health care settings. (Article, 2)

Similarly, units (11, 13, 14 and 18) have also identified the poor hand hygiene, hypertension and atherosclerosis as significant associated risk factors for HD patients which can lead to Catheter related bacteraemia (CRB). Likewise, unit (18) references that Catheter related exit site infections and blood stream infections are the major results of CVC use and the frequent use of Tunneled Catheters in hemodialysis patients increases the risk of infectious complications, hospitalizations, and mortality. Catheter avoidance and reduction are the obvious strategies for avoiding these complications.

In study (16), Soi V. et al (2016) has focused on skin flora as one of the significant associated risk factors for colonization of catheters which leads to the production of biofilm and acts as a reservoir for infectious bacteria. There are 13 different bacteria that migrates into the lumen of the catheter through the skin flora around the HD access sites or through the hands of health care providers during taking care catheter hubs. Not only skin flora but delayed removal of sutures and higher heat and humidity may also serve as co-factors for local infection. Monthly hand hygiene observation of health care providers and patients are also recommended. (Article, 20)

Risk factors associated to health care providers

Similarly, the factors that contributes to infections from health care providers side are poor hand hygiene during HD procedure, no change of gloves, poor site cleansing, improper handwashing and

not using the mask. (Article, 13)

The research in unit 9 insist on healthcare providers to understand the clinical feature of infections because it helps the healthcare provider to act on time and prevent more serious problems. Fever and chills are considered the most sensitive clinical feature. More clinical signs and symptoms of catheter-related bloodstream infections (CRBSIs) include, altered mental status hemodynamic instability, low body temperature or hypothermia, catheter dysfunction, , nausea/vomiting, and generalized body pain or malaise . This unit also points out that the femoral and internal jugular insertion sites of CVC and no adherence to submaximal barrier precautions at the time of catheter insertion increases the risk of infection. (Article, 9)

Furthermore, due to lack of vaccines of different viral disease more importantly for HIV and HCV the haemodialysis patients and workers are both at high risk of viral disease. Unit (10) has describe currently the incidences of chronic HCV is much higher than HBV among the HD patients and the consequences of HCV and HIV infections are severe and fatal. More importantly the fact is that the recommended standard precautions of infection control in HD settings cannot be always guaranteed to be practiced reliably and consistently and the unintentional occurrence of hygienic mistakes (poor hand hygiene, not using the disinfectants while switching from one patient to another) is always possible especially during the urgent interventions. (Article, 10)

Risk factors associated to Environment and equipment

The environment and the equipment used for HD treatment are also considered as contributing factors for infections among hemodialysis patients. The associated risk factors from these two sources are described as unclean home, pets at home, airborne pathogens, air drafts on open HD access sites, surgical procedures, cracked and improperly fitted caps and contaminated supplies. (Article, 10)

Hot weather can also be a risk factor because at these conditions the protective barriers around the injected areas fail to stick and remain adhesive which increases the risk of infection. (Article 5, 16). The HD treatment environment can be contaminated with an infected patient as well and it is considered one of the serious risks among HD patients, so it is very important that all patients need to be screened for infectious disease before the admission to HD settings. (Article 11, 15)

However, Karkar, A. et al (2014) in article (10) have provided a broader view on sources of infections in hemodialysis settings. As that HD patients can be exposed to different types of infections, such as bloodstream infections and local infections of HD access sites, blood-borne infections with HBV, HCV and/or HIV and airborne infections like tuberculosis. The sources of infection in dialysis centers could be contaminated water, tools, environmental surfaces in care area and already infected patients. The risk of health care associated infections (HAIs) is very high in HD patients due to their immune compromised status, frequent and prolonged exposure to blood during haemodialysis care process, less space and more patients in HD facility, frequent contact of healthcare provider with the patients and HD machines, recurrent hospitalization, surgery, and most importantly the lack of adherence in implementation of recommended infection prevention practices. Reasons for not implementing the recommended practices or guidelines could be one or more of the following factors, poor nurse to patient ration, recurrent staff changing or turn over, insufficient staff training, low level of competency among caring staff, lack of patient education, inadequate supply of equipment and poor design of haemodialysis units or settings.

7.2 Nursing Intervention for Infection Prevention

Regarding the outcomes of this task, most of the article authors from chosen articles have recommended the CDC and APIC and WHO guidelines as nursing intervention for infection prevention. They are described as bellow.

Hand hygiene

The nursing intervention guidelines of APIC, CDC and WHO have considered the hand hygiene as the most important concept in infection prevention among HD patients. It is suggested that the hand hygiene should be practiced by healthcare providers before touching the patients, after contact with body fluids, before leaving the patient, before accessing or restocking the supplies and after removing the gloves. CDC suggests the hand hygiene before touching a patient even the gloves will be used or prior to performing an aseptic task. Moreover, the estimated minimum number of times where hand hygiene is required per dialysis session per patient regardless of use of gloves is recommended almost 30 times. (Article 4, 6, 10, 15, 16, 19 & 20)

On the other side when a hemodialysis nurse is required to perform hand hygiene so frequently, it may lead to lack of compliance to recommended guidelines. Still it can be improved with continuous staff education and supervision, by providing convenient care settings with sufficient number of sinks and soap dispensers, paper towels, hand lotions (e.g., one for every 2-4 dialysis stations) and Alcohol-Based Hand Rubs (ABHRs) placed at each patient station. (Article 10, 15, 20)

Alcohol-Based Hand Rubs (ABHRs) is recommended to be used in all clinical situations particularly when hands are not visibly soiled. Hand washing with soap and water is recommended when exposure to bacterial spores (i.e., Bacillus anthracis and/or Clostridium difficile) because spores are resistant to most antiseptics and require physical removal by washing and rinsing. Other preventive measures required for health care providers are not to keep long nails, artificial fingernails or extenders as artificial nails could harbor gram negative bacilli and yeasts. (Article 12, 10, 15)

Personal Protective Equipment (PPE)

Personal Protective Equipment means gloves, gowns, masks, eye goggles, face shields and respirators. In hemodialysis settings the gloves are strongly recommended to be used when the health care provider is contacting patient's intact skin or equipment. Each contact needs to be followed by changing the gloves and hand hygiene specially when starting the care for next patient or changing the station. Using gloves is a must when visible or grass soiling is present at caring field. If sterile aseptic technique such as catheter insertion or dialysis catheter handling or manipulating is required, then the sterile gloves must be used during the procedure. When performing procedures where splashes of blood is anticipated such as at the start and at the end of dialysis procedure the wearing gowns over the uniform, face mask and eye protectors are recommended. During catheter handling if a face shield is used a surgical mask should be worn underneath, in order to protect the patient from health care provider's respiratory droplets. At the same time, it is equally important if the patient is also using a mask and turning the face to opposite side, so the health care provider and patient's catheter insertion site is protected from droplets. Also, the use of mask in more important when a patient, health care provider or a visitor has cold or symptoms like cough. If a patient has air born infection, then the assigned health care provider is recommended to use the respirator. (Article 4, 10, 12, 13, 14, 16, 20)

Skin antiseptics

Authors from most of the articles have provided information that HD patient's Skin can be cleaned with Chlorhexidine, povidone iodine or alcohol. Chlorhexidine has been shown more useful than povidone iodine and alcohol. An alcoholic chlorhexidine solution (1% to 2% chlorhexidine gluconate in ≥70% ethyl or isopropyl alcohol) should be used to clean the area. This antiseptic solution should be applied with friction for at least half a minute and let it to dry itself without wiping or blotting. Povidone-iodine 10% in 70% ethanol should be used if Chlorhexidine is contraindicated. According to article 9 and 11 the use of aqueous or alcoholic chlorhexidine solutions has been considered superior in relation to reduce significant catheter colonization. (Article 4, 5, 6, 9, 11, 12, 13, 14, 16, 17, 19, 20)

Article 11 is emphasizing that after antiseptic application, the catheter insertion site should not be touched and can be kept cleaned with polymyxin B/ bacitracin/ gramicidin (e.g., Polysporin Triple) or povidone-iodine antiseptic ointment. Also, the access port of catheter should be scrubbed with an antiseptic (chlorhexidine, povidone-iodine, or 70% alcohol) before connecting it to a sterile device. During the insertion step of catheter, aseptic technique has to be followed with using a sterile gown, sterile gloves, a cap, a mask and a sterile full body drape.

Catheter exit site care and dressing

For Catheter Related infection prevention, the author in article 14 suggests that both the patient and the HD staff should follow universal precautions and hygienic measures. The KDOQI (Kidney Disease Outcomes Quality Initiative) recommends the health care personnel handling the catheters should use a mask and clean or sterile disposable gloves. For catheter exit site cleaning the chlorhexidine 2% and alcohol 70% or povidone-iodine 10% solution are recommended with aseptic techniques. Site care includes insertion site cleansing with chlorhexidine scrub for 30 seconds allowing the area spontaneously. Prior to catheter access, two 30-second scrubs are performed with alcohol wipes using aseptic technique with both the provider and the patient wearing masks. In respect to buttonhole technique safe removal of scabs from insertion sites is preferred a day before the dialysis session. (Article 2, 7, 9, 14, 17, 19)

The dressing of catheter exit site can be done either with transparent semi-permeable dressings or standard gauze dressings. Topical antibiotic ointments such as mupirocin, povidone-iodine, or polysporin triple antibiotic ointment at the CVC exit site have been shown effective in reduction to catheter related bacteraemia. Medical-grade honey has also antimicrobial effects and have equivalent efficacy as mupirocin for CRB prophylaxis. Mupirocin nasal decolonization in HD patients has also been shown to reduce the rate of S. aureus bacteraemia by 78%. But it is not used routinely in the HD population as it is cost effective, may require repeat applications and due to emergence of resistance. (Article 2, 6, 7, 11, 12, 14, 18, 19)

Article 16 adds that there are no reports of microbial resistance to povidone-iodine in dialysis patients. Also, a 6-year prospective follow-up study using a polysporin triple ointment application at the exit site of HD catheters has not shown any microbial resistance or loss of efficacy for infection prophylaxis. Likewise, the microbial resistance to honey has also never been reported and it can be a promising future topical agent for CRB prophylaxis.

In article 18 the efficacy of a chlorhexidine (CHG) sponge has also been analyzed in 601 patients with cancer receiving chemotherapy. The incidence of CRBSI was reduced in patients receiving the CHG sponge compared to standard dressings. In a prospective, randomized, assessor-blinded study has shown that the CHG-impregnated sponge was associated with a lower rate of catheter colonization and CRBSI even when the background rate of infection was low. Furthermore, there was no evidence of increased bacterial resistance at the site of insertion. Based on these data, CHG-sponge dressings should be used in patients undergoing short-term vascular catheterization. CHG-sponge has also been added to 2017 updated CDC recommendations. In case of inconsistent practice of chlorohexidine sponge the Chlorhexidine, gel pad can also be used. (Article 2, 9, 18 &19)

There are two published studies in which chlorhexidine-based exit site applications were performed in patients using temporary catheters (TCs) for hemodialysis, however the outcomes are conflicting. The first study compared a chlorhexidine-impregnated sponge dressing vs. a transparent dressing (dressings were changed weekly in both groups), and found no difference in CRBSI in a small crossover study.[18] In contrast, a significant reduction in CRBSI was reported in a recent quality improvement project using chlorhexidine transparent dressings (changed weekly) vs. dry gauze dressings and antibiotic ointment (changed thrice weekly). A well-powered, and well-designed study

is needed to evaluate chlorhexidine-based exit site applications for use in hemodialysis TCs. (Article 5, 9 &18)

Needleless Connectors/Catheter hub devices

Articles (3, 6, 7, 9, 11, 12, 15, 16, 17, 18, 19, 20) described and recommended the use of a variety of novel products that have been developed to minimize contamination of catheter access ports. One of these products is the TEGO needle-less connector system which is a neutral valve connector and is designed to decrease catheter hub manipulation and minimize contamination via the use of a silicone barrier system. This apparatus was also designed to avoid the need for heparin-locking solution as an anticoagulant and is should be changed once a week. Also, the Curos Disinfecting Port Protector is a plastic threaded device that contains 70% isopropyl alcohol and is designed to be used in conjunction with Luerlock needleless systems. Another product is catheter hub device which is developed for CRBSI prevention is the ClearGuard HD Antimicrobial Barrier Cap (Pursuit Vascular, Inc.) which contains a rod coated with chlorhexidine, which extends into the TC hub, and is changed three times a week, using heparin lock.

The authors in article (3) claim that the Clear-Guard HD cap is FDA approved for use in HD patients with Tunneled Catheter as it is effective and has a low-risk of resistance. In a recently published prospective cluster-randomized trial compared CRBSI rates between HD facilities using the ClearGuard cap with HD facilities using the Tego® connectors with Curos (3 M Healthcare) disinfecting caps. The use of the ClearGuard cap was associated with a significant (63%) reduction in CRBSI compared to the Tego® connectors + Curos cap.

The needle-less connectors need to be disinfected properly prior to access, preferably with chlorhexidine-based disinfectants (chlorhexidine with alcohol, povidone iodine, and iodophor, or 70% alcohol). Among the available devices, split system valve designs are preferred over positive pressure mechanical valves because they are associated with a lower rate of CRBSI. If not handled properly, these connectors have been shown to increase the rate of CRBSI. (Article 6, 9, 11, 12, 15, 16, 18, 20).

Article 3 also describes more about the advances in catheter-coating technology that provides more prophylactic options against CRBSI. Such as, Nano silver deposition over dialysis catheters that blocks the adhesion of S. Aureus on catheter surface. Organoselenium compound can prevent the development of S. aureus biofilms within 3 days in HD catheters and in temporary non-tunneled hemodialysis catheters the Bismuth coating is reported very useful in respect to reduce the bacterial colonization.

Prophylactic Antimicrobial locking solutions (ALSs or AML)

Prophylactic Antimicrobial locking solutions involves instillation of a disinfectant solution into the intraluminal portion of a dialysis catheter between treatments to sterilize the interior part of the catheter from biofilm and preventing infection prevention. Though the continuous use of antibiotic locking solutions is not preferred due to resistance development in the organisms, patient situation of susceptibility to infection may require. Choosing of solutions are dependent on the hospital facility protocol and the need of patient determine by the doctor. It is strongly recommended for the nurses for what they are putting and why for getting the best quality and patient safety. Nurses are recommended to be aware about the characteristics of locking solutions and long-term side effects such that they can explain to patient and use them effectively. Some locking solutions are Taurolidine, Ethanol, Acetylase and heparin. (Article 3, 6, 9, 12, 14, 15, 16, 17, 18, 20).

In addition to AMLs the author in Article 16 is also focusing on antimicrobial coated catheters which is slightly helpful in reducing blood stream infections.

Cleaning and disinfecting the environmental surfaces and equipment

The external surfaces of equipment such as hemodialysis machine, chair, bed, trolley and all other environmental surfaces inside hemodialysis setting specially the ones that are touched by patients and health care providers should be cleaned and disinfected at the start and end of each procedure to prevent and control the spread of microorganisms. Friction during cleaning of surfaces is emphasized since some organisms like Clostridium difficile cannot be removed from surfaces without friction. Such organisms are not easily inactivated by most disinfectant except the bleach and friction. (Article 10, 11, 4)

Apart of external surfaces in hemodialysis settings, the authors in article 10 has also emphasized that all reusable items should be cleaned and disinfected before it is used for another patient such as reusable jugs for mixing bicarbonate solution, priming buckets and external pressure transducers. Due to current developed technology in some of the newer models of HD machines, prime collection bags or transducer protectors are not even required, because priming solutions can be drained by connecting the bloodline to a drainage port in the machine and blood pressure sensors are completely non-invasive without using transducer connections and protectors. Hemodialysis staff are emphasized to be precise on using the HD machine with Association for the Advancement of Medical Instrumentation standards (AAMI). The CDC and APIC guidelines suggest the disinfection of internal fluid pathways of hemodialysis machine only at the start or at the end of the day. It is recommended between patient uses. (Article 10, 4)

After each session of dialysis, articles 10 and 4 describes that the external surfaces of hemodialysis machines should be cleaned and disinfected based on manufacturer's recommendations. If blood spills or any other infectious material are visible or present on the external surface, it should be removed and cleaned separately (not to spread) before using the disinfectant solution. In such cases, it is recommended to apply an intermediate-level disinfectant or tuberculocidal agent (with specific label claims for HBV and HIV) or a 1:100 dilution of a hypochlorite solution (500– 600 ppm free chlorine). In case of disinfectant wipes, one wipe should be used separately to remove or clean the blood stain followed by more wipes for disinfecting the area. All external surfaces of the machine, especially the surfaces frequently touched by health care providers such as front panel, including the intravenous pole, the side, back and base, should be regularly cleaned and disinfected using friction and be allowed to air dry. (Article 10)

Safe injection practices

In general, apart from aseptic techniques, according to articles (10, 49) CDC and APIC have more specific complementary recommendations for haemodialysis during the clinical procedure of injection giving. They are described as; all single use injectable medications and solutions should be dedicated for only one time use and for a single patient. Multi-dose packaged medications should be assigned to a single patient whenever possible. Medication preparation should be done on a clean surface a way from patient treatment area and should be delivered separately for each patient. Multi dose medication vials, syringes, alcohol swabs or supplies in pockets should not be carried from one

station to another. Once unused medications or supplies taken to the patient's treatment area should be used only for that patient and should not be returned to the common clean area or to another patient. Medication delivery carts should be cleaned and disinfected regularly between patients. The CDC's full recommendations for safe injection practices are further recommended.

Regarding the Prevention of Catheter-Related Infections in needleless intravascular catheter systems the updated CDC guidelines (2011) of scrubbing and soaking of the catheter access port with an appropriate antiseptic such as chlorhexidine, povidone iodine, an iodophor or 70% alcohol was recommended. For dialysis bloodstream infection (BSI) prevention the routine scrubbing of dialysis catheter hubs (after cap removal before accessing and before replacing a new cap) with an appropriate antiseptic was included as part of a recent CDC's core interventions. (Article 15)

In order to avoid passage of used antiseptic solution into the bloodstream the dialysis health care providers should be very careful, so it is recommended to choose a safe and non-toxic solution for cleaning an open catheter hub. In such cases only wiping is not enough so friction and scrubbing is emphasized. (Article 15)

Screening/routine serologic testing and patient placement

The current status of the patient regarding different communicable diseases are strongly considered to recognize for all dialysis execution sessions. According to article [10] all haemodialysis patients should be screened for Hepatitis B, Hepatitis C, Human immunodeficiency viruses (HIV) and Tuberculosis infections. Except for HBV isolation, due to the following reasons the APIC, CDC and KDIGO did not recommend the isolation of HCV and HIV infected patients during haemodialysis treatments. HCV and HIV are not transmitted as efficiently as HBV, standard precautions and the specific measures of infection control recommended for haemodialysis settings are considered to be sufficient to prevent their transmission.

Infection prevention and control practices for hemodialysis settings are stricter compare to the standard precautions used in hospitals. However, extra safety measures and precautions are recommended for patients who are at risk of transmitting the pathogenic organisms. For example, a patient with infected skin wound and drainage, incontinence or diarrhea. The drainage from infected skin wound must be cultured for positive or negative for VRE (Vancomycin-Resistant Enterococci),

MRSA (Methicillin-resistant Staphylococcus aureus) or other specific pathogens. The extra safety measurements or precautions for such patients include, placing the dialyzing patient at station need slight adjacent (such as at the end corner of the HD unit), health care provider's needs to wear a gown over usual clothing, proper removal and disposal of the gown at the end of caring process and no contact of health worker with other patients while caring for risky one. [Article 10]

To promote compliance, the dialysis settings should provide required materials in waiting and treatment areas. These materials include supplies of tissues, pedal-operated waste containers, alcohol-based hand rubs and supplies for hand washing close sinks. Symptomatic patients such as influenza patients are given face masks to use, isolated in a single room, kept away from others (at least 3 feet away) in waiting areas and instructed to observe respiratory hygiene/cough etiquette. If not possible, then dialysis will occur in an area with few adjacent stations in 3– 6 feet away from other patients, separation the treatment area with curtains and minimize contact with other patients. The health-care providers caring for such patients should wear a surgical mask, a properly fitted respirator (airborne pre-cautions) and perform hand hygiene as indicated (droplet precautions). Only immunized personal should care for these patients because they may have vaccine-preventable diseases such as mumps, rubella and diphtheria. [Article 10]

The air-born infected hemodialysis patient should be treated in an air-borne infection isolation room (AIIR), which is equipped with monitored negative air pressure (12 air exchanges per hour for new construction and renovation and six air exchanges per hour for existing facilities; air exhausted directly to the outside or re-circulated through HEPA(high efficiency particulate air) filtration before return). Inside the AIIR the patient may remove the mask. After the patient leaves the AIIR, the room should remain vacant for at least one hour to allow for a full exchange of air. It is recommended to assign documented immunized skilled certified health care providers to take care for patients in AIIR. [Article 10]

Immunization of patients and health-care personnel

Immunization recommended for patients with chronic kidney disease (CKD), especially dialysis dependent patients include hepatitis B vaccine, pneumococcal vaccine and influenza-inactivated vaccine (IIV). Other vaccines are also recommended if needed for the infection prevention

maintaining the proper record files and updating as per need. Immunizations recommended for dialysis personnel include Hepatitis B vaccine, Influenza vaccine, Measles, mumps and rubella (MMR) vaccine, Varicella vaccine and tetanus, diphtheria with acellular pertussis (Tdap) vaccine. Hepatitis B immunization is specifically recommended for susceptible health-care providers who are at risk for blood and body fluids exposure like hemodialysis personnel. [Article 10]

Further, infected HBV and influenza hemodialysis patients should be treated in an isolation station with dedicated room, machine, supplies, and health care providers. (Article 10, 11, 4)

Educational activities for staff and patient

Education and training in infection prevention and control should be provided and repeated at least once or twice a year on regular basis to all health-care workers. Basic principles and practices for preventing the spread of infections should be covered and staff competencies should be evaluated and documented, and this should be repeated as appropriate for the specific staff and position. The patient(s) and/or healthcare provider(s) should also be educated using different tools on the care of new access and if there are any changes in access type such as the patients need to be educated about the type of hemodialysis access they receive (Article 15). The main components of patient education include hand hygiene, infection clinical feature, basic infection control practice during catheter accessing process, access care at home and risks associated with catheters (Article 12). Education with implementation and regular monitoring using IT (information technology) hardware and software's is the key for infection prevention for nurses. Nurses educates the patients about infection preventions according to the need of the patients individually or publicly on hemodialysis unit's places using the posters or display screens through instructive information of clear, simple and appropriate languages. Article 17 has mentioned about the 5 steps (web based education program, making ready CVC insertion cart ,use of daily checklist during patient rounds, using the checklist by the bedside by the nurses during the procedure, empowering the nurses to stop procedure if the guidelines are not followed properly) infection prevention model of Berenholtz et al (2004) which are utilized by other studies as well. (Article 2, 4, 6, 9, 10, 11, 12, 13, 15, 16, 17, 19, 18, 20)

Article 11 has also focused about online trainings developed by CDC for continuous educations because it is the organization concerned with the infection prevention research and education programs. Similarly, article (16) has described about standard application of education program in

vascular access care for patients. Article 17 describes didactic educational program a 10-page self-study module with a pre and post-test, posting pictures of every step of care process and yearly lectures to the nurses achieved success in community hospitals. Articles (5,7) described the showering techniques for HD patient with CVC particularly it is more important when the catheter insertion point is not healed yet. Patients awareness is essential about HD access types that CVC is more prone and open to infections compare to AVF and AVG (Article 17).

Kotter and Rathgeber (2005) a process of eight steps of successful change in case of infection risks has been described which involves creating a sense of urgency, pulling together a guiding team, developing a vision and strategy, communicating for understanding, empowering others to act, producing short term wins, not letting up, creating a new culture. Educating and involving the staff in this process can help build momentum to support changing practice. Although the process takes time and planning, it is possible to achieve goals when staff understand the goals, feel empowered to make a difference, and have consistent feedback on progress. (Article 19).

Continuous quality improvement through tracking the failures in infection

Reducing infections or establishing continuous quality improvement in hemodialysis care, it is important to track and analyze the risk during the care process. To do so, it has been suggested to use the Healthcare Failure Modes Effects Analysis (HFMEA) tool, Failure Mode effects analysis (FMEA). According to article (1) these tools proactively evaluate the healthcare processes in different environments and aims on prevention and risk analysis. Also, it helps to understand how a care process can fail and how it can be made safer before any adverse effects occurs finding the root cause. Similarly, the authors of some units of this study emphasized a centralized surveillance system for health care associated infections like the CDC's National Health Care Safety Network (NHSN) following strictly for the participating requirements and rules for the dialysis event protocols. From this centralized surveillance system hemodialysisiss units are updated by latest information for the patient safety and quality updating. (Articles 4, 6, 9, 11, 10, 12, 13, 15, 16, 17, 20)

Furthermore, article (1) specifies proactive action by considering the probability of failures in the haemodialysis unit by following PDSA (Plan-Do-Study-Act) model with full monitoring for the nurses to improve the patient safety.

Waste product management in hemodialysis centers

Hemodialysis units where the invasive procedures take place in the patient, have the waste product and can be a potential source of infection. They must be organized through distinctly defined procedures. The CDC and APIC have recommended specific measures which has been reported in researched articles that include the following, items taken into an individual patient's HD station should be used only for that patient and be disposed of after use, unused item(s) should be cleaned and disinfected before returning to a common clean area or used on another patient or be disposed of if it cannot be disinfected and non-disposable items that cannot be comprehensively cleaned and disinfected such as adhesive tape, cloth-covered blood and pressure cuffs should be dedicated for use on a single patient before it is used for another patient. There should also be a clear separation for storage and handling of clean supplies and medications from contaminated items for example used supplies/equipment, blood samples, biohazard containers. (Article 4, 10)

8. Discussion

The reviewed articles have evaluated different nursing interventions using different approaches to reduce the risk of infection in haemodialysis patients. The literature review has provided us the approaches to understand the infection risks and nursing interventions. Most of the articles have evaluated the impacts of all aspects and reported remarkable and noticeable reduction rates of infections among haemodialysis patients and nursing staff. However, the studies have claimed the reduction of infections with different rates, still some efforts are needed so that the implementation and compliance to recommended guidelines of infection prevention are improved.

In respect to infection risks, the study has summarised the four different sources that can cause or contribute to infection, the patient, the healthcare provider, the equipment and the environment. Diabetes, longer duration of CVC, old age, serum low level of haemoglobin and albumin, past catheter-related bacteraemia, catheters in left-sided internal jugular vein, immunosuppression, recent surgery, nasal carriage of staphylococcus aureus, poor hand hygiene, hypertension and atherosclerosis are significant risk factors that can make the haemodialysis patient more susceptible for being infected. This finding is also supported by Lisa M. Miller et, al (2016) as at the same time insisting on clinical feature because it helps the care providers to act on time for prevention.

In addition, Karkar A. et al (2014) in his study have provided a broader view on sources of infections in haemodialysis settings as, that HD patients can be exposed to different types of infections, such as bloodstream infections and local infections of HD access sites, blood-borne infections with HBV, HCV and/or HIV and airborne infections like tuberculosis. The sources of infection in dialysis centres could be contaminated water, tools, environmental surfaces in care area and already infected patients. Skin flora is also one of the significant associated risk factors for colonization of catheters which leads to the production of biofilm and acts as a reservoir for infectious bacteria, this concept is been supported by Soi, V. et al, (2016).

Regarding nursing interventions, this study has reported guidelines and recommendations on infection prevention and control for implementation in the hemodialysis centers from different international organizations such as Centers for Disease Control and Prevention (CDC), the Association of Professionals in Infection Control (APIC), the Kidney Disease Outcomes Quality

Initiative (K/DOQI), the European Best Practice Guidelines/European Renal Best Practice (EBPG/ERBP) and the Kidney Disease: Improving Global Outcomes (KDIGO). Most of the studies have supported the CDC and APIC guidelines.

The use of topical antimicrobial ointments, dressings, intranasal ointment, prophylactic antibiotic and non-antibiotic catheter locking solutions, needleless connectors or catheter hub devices for the prevention of catheter blood stream infections have also been reported in most of the studies. (Karkar A. et al 2014)

Regarding the Prevention of Catheter-Related Infections in needleless intravascular catheter systems the updated CDC guidelines (2011) of scrubbing and soaking of the catheter access port with an appropriate antiseptic such as chlorhexidine, povidone iodine, an iodophor or 70% alcohol is recommended. For dialysis bloodstream infection (BSI) prevention the routine scrubbing of dialysis catheter hubs (after cap removal before accessing and before replacing a new cap) with an appropriate antiseptic was included as part of a recent CDC's core interventions.

On admission all haemodialysis patients should be screened for Hepatitis B, Hepatitis C, Human immunodeficiency viruses (HIV) and Tuberculosis infections. The APIC, CDC and KDIGO did not recommend the isolation of HCV and HIV infected patients during haemodialysis treatments Except for HBV isolation

For reducing infections or establishing continuous quality improvement in hemodialysis care, it is important to define and analyze the risks during care process. To do so this study has suggested to use the Healthcare Failure Modes Effects Analysis (HFMEA) tool. HFMEA tool proactively evaluates the healthcare processes in different environments and aims on prevention and risk analysis. Also, it helps to understand how a care process can fail and how it can be made safer before any adverse effects occurs. This tool is been supported by American Nephrology Nurse's Association. It is a five-step process of defining the failure issue, preparing the team, conducting the hazard analysis and Action with outcomes analysis (DeRosier et al., 2002). By completing HFMEA, it is essential to identify and review the infection risk whether it is in a central venous catheter (CVC), an arteriovenous graft (AVF) or an arteriovenous fistula (AVF) patient. (Strong, 2010)

The advances in technology have also provided prophylactic options against infection in hemodialysis patients especially in CVC cases. Such as, the TEGO needle-less connector system (Victus Inc., Miami, FL, USA), the Curos Disinfecting Port Protector (Ivera Medical Corporation, San Diego, CA, USA) is a plastic threaded device that contains 70% isopropyl alcohol and the ClearGuard HD Antimicrobial Barrier Cap (Pursuit Vascular, Inc.) which contains a rod coated with chlorhexidine. The use of the ClearGuard cap was associated with a significant (63%) reduction in CRBSI compared to the Tego® connectors + Curos cap (P = 0.003). The Clear-Guard HD cap is FDA approved for use in TC used for HD, is efficacious and has a low-risk of resistance.

Skin can be cleaned with Chlorhexidine, povidone iodine or alcohol. Chlorhexidine has been shown more useful than povidone iodine and alcohol. An alcoholic chlorhexidine solution (1% to 2% chlorhexidine gluconate in ≥ 70% ethyl or isopropyl alcohol) should be used to clean the subjective area. This antiseptic solution should be applied with friction for at least half a minute and let it to dry itself without wiping or blotting. Povidone-iodine 10% in 70% ethanol should be used if Chlorhexidine is contraindicated. This finding has been supported by Lisa M. Miller et, al (2016) and Neil Gupta (2013).

Antimicrobial lock (AML) therapy involves instillation of a disinfectant solution into the intraluminal portion of a dialysis catheter between treatments to sterilize the interior of the catheter from biofilm. While treating an established infection has been considered appropriate therapy for catheter salvage, the prophylactic use of AML has been controversial, given concern for the emergence of resistant organisms. So, the prophylactic antimicrobial locking solutions (ALSs) and their resistance is also a concern in reduction of CRB in HD patients. Instead the use of non-antibiotic locks would be a desirable solution.

In 2017 update to the 2011 CDC guidelines for intravascular catheter related infection prevention, chlorhexidine impregnated sponge dressings have been newly added as an alternative to ointments at the exit site for prophylactic use in short term, non-tunneled catheters. These data are derived from studies performed in hospitalized adult patients with short term, non-tunneled catheters in an ICU setting in which there was a marked reduction in the CRBSI rate using chlorhexidine impregnated dressings. (Lok & Mokrezycki, 2011).

In relation to waste product management in hemodialysis centers and safe injection practices, almost the studies in articles were similar and agreed on CDC and APIC recommended guidelines.

Researchers here express about the practicalities and limitations of applicability of solutions/interventions offered by the analysis of articles like total number of handwashing 30 times per hemodialysis sessions to nurses in respect to available resources like time, number of patients to be treated. It would be more practical if there is some technology of disinfectant for quick disinfection or sterilized environment in clinical procedure such that nurses could meet the standard evidence-based practices absolutely and infection prevention aim will be enhanced.

The concept of Joanne theory of Quality Care Model became useful in finding the nursing interventions and risks based on latest evidenced practices. Providing best professional caring activities for patient can create the feeling of cared of, being safe and to be active in own care through learning new behavior which leads to new self-advancing system of infection prevention. The understanding of infection risks and implementing nursing interventions based on evidence are well enough to create the trust and feeling of care in patient. Additionally, the education and continuous quality improvement culture specifically in infection prevention shows the professionalism in the health care providers. Simultaneously, the possibility of infection transmission in every clinical and non-clinical procedures due to pathogens by Germ theory of Pasteur was considered while determining the nursing interventions and risks.

9. Conclusions and recommendations

The researchers have collected only twenty articles, the conclusions can be impossible to make for the nursing world based on such few numbers of articles with number of limitations explained in exclusion and inclusion criteria. However, according to the researcher's literature review the followings are conclusive points to be considered for the nurses with respect to risk factors and nursing interventions for infection preventions. According to this literature review CDC, WHO and APIC guidelines are mostly found accepted for the infection prevention for dialysis patients.

Patient related infection risks are poor hygiene, perspiration under dressing, nasal carriage of staph aureus, catheter's exit site manipulation, removing the dressing at home, showers and wet dressing, sneezing on exposed HD access sites and unintentional removal of dressing during activities or sleep. Diabetes, longer duration of CVC (more than 10 days), old age, iron overload, serum low level of hemoglobin, weak immunity and albumin were also mentioned as risk factors for CVC patients. Skin flora is also considered as a risk of infection.

Nurse related infection risks are lack of aseptic technique skills in procedure, poor hand hygiene during HD procedure, no change of gloves, poor site cleansing, improper handwashing and not using the personal protective equipment. Lack of understanding about clinical feature of infections. Fever and chills are considered the most sensitive clinical features. Lack of vaccinations and continuous education.

Environment and equipment related infection risk factors are unclean home, pets at home, airborne pathogens, air drafts on open HD access site, cracked and improperly fitted caps and contaminated supplies. Infected patients, small spaces between patient beds and poorly designed devices used in HD. Lack of supply of sterile field in the HD execution. Lack of monitoring the standard instruments for their sterilization.

Hand hygiene considered as the most important concept of infection prevention. At least it has to be performed 30 times / HD session regardless of use of gloves. Friction is important. Hand washing with soap and water is strongly recommended when hands are clearly spoiled. Alcohol-Based Hand

Rubs (ABHRs) is recommended to be used in all clinical situations particularly when hands are not visibly soiled. Long nails, artificial fingernails or extenders or jewelry are recommended not to be used during HD care.

Gloves must be used when contacting patient's intact skin or equipment during procedure. Sterile gloves are needed during CVC insertion procedure. When splashes of blood are anticipated such as at the start and at the end of dialysis procedure, the wearing gowns over the uniform with face mask and eye protectors are recommended.

During catheter handling, the use of a face shield and a surgical mask are recommended. It is equally important if the patient is also using a mask and turning the face to opposite side, so the health care provider and patient's catheter insertion site is protected from droplets. Also, the use of mask is more important when a patient, health care provider or a visitor has cold or symptoms like cough.

HD patient's Skin can be cleaned with Chlorhexidine, povidone iodine or alcohol. Chlorhexidine has been shown more useful than povidone iodine and alcohol. Antiseptic solution should be applied with friction for at least half a minute and let it to dry itself without wiping or blotting. Povidone-iodine 10% in 70% ethanol should be used if Chlorhexidine is contraindicated.

The catheter insertion site should not be touched and can be kept cleaned with available and recommended antiseptics ointments. Also, the access port of catheter should be scrubbed with an antiseptic (chlorhexidine, povidone-iodine, or 70% alcohol) before connecting it to a HD device.

Chlorhexidine 2% and alcohol 70% or povidone-iodine 10% solution are recommended for catheter exit site care. Insertion site cleansing with chlorhexidine scrub for 30 sec (self-dry). Prior to catheter access, two 30-second scrubs of alcohol wipes and masks on. Topical antibiotic ointments (mupirocin, povidone-iodine, or polysporin triple antibiotic) are effective in reducing CVC related bacteremia. Medical-grade honey has also antimicrobial effects and have equivalent efficacy as mupirocin for CRB prophylaxis. (No report of bacteria resistance). Dressing can be either with transparent semi-permeable dressings or standard gauze dressings. If not sponge then gel pads of chlorhexidine also available.

According to needleless connectors the use of the ClearGuard cap (FDA approved) was associated with a significant (63%) reduction in CRBSI compare to the Tego® connectors and Curos cap. Nurses are also recommended to be aware about the characteristics of locking solutions and long-term side effects such that they can explain to patient and use them effectively according to patient's situation.

All single use injectable medications and solutions should be dedicated for only one time use and for a single patient. Multi-dose packaged medications should be assigned to a single patient whenever possible. Medication preparation should be done on a clean surface a way from patient treatment area and should be delivered separately for each patient. Multi dose medication vials, syringes, alcohol swabs or supplies in pockets should not be carried from one station to another.

Prior to admission, all hemodialysis patients should be screened for HBV, HCV, HIV and TB. HD HBV positive and influenza patients should be treated in an isolation room. Immunization recommended for HD patients HBV vaccine, pneumococcal vaccine and influenza-inactivated vaccine (IIV). Immunization recommended for HD HCWs include, HBV, Influenza, MMR, Varicella and tetanus and diphtheria with acellular pertussis (Tdap) vaccines. HBV immunization is specifically recommended for susceptible health-care providers who are at risk for blood and body fluids exposure like hemodialysis personnel.

Educational activities for staff and patient are recommended at least once or twice a year on regular basis. Also, basic principles and practices for infection prevention by HCWs should be evaluated and documented. Waste products in HD settings can be a potential source of infection, they must be organized in the distinctly defined procedures.

Possibly the creation of an ideal environment of infection prevention with absolute success is a great challenge for nurses due to various factors. The initiatives of infection prevention culture in a multidimensional approach based on evidence can guide the nursing professionals to reach this aim.

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Appendixes

Table 1.

Databases (Searching engines)	Key words used	Number of hits	Number of articles chosen
Academic Search Elite (EBSCO)	risk factors AND hemodialysis access sites	1	0
			1
	hemodialysis access sites AND infection prevention	19	1
			4
	hemodialysis access sites AND infection	93	
	hemodialysis patients AND infections	235	
Total from Academic Search Elite (EBSCO)		**348**	**6**
CINAHL(EBSCO)	Hemodialysis access	3	1

	Hemodialysis access sites AND infection prevention	15	3
Total from CINAHL (EBSCO)		**18**	**4**
SAGE journals	Hemodialysis access AND infection prevention	215	2
PubMed	hemodialysis access AND infection prevention	58	5
	Risk factors in hemodialysis access sites (From 2009/01/01 to 2019/01/31)	44	1
		20	1
	Prevention and management of catheter related infections in hemodialysis patients (Free full text, 2009-2019)		
Total from PubMed		**122**	**7**
	hemodialysis access AND infection prevention 2009-2019,	7	1
	Hemodialysis Infection Prevention (2009-2019, research articles, open access)		1
		11	

Science Direct	Vascular access complications and risk factors (2009-2019, research articles, open cases)		0
	Risk factors in hemodialysis access sites (2009-2019, research articles, open cases)	34	0
		8	
Total hits from Science Direct		**60**	**2**
Cochrane Library	vascular access sites infection prevention AND nursing	0	0
Total number hits		**763**	**20**

Table 3. Information about 20 articles chosen for this study.

Author(S)	Article	Journal & Year	Purpose of the study
Article 1 CNE Shean Strong Lisle Mukai	A New Quality Approach to Reducing Vascular Access Infections	2010	Outline the factors that can cause or contribute to infection. Reducing Vascular access infections

Article 2 Shigeki Toma Takahiro Shinzato Kunihiro Hayakawa	Access relating infections related button-hole techniques	Blood Purification 2016; 41:306 – 312 2018	development of access-related Staphylococcus aureus infections in patients on buttonhole (BH) method and logically construct a measure to prevent such infections on the basis of the mechanism.
Article 3 Lalathaksha Kumbar and Jerry Yee	Current concepts in haemodialysis vascular access infections	ACKD 2018 by the National Kidney Foundation	overview of hemodialysis catheter-, graft-, and fistula-related infections with emphasis on diagnosis and management in specific settings
Article 4 Sally Hess and Virginia Brent	Essential components of an infection Prevention Program for outpatient Haemodialysis Centers	UNDERSTANDING & PREVENTING INFECTIOUS Complications in Dialysis, 2012	essential core components required for an effective infection prevention program, extrapolating from acute-care programs and building on current dialysis guidelines and recommendations
Article 5 Timmy Lee and Charmaine E. Lok	From Barrier Protection to Showering, Extraluminal Prophylaxis and Management of Catheter Infections	Seminars in Dialysis—Vol 29, No 3 (May–June) 2016	Prevention and Treatment of Extraluminal Catheter Infections

Article 6 Lesley C. Dinwiddie Cynthia Bhola	Hemodialysis Catheter Care: Current Recommendations for Nursing Practice In North America	CNE 2010 American Nephrology Nurses' Association	recommendations for nephrology nursing in caring for adults having a catheter for HD.
Article 7 Elizabeth C. EvaLeslie A. Dork Debra HainChristine Schrauf Tamara M. Kear	Haemodialysis Catheter Outcomes Pilot STUDY, No Dressing Coverage with Prescribed Showering	CNE, Nephrology Nursing Journal January-February 2014.Vol. 41, No. 1	the outcomes of a haemodialysis catheter pilot study on dressing coverage with prescribed showering.
Article 8 Farida Sahli, Razika Feidjel, Rima Laalaoui	Haemodialysis catheter- related infection: rates, risk factors and pathogens	Journal of Infection and Public Health (2017) 10, 403— 408	Promotion of the infection control precautions by educating and training the health providers
Article 9 Lisa M. Miller[1], Edward Clark[2], Christine Dipchand[3], Swapnil Hiremath[2], Joanne Kappel[4], Mercedeh Kiaii[5], Charmaine Lok[6], Rick Luscombe[7], Louise Moist[8], Matthew Oliver[9],	Hemodialysis Tunneled Catheter Related Infections	Canadian Journal of Kidney Health and Disease Volume 3: 1–11 2016	definitions for catheter related infections and different preventive strategies are discussed

and Jennifer MacRae[10]; on behalf of the Canadian Society of Nephrology Vascular Access Work Group			
Article 10 Ayman Karkar, Betty Mandin Bouhaha, Mienalyn Lim Dammang	Infection Control in Hemodialysis Units: A Quick Access to Essential Elements	Saudi J kidney Dis Transpl 2014	Prevention and Control of Infections in Hemodialysis Units
Article 11 Neil Gupta, Marjory Cannon and Arjun Srinivasan for the members of the Working Group of the Federal Steering Committee for the Prevention of Healthcare-Associated Infections in End-Stage Renal Disease Facilities	National Agenda for Prevention of Healthcare-Associated Infections in Dialysis Centers	UNDERSTANDING & PREVENTING INFECTIOUS COMPLICATIONS IN DIALYSIS, 2013	focuses primarily on interventions to reduce vascular access-related complications and infections with hepatitis B and hepatitis C virus.

Articles 12 Alexander Schweiger Sergio Trevino [b]Jonas Marschall [a, b]	Nosocomial Infections in Dialysis Access	Patient Safety in Dialysis Access 2015	Recommendations to Improve Patient Safety before, during and after HD
Article 13 Mary Lincoln	Preventing Catheter-Associated Bloodstream Infections in Hemodialysis Centers: The Facility Perspective	CNE, American Nephrology Nurses' Association	To provide an overview of the complication of bloodstream and catheter exit site infections in patients on hemodialysis and describe a team approach to reducing such infections.
Articles 14 Charmaine E. Lok[1] and Michele H. Mokrzycki[2]	Prevention and management of catheter related infections in HD patients	Kidney International (2011) 79, 587–598; doi:10.1038/ki.2010.471; published online 22 December 2010	the epidemiology and pathogenesis of hemodialysis CRB and , interventions that include: the use of prophylactic topical antimicrobial ointments at the catheter exit site, catheter locking solutions for the prevention of CRB, strategies for management of the catheter in CRB, and vascular access managers and

			quality initiative programs.
Article 15 Bernard C. Camins	Prevention and Treatment of Hemodialysis-Related Bloodstream Infections	UNDERSTANDING & PREVENTING INFECTIOUS COMPLICATIONS IN DIALYSIS	Access-Related Preventive Strategies
Article 16 Vivek Soi Carol L Moore Lalathakasha Kumbar Jerry Yee	Prevention of catheter-related bloodstream infections in patients on haemodialysis: challenges and management strategies	International Journal of Nephrology and Renovascular Disease, 2016 Dovepress	Catheter maintenance procedures
Article 17 J. Matthias Walz, MD. Stavros G. Memtsoudis MD, PhD and Stephen O. Heard, Md	Prevention of Central Venous Catheter Bloodstream Infections	Journal of Intensive Care Medicine 2010	Behavioral and Educational Interventions in respect to HD infection prevention
Article 18 Ladan GOLESTANEH, Michele H. MOKRZYCKI	: Ointments, dressings, locks, and catheter hub devices for the prevention of haemodialysis catheter infections	Hemodialysis International 2018; 22: S75–S82	PREVENTION OF CATHETER-RELATED INFECTIONS CDC clinical practice guidelines

Article 19 Nancy Colobong Smith	Prevention of Hemodialysis Central Line-Associated Bloodstream Infections In Acutely Ill Individuals	CNE, Nephrology Nursing Journal, 37(5), 523-529, 2010	To provide an overview of tunneled, cuffed catheter use and quality improvement measures in one center's inpatient hemodialysis setting. Explains the process of hemodialysis catheter care
Article 20 Priti R. Patel and Kristin Brinsley-Rainisch	The Making Dialysis Safer for Patients Coalition, A New Partnership to Prevent Hemodialysis-Related Infections	2018 by the American Society of Nephrology	Core Interventions for bloodstream infection Prevention