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**CENTRAL VENOUS CATHETER: CARE AND PREVENTION OF
INFECTION**

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ABSTRACT

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<p>The rate of catheter-related infection is getting higher. But not all the nurses and patients notice that central venous catheter can cause serious consequences such as central line-associated Bloodstream infections which have high motility and morbidity. We know when the infection happens, it takes a long time to treat it. If the infection gets worse, patient's life will be in danger.</p> <p>We believe that prevention is better than a cure. So, this thesis focusses on the prevention of infection and how to educate patients about the care of CVC. Nurse, patient and patient's family are a team. In order to get better treatment result, we have to work together. This thesis also wants to let nurses be aware of the catheter-related infection.</p> <p>The methodology we used is a literature review. We did the data collection and data analysis. Finally, we found 10 articles that we used to conduct the deeper study. According to our research questions and research study, our results are there are many nursing interventions we can do to prevent infection regarding the CVC. Educating patients not only needs the patient's cooperation, but also nurse's self-development on that knowledge of CVC care.</p>		
Key words Central venous catheter, nursing education , CLABSIs, CVAD		

ABBREVIATION

CVC	Central Venous Catheter
PICC	Peripherally Inserted Central Catheter
TPN	Total Parenteral Nutrition
IV	Intravenous
ICUs	Intensive Care Units
CDC	The Centers for Disease Control and Prevention
CVP	Central Venous Pressure
CLABSIs	Central line-associated Bloodstream Infections
CDC	The Center for Disease Control and Prevention
HABIS	Healthcare-Associated Bloodstream Infections
PPE	Personal Protective Equipment
CVADs	Central Venous Access Devices

ABSTRACT

ABBREVIATIONS

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1 INTRODUCTION

As nursing students, we have studied the fundamentals of nursing knowledge and basic nursing skills already. We have practised in many departments in Chinese and Finnish hospitals. There were many good experiences during the practising. We got inspirations from these experiences. In this thesis, we wanted to select the topic that left us impressions when we practised in the hospital. We found out in most departments that prevention of infection is the priority of nursing work, especially for the departments which give treatment to cancer or hemodialysis patients.

CVC is a very important device that prevents patients from the pain of repeated punctures, it is usually inserted by a doctor; the pre-insertion cares and post-insertion cares are done by nurses. As nurses, it is very important to recognize signs and symptoms of catheter-related infection.

We saw that a lot of patients had an infection after placing the catheter. It is not easy to take care when the infection has already happened. We saw how patients suffered from pain and we knew it needed long-term treatment. We wonder why infections can't completely be avoided. Thus, it can be said that prevention is the most important part of maintaining patient's health. Therefore, we want to do more research and deeper study on the care and prevention of infection cause by CVC.

During our practice in the hospital, we found most patients did not have enough knowledge of CVC. Some of them did not even know the names of the devices that they carried every day. We want patients to know how to take care of CVC in such circumstances and the importance of educating both patients and their families through our thesis.

CVC can establish the intravenous access rapidly, that provides the important guarantee for first-aid of patients, at the same time, it can offer the short-term and long-term intravenous infusion treatments for patients, duration of retaining catheter is 7 days to one year. As for treatment, CVC can directly reach the big veins close to heart, that avoids the direct contact with the arm vein and chemotherapy drugs, which can be quickly diluted drugs, prevent the blood clots effectively. So, CVC application has a wide range of usage in the clinical care at

present. Nurses should pay more attention to the care of CVC, and focus on the prevention of complication, catheter-related infection.

As nurses, we should know the signs and symptoms of infection, the most severe consequence of catheter infection is called central line-associated bloodstream infections (CLABSIs). It is an important indicator of nursing care quality in critical nursing and ICU. The risk of CLABSI increases along with the catheter duration, that also involves a risk to increase the morbidity and mortality. Nurses should make the health professional interventions for the prevention of infection. (Zingg, Cartier-Fässler & Walder 2008, 410).

The purpose of our thesis is to acquire deeper insight into the care of CVC and let nurses know the importance of preventing catheter infection. We hope people can get more familiar with CVC. When they face the situation in case, they will not feel strange to this device and afraid of the procedure. At the same time, we want to improve the nursing skill for the care and prevention of infection related to CVC, which makes people feel comfortable and secure when CVC comes to their lives.

2 THEORETICAL BACKGROUND

Around the discussion on CVC and prevention of infection, our framework will introduce three parts: the definition of CVC, the definition of infection, the prevention of infection and nursing interventions. In this chapter, we aim to provide the clear perspective of the major concepts of the study and research to readers. At the same time, combined with our clinical practice experience, that's more active and meaningful to communicate with readers. Some required and detailed concepts are also mentioned and explained, such as CVC's care, required nursing skills, and detailed definition, these concepts are so important that readers can understand the topic more clearly.

2.1 Definition of CVC

Central Venous Catheter (CVC) is a bigger, longer catheter that's put into a large vein. There are many different kinds of CVCs are available, in clinical, according to illness situation, medical workers can choose short term or long-term CVC for patients to implement treatment, some types of CVCs can stay in for many weeks, months, even years. In addition, the catheter can stay in as long as the patient getting treatment, so, patients don't need to be stuck with a needle each time, which can relieve the pain of patients effectively. Every type of CVCs all have its own specific nursing care because they have different complications and possible problems. So, in this chapter, we will introduce some most common types of CVCs, list the advantages, disadvantages, and applications, that's good to learn for our clinical nursing work.

CVC is vital for the care of hospitalized and critically ill patients because it provides a great venous access to many clinical operations, such as medication infusion, blood sampling, hemoglobin measurement. CVC is more frequently used in ICUs than in other areas of the hospital, and the strongest predictor of developing CLABSIs. Some CLABSIs may be due to infection at other sites, such as pneumonia or urinary tract infection, also at some sites that are difficult to detect, such as gastrointestinal tracts or mucosa by chemotherapy. Even though CLABSIs is very popular and hard to control, CVCs is largely used within the context of clinical care and research. (Fang, Yang, Song, Jiang & Liu 2017.)

2.1.1 Types of CVC

There are different types of Central venous catheter, non-tunneled CVC, tunneled CVC, implantable ports and peripherally inserted central catheter (PICC) are widely used in the clinical work as we observe. Firstly, non-tunneled CVC is a central line which inserted percutaneously into central veins in surgical ways, medical workers often choose subclavian vein, femoral vein and internal jugular for catheter insertion. This kind of catheter is fit for short-term therapy and less than three weeks, that's usually used to give treatment and to take blood. In addition, non-tunneled CVC is the type most commonly associated with CLABSI, so, nurses should pay more attention to the prevention of CLABSI for non-tunneled CVC care. Another type is tunneled CVC, that is the catheter implanted into the large veins and fit for long-term therapy. Tunneled CVC has a cuff below the skin that prevent organisms or migrations down the catheter track, so, its CLABSI rate is lower than non-tunneled CVC. Next one, the implanted port is similar to a tunneled catheter, they are both fits for long-term therapy. Port is a small drum made of metal or plastic with a thin tube going from the drum into a large vein, and it is permanently placed under the skin of the chest or arm during surgery, medicines can go through the skin into a catheter. The last one, PICC is inserted percutaneously into arms and cephalic or enters the superior vena cava. It's usually used for short to intermediate, so it stays in for many weeks to months. (Pittiruti, Hamilton, Biffi, Macfie & Pertkiewicz 2009.)

The four major types of CVC all have different advantages and disadvantages, as a nurse, we should choose the most suitable therapeutic schedule for patients according to the ill situation. The non-tunneled CVC is usually used in short-term therapy, so, that's needed to change the dressing very frequently, otherwise, CLABSI is easy to happen. But non-tunneled CVC also has an advantage, for example, the percutaneous insertion is a not difficult operation so that it's convenient and easy for medical workers to work for CVC. In addition, non-tunneled CVC can relieve the pain of patients effectively, and the cost is quite appropriate. Although the non-tunneled CVC has high likely to get CLABSI, it is more commonly used than long-term CVCs. Tunneled CVCs and implantable ports are both long-term CVC, they are almost the same, the most important disadvantage is the increase of cost, that takes a financial burden for patients, also the increased costs of the hospital. But implantable port can stay in the bloodstream long time, and it doesn't need the special care when there isn't IV medication management in it. (Pittiruti, Hamilton, Biffi, Macfie & Pertkiewicz 2009.)

In clinical, CVC and PICC are both considered as good treatment methods at the same time, different puncture site, different insertion way, different advantages and disadvantages. As a nurse, we should aim to improve the work efficiency and relieve the pain of patients, so, according to evidence-based practice and research, we can compare CVC with PICC in all kinds of features in clinical. The first, the central line compares with peripheral vein remaining needles: CVC can decrease the times of puncture and protect the venous system. So, CVC is usually used in acute and severe major surgery. It's also good for many drug administration therapies in chronic disease, cancer tumor and Intensive Care Units (ICU). Moreover, it can reduce the interruption of treatment to provide safe transfusion pathways, ensure the patient safety issues. However, the CVC needles need to remain for a long time, there are many common life-threatening risk factors associated with central venous catheters (CVCs), such as CLABSIs, so, CVC has a higher occurrence rate of infection than PICCs. (Fang, Yang, Song, Jiang & Liu 2017.)

2.1.2 Clinical application of CVC

CVC is a flexible long and thin tube, in clinical, CVCs usually used for giving medicines, fluids, nutrients, or blood products over a period of treatment. But when we practiced in hospital, we can find out the CVC usually used in cancer and critically ill-treatment, because these patients need most chemotherapy drugs are put right into bloodstreams, if put the needle into vein each treatment, that can cause tears, wear, even broken of veins, so, CVC have this best application for long-term therapy. In addition, CVC are widely used in rapid and large volume expansion therapy, some stimulating and hypertonic drug therapy, such as TPN, amino acid, lipid emulsion, mannitol. Next, sometimes, the treatment needs to get more than one drug at a time or getting continuous infusion chemotherapy, CVC is a necessary method to be recommended. As for patients, some patients with chronic disease don't need to go to the hospital every time, CVC can get treatment at home and get the long-term therapy, that's convenient for patients, and decrease the costs. (Klabunde 2012.)

CVC is also widely used for measurement of central venous pressure (CVP). The CVP monitoring in the critically ill is established that reflects ventricular preloads and represents the driving force for filling the right atrium and ventricle. CVP can indicate the ability of the competency of the heart is pumping, also can estimate the blood volume deficit or overload. As for some cardiovascular diseases, such as heart failure, burns, shock and post-operation of cardiac surgery, CVP measurement can help establish whether the patients need the fluids or diuretics,

in other words, CVP can predict fluid responsiveness has been challenged by the whole body of evidence. At the same time, the measurement results can reflect the patient's response to CVC therapy. So, CVP is often a good approximation of right atrial pressure, it's a useful and important physiological index of the cardiovascular system, it's also an important application of CVC. (Nealis & Buchman 2011.)

2.2 Definition of infection

In this chapter, our discussion point is an infection. Because the topic of the thesis is CVC, and the Central line-associated bloodstream infections (CLABSIs) is the most common and severe infection in all infectious diseases about CVADs (Central Venous Access Devices), it also has a deep influence on medical treatment and research. So, we do the research firstly for CLABSI, it's very good and necessary for our clinical nursing work. Next, there are some main elements about infection, such as the germ (bacteria or virus), the route of transmission, the measurements of the precaution of infection, patient's own factors, the medical treatments, the symptoms of infection. Above all, we do the further research about risk factors and symptoms, we found out the risk factors that are good for early treatment, and it's also a kind of caution in nursing daily work to prevent infection. The symptom is a so good sign that we can find infection in time, when we feel any abnormal situation or suspected the symptoms of infection, we can give the nursing interventions in time. So, three main points are all important and valuable.

2.2.1 Central line-associated bloodstream infections

Firstly, we should know the definition of Central line-associated bloodstream infections (CLABSIs). CLABSI is the patient with a central catheter or removing the catheter within 48 hours appear the bacteremia, at the same time, the patient also appears fever, chill, hypotension and more infection performances, then, except for catheter-related catheter, other sources of infection can't be found. The diagnosis of CLABSI is a positive culture of the catheter with the same microorganism can be found in the blood culture. Absolutely this infection happens on central line, normally we call it CVC. Because the location of the central line often places in the large vein that is close to the heart, such as a jugular vein, femoral vein. So, compared with other intravenous catheters that are used frequently to give the medicine of liquids into peripheral

vessels or arterial line catheter, the CVC is much more likely to cause serious infection. (WHO 2015.)

In the daily nursing work, we can find out CLABSIs has three major transmission pathways. Firstly, we know the bacteria or viruses normally live on the skin, they will sometimes track along the outside of the catheter then spread in the blood. Secondly, if medical workers don't obey the aseptic principle or put in correctly, the central line can become a freeway for bacteria, that can start to grow on the central line catheter, especially in the head of the catheter, because nurses always use the head of the catheter to administrate the medication treatment, so, that is a place that bacteria can easily enter the blood and cause the severe infection, even the death. Thirdly, the infection in other parts of the body can also cause CLABSIs. Because the bacteria can enter the blood circulation, then that maybe touch the catheter in the bloodstream and form a foreign substance, that is a good environment for bacteria to grow up. Even worse, the foreign substance that formation of bacteria can become blood clots and cause the catheter blocking. CLABSIs has wide pathways to transmit, that's why it can cause high morbidity and mortality. (Conley 2016.)

CVADs (Central Venous Access Devices) are very important to the treatment and supportive care for many patients with cancer, dialysis, hematologic diseases, oncology diseases, with the development of advanced medicine and medical device technology, invasive catheters are widely used in medical filed gradually, especially in central catheter, so, CLABSIs has become one of the most common hospitals acquired infections. The occurrence rate of CLABSIs is still quite high, that not only takes a big problem to medical workers, the difficulties of the medical treatment, due to its routes of transmission are various and complicated, the widely used CVC cause the large area patient has high risk to get infection; but also has a big influence on patients, such as the duration of hospital stay get longer, the increase in hospitalization costs, the increase in the pain of patients.

2.2.2 Risk factors

CLABSI is usually associated with many kinds of risk factors, we have to research and analyze these risk factors, it's very important for the early detection, early diagnosis, early treatment. There are some main risk factors in daily nursing work, such as the location of catheter insertion,

the duration of catheter retention, the type of catheter and some infusion treatment problems. With the widely used of CVC, we can find out different patients have a different situation, the age, the history of medicine, the immunologic function and more objective factors all have a high risk to cause infection. (Tao, Zhou, Gong, Liu, Long, Huang, Luo, Peng & Wu 2015.)

As for the prevention of infection, the most important advance is CLABSIs prevention. Some advances have been the identification of individual risk factors associated with prevention infection, which include lengthy hospitalization before venous catheterization, the hospital environment, and medication usage situation all have an influence on infection condition, prolonged the duration of catheterization. The maintain of catheter need to replace catheter site dressing, observe the situation of puncture site all the time, and keep the clean around catheter sites, inadequate care and maintenance of CVC after insertion is also an important cause for infection control, so, prolonged duration may increase the rate of infection. Heavy microbial colonization at the insertion site, this is a high requirement for daily nursing work, hand hygiene, change the dressing, and aseptic technique, nurses have to try to control infection on these points. On the other hands, many objective factors about the infection control still exist, operators are inexperience or lack of implementation of practice during the CVCs insertion, so, the selection of catheters and sites may also meet some problems due to operator's inexperience. (Lin, Chang, Chen, Yang, Lin, Wu & Huang 2016.)

Nurse care for all kinds of venous catheters every day, according to the patient's own situation and treatment process, nurses can remove the catheter in one day, three days, one week or longer time. The duration of catheter placement has a close relationship with the incidence rate of CLABSI. The prolonged of the catheter remains, medical workers will do more operations on the catheter, that will bring to a series of high-risk problems. If the time that the catheter is exposed to the air is extended, besides, some airborne transmission and droplet transmission are still existing in the environment, which increases seriously the possibility of infection. With the duration of the catheter is extended, the bacteria can also grow on the skin surface, then bacteria have a high risk to enter the catheter and blood and cause CLABSI. CVC is completely implanted in the blood vessel if the duration of catheter retention gets longer, the skin care also gets more difficult, medical workers are easy to ignore the situation of surrounding area of insertion puncture site. If the skin has the signs of redness, harden, fever and swell, maybe the skin ulceration already happened, once the effusions of pus flow out to catheter and blood, the CLABSI will happen. (Tao et al. 2015).

The location of catheter insertion is also an important factor we should pay more attention, even though the CVC is inserted by a doctor, nurses have to know the different anatomy location has different levels of infection risk, that is good for treatment and the prevention of infection. Medical workers usually choose femoral catheterization, internal jugular catheterization, subclavian catheterization. According to the anatomical physiology, the femoral vein has the highest risk to get an infection, because the femoral vein is nearby the urethral orifice, it can easily be contaminated by urine or some other excrements, so, that area has many bacteria cause the high risk to get an infection. As for the internal jugular vein, the neck is easy to sweat and always move actively, so, the dressing is easy to fall off or get wet, which is a good environment for bacteria reproduction. Besides, the neck is normally exposed to air, so, compared with the subclavian vein, the internal jugular vein has more likely to get an infection by airborne transmission. Through our analysis, the subclavian catheterization has the lowest rate of CLABSI. (Callister et.al 2015.)

Some cancer patient or critically ill patient maybe have the oral tube or just having a big operation cause the digestive tract function can't use normally, so, the parental nutrition is necessary for that patient. The use of total parental nutrition is an independent risk factor because the nutrition infusion is a kind of very thick fat emulsion, the concentration is very high, that is easy to cause the catheter blocking. Once the catheter is blocked, the catheter's shape and smoothness will change a lot, bacteria are easy to reproduce and stay in the catheter. In addition, if some patients receive the long-term total parental nutrition treatment, the normal and healthy gastrointestinal bacterial will get disorder, they can change original normal functions of gastrointestinal tracts, patients will have high a risk to get CLABSI. (Pavcnik 2013.)

In fact, patient's own factors have very a deep influence on any infection disease, age, disease situation, immunologic function, the decrease of white cells, these objective factors also have a high risk to cause infection. If the patient is too old, the whole body's immune function goes down, the ability of anti-infection also goes down, that can easily lead to other site infection happen. For example, if the patient gets CVC treatment, at the same time, he gets the urinary tract infection due to the disorder of immune function, the bacteria can transmit to the catheter in the bloodstream and cause CLABSI. In addition, according to different disease situation, patients will get different treatment, as for treatment, the hand hygiene, sterile technique, the

dressing change, and more problems will come out. So, nurses should give more personal care to every patient during the hospitalization.

2.2.3 Symptoms

As a nurse, we should know the symptoms of infection in detail, it's helpful for diagnosis and treatment. CLABSI usually appear a catheter-related bacteremia, its clinical performance has two main types: the sudden chill and high fever, in addition, depending on different situations of disease, patient maybe appears the hypotension, tachycardia, tachypnea, blood poisoning, shock, thrombophlebitis (Xiong & Ren 2010). The high fever and chill are common symptoms of any infection diseases, nurses should check the vital signs all the time for a patient with CVC. At the same time, when nurses change the dressing, it is important to assess the dressing situation and the surrounding skin situation. The dressing gets wet or falls off that are potential symptoms of infection. In CVC care process, the skin of puncture sites often appears some redness, swell, hot, pain and blood leaking, nurses should combine the vital signs assessment to assess CLABSI.

Except for the systemic infection symptoms, CLABSI usually accompanies with some other site infection symptoms, the most major two types are the symptom of digestive tracts and urinary tract. Because the long-term hospitalization and long duration of catheter retention, the immune function goes down, patients will appear some symptoms of digestive tracts: vomiting, nausea, stomachache, abdominal distension, these symptoms have high likely to get CLABSI. Next, the urinary tract infection, because many cancer or critically ill patients usually can't take care themselves and move by themselves. So, they have to have urine catheter, if medical workers don't care it carefully, patients will appear headaches, renal area painful, frequent urine, urgent urine, dysuria and high fever. Although the urine catheter doesn't seem to have any relationship with CLABSI, urinary tract infection can cause the increase in the white cells and disorder of body function, that is potential infection symptoms of CLABSI. (Xiong & Ren 2010.)

2.3 Prevention of Infection: Nursing Interventions

World Health Organization (WHO) and the Center for Disease Control and Prevention (CDC) are involved in setting guidelines for infection prevention. In recent years, healthcare-associated bloodstream infections (HABIS) is growing. The cost of these infections is large, both in financial resources expended and the morbidity of infectious diseases. As for the prevention of infection, there is considerable interest by healthcare providers, regulators, insurers, and patient advocates in reducing the incidence of these infections, which to improve the patient recover condition and to reduce healthcare costs.

The CDC provides timely recommendations about many of the situations that a nurse may face when caring for or teaching patients how to prevent infection in the hospital. And infection prevention can be divided into many parts. Isolations precautions are the basic safeguard for the prevention of infection, that are guidelines created to prevent the transmission of microorganisms in hospitals. The CDC recommends two tiers of isolation precautions, the first tier is called standard precautions, it is designed for the primary strategy for preventing Healthcare-Associated Bloodstream Infections and the care of all patients in the hospital. The second tier is called transmitted-based precautions, it is designed for are of patients with known or suspected diseases spread by some transmission, such as airborne, droplet and contact routes. In this chapter, we aim to do the safety nursing, provide the treatment for patients, at the same time, protect the safety of patients and ourselves. (Calfee 2015.)

2.3.1 Standard precautions

The exposure to body fluid and blood and CLABSI are serious problems that threaten the safety of both patients and medical workers, also include nurses. An infection can result in serious morbidity and mortality, the infections complications can be very serious and cause death. Nurses play important roles in the prevention of infection. Standard precautions include hand wash, eye protection, needle recapping, appropriate glove use and so on. Before and after patient contact, hand wash is necessary to protect the patients and ourselves, and use of face masks, the avoidance of a used needle that is disassembled from a syringe, and the implementation for all patients. (Zitella, Friese, Hauseer, Gobel, Woolery & Andrews 2006, 739-740.)

Hand hygiene is the most frequent cause of infection outbreaks in healthcare institutions is spread of microorganisms by the hands of healthcare workers. Hands should be washed or

decontaminated very frequently during CVC care. In many working places, medical workers used to use alcohol-based products and some antiseptic soaps or gels to wash hands, especially in CVC care, it's very effective to prevent CLABSI. Hand hygiene should go through the whole CVC treatment, at the time of catheter insertion, before wearing the sterile gloves and after removing gloves, nurse both have to perform hand hygiene, this is the first step of sterile technique. Then, also do it before and after inserting, replacing, accessing, changing the dressing or repairing the intravascular catheter. Hand hygiene can reduce the bacterial load and decreases the risk of transfer to other patients (CDC, 2007). Nurses do some basic nursing care every day, such as after taking blood pressure, pulses, lifting or moving patients, these operations all have high possibility that nurses maybe contact body fluids, excretions, mucous, membranes, intact or not intact skin, or open wound dressing, so, nurses have to wash hands very carefully, that protects self, also protect for patients that nurse can't take outside bacteria into body.

All patients are colonized or infected with microorganisms, whether or not there are any signs or symptoms, the care givers should use additional barriers in the form of personal protective equipment. Glove use is also a very important safety guarantee in infection prevention. This is due to the fact that gloves provide an effective barrier for hands from the bacteria or virus associated with patient care. So, the hand hygiene is a basic standard precaution, glove use is a much stronger precaution, when nurse contact with any patient secretions or excretions, they need both hand hygiene and glove use at the same time, then, hands must be washed or disinfected after gloves are removed. (CDC 2017.)

Needle-stick prevention is the most important aspect of reducing the risk of CLABSI, because once the needle-stick happens, the skin will be broken, and bacteria are very easy to enter the blood and cause infection. Extreme care is necessary for all situation in which needles, scalpels, knives, and other sharp objects, nurses should take caution when they use the sharp instruments, never recapped the needle, that's very dangerous to hurt their own hands. (CDC 2017.)

2.3.2 Transmission-Based precaution

In addition to standard precautions, when some patients with known or suspected to have serious infection transmitted by airborne, droplets and contact, transmitted precautions should

be used. There are some strategies for reducing the risk of CLABSI, medical workers try to use all kinds of replaced and improved methods of controlling infection, through a lot of practices, these skills methods were developed based on evidence from clinical training and have become important documents in the field of hospital-acquired infections (nosocomial infections). So, some evidence-based guidelines about transmitted precautions outlined for the Prevention of CLABSI. (Siegel, Rhinehart, Jackson, et al., 2007.)

First, maximal sterile barrier precautions are prominently influential on the whole CLABSI. There are some important preventative measures, the use correctly of sterile gloves, a mask, a large drape, these measures are highlighted to reduce the risk of infections. Next, aseptic skin preparation and catheter access are also important, the use of skin aseptic that include based iodine solution and alcohol and chlorhexidine gluconate during pre-CVC insertion skin preparation. The uses of these skin antiseptics reduce the risk of intravascular catheter-related infection efficiently. (CDC 2017.)

As for contact precautions, that are usually used for organisms that are spread by skin-to-skin contacts, such as antibiotic-resistant organisms. So, contact precautions are designed to emphasize cautions technique and the use of barriers for organisms that easily transmitted by contact between health workers and patients. Ensuring appropriate patient placement is the first step, for example in ICU, when medical workers perform the insertion or caring of an intravascular catheter, we have to block the possibility of infection from all room setting. In the ambulatory setting, place patients requiring contact precautions in cubicles as soon as possible; in long-term and other residential settings, make room placement decisions balancing risks to patients. The environment control is also a part of infection control, prioritize cleaning and disinfection the rooms of patients on contact precautions ensuring rooms, especially frequently touched surfaces in patient care areas, try to develop procedures for routine care. Next, limit the transport and movement of patients, when transport or movement is necessary, cover or contain the infected or colonized areas of patient's body. At the same time, medical workers should also protect themselves, use personal protective equipment (PPE), including the use of sterile gown, sterile gloves, masks, and a sterile full body drape, for the insertion of CVCs, PICCs. But for infection control, medical workers have to remove and dispose of contaminated PPE and perform hand hygiene prior to transport patients on contact precautions. (CDC 2012.)

As for droplet precautions, this is also very widely used in CVC care, because some situations always suddenly happen, so, the precaution should be prepared in advance. For example, when the patient is known or suspected to be infected with pathogens transmitted by respiratory droplets, they are coughing, sneezing, or medical worker talking with them, these respiratory secretions are too close to contact, medical workers have to use droplet precautions. Using PPE appropriately is an important method, put on a mask when entry into the patient room or patient space, and put a mask on the patient. (CDC 2012.)

The airborne precaution is almost requirements are the same with other precautions, but the air environment has a very important influence on the infection control of wound. For example, CVC and PICC puncture site. To prevent airborne infection and maintain the catheter, setting where airborne precautions can't be implemented due to limited engineering resources, masking the patient and placing the patient in a private room with the door closed will reduce the possibility of airborne transmission. (CDC 2012.)

3 AIM, PURPOSE AND RESEARCH QUESTIONS

The purpose of this study is to establish interventions of nurses for infection of Central Venous Catheter and the aim is to provide knowledge for nurses and patients about the care of CVC.

Research questions

1. What are the nursing interventions to prevent infection of a patient's CVC?
2. How to educate patients regarding the care of CVC?

4 METHODOLOGY

In this part, we explain the scientific method to clarify the working process. Writing methodology helps readers understand the validity of the data. There are some difficulties when writing about methodology. It needs to have good structure and layout. We need to find the balance between keeping the section short and having all the relevant information. (Shuttleworth 2009.) In this thesis, we used literature review. We reviewed the most relevant articles that based on our inclusion and exclusion criteria. We show readers how we collected the data and analyzed the data.

4.1 Literature review

The literature review is an overview of a selected topic and sources. Sources can be reviewed include journals, books, reports, etc. The purpose of the literature review is to provide a description of the selected topic. It can identify new interpretations and reveal any gaps in previous studies. The literature review helps to point out the further direction of research. There are 4 steps in the literature review process. Step 1 is making a decision on your topic and the scope of the review. Step 2 is searching databases to find relevant data. Step 3 is reading and evaluating the sources and to determine if they suit to your topic. Step 4 is analyzing, discussing and explaining the selected sources, then give the conclusion based on your analyzing. (Concordia 2017.) About care and prevention of infection of CVC, there is upside potential in this field of nursing.

4.2 Inclusion and Exclusion Criteria

By using the inclusion and exclusion criteria, the author can determine whether the sources are relevant to the research topic or not. Inclusion and exclusion criteria should be clearly and properly defined in order to prevent authors from getting distracted with irrelevant data. The box below includes all the inclusion and exclusion criteria.

TABLE.1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion Criteria

Research articles published during 2007-2017	Research articles published before 2007
Research articles about central venous catheter: care and prevent infection	Research articles not about central venous catheter: care and prevent infection
Research articles are on nursing perspectives	Research articles are not in nursing perspectives
Research articles are in English	Research articles are not in English
Research articles are available in full text with abstract within the key words	Research articles are not available in full text with abstract within the key words
Research articles from Centria library databases	Research articles not from Centria library data-bases

4.3 Data collection

Data collection process helps verify, organize, transform, integrate and extract data. The process must be strictly documented in order to make sure all the data are useful and complete. It is a process that can collect and measure variable information in a systematic way. Then it enables the writers to answer questions and evaluate the results. Data collection is a field that we use to maintain the credibility of learning. (Tartu Ulikool 2015.) The databases that were used by us are CINAHL, ABI INFORM, and OVID. These 3 databases provided us plenty of reliable articles that we could analyze and get useful information.

According to the inclusion and exclusion criteria, we chose the articles that were available in full text with abstract and published not more than 10 years ago. Because of the language barrier, we chose all the articles that were written in English. At the beginning, while we planned the research and before we did the actual search, we used key words such as prevention infection, central venous catheter, and nursing intervention to have a general overview of the

results. On the final research, we used terms, (Central venous catheter and Nursing education), (Central venous catheter and Prevent infection), (Central venous catheter and Care), and (Central venous catheter and Nursing interventions). Since there were more than hundreds of articles, we read the titles and abstract based on our inclusion and exclusion criteria to reduce the number of articles. Then we read through the articles, as well as the introduction, conclusion and some chapters. We eventually picked 10 articles that related to our research topic.

TABLE 2. Initial search results

Search terms	CINAHL	ABI INFORM	OVID
Central venous catheter and Nursing education	22	49	1606
Central venous catheter and prevent infection	72	20	808
Central venous catheter and care	326	3174	54
Central venous catheter and nursing interventions	27	348	6

4.4 Data analysis

The data analysis helps to describe facts, detect patterns, develop explanations and test hypotheses. It includes the quality of data, statistical data analysis, modeling and interpretation of results. (Tartu Ulikool 2015.) To ensure validity, only 10 articles were used in analyzing. We endeavored to present the data without any misrepresentation. We summarized these articles in order to make sure readers can understand and know the main points of them.

While analyzing the data, it is very important to abandon biases and strive to be objectivity. We read the abstract and conclusion carefully. We tried our best to use simple words to summarize the data. There are 4 articles about CVC nursing education, 4 articles about infection related to CVC and 2 articles about patient's education.

The summary of articles can be found in Appendix 1.

5 RESULTS

5.1 What are the nursing interventions to prevent infection of a patient's CVC

As nurses, we should understand the possible consequences that are caused by CLABSI. Overall, we should pay attention to the aseptic technique in every nursing intervention, especially the pre-insertion and post-insertion care of CVC. It is obvious that catheters are foreign objects to the human body. Patients are easy to get an infection from external microbial contamination from surrounding area. We have to ensure the security of the device to prevent microorganism and ensure the patient's safety. If the rate of CLABSI is getting higher, despite the implementation of these infection prevention strategies, the use of novel antimicrobial technologies and some medication or nutrition administration may be considered. These strategies contain antimicrobial agents, such as antibiotics, needleless intravenous access devices coated with silver or chlorhexidine, IV dressings incorporating chlorhexidine.

The clinical application of CVC is wide, such as for hemodialysis patients. It becomes essential to them. Even though CVADs decrease the pain of skin puncture and allow fast access to the bloodstream, they can cause infection which has certain morbidity and mortality. Preventing CRBSI requires more attention from clinical workers. (Ullman, Long, & Rickard 2014, 206). CVC brings advantages to patients; however, we can't ignore the possible harm caused by it. (Kelly, Green & Hainey 2015,469). When nurses handle CVC, we need to make sure we use enough and effective nursing interventions to prevent infection of CVC.

From the literature review, we found many nursing interventions that can help prevent infection of a patient's CVC.

Firstly, measuring pre/post-treatment axillary temperature. There are many routes we can choose to measure temperature, but the axillary temperature is easy to measure and it is a safe way. If a patient is a hemodialysis patient, he or she may have weak immune system. Even small change of body temperature can tell us if the risk of infection goes up. Secondly, keeping the dressing closing is important. It is the way to protect the insertion part from growing of microorganisms. Thirdly, nurses should keep an eye on the signs and symptoms associated with local and systemic infection. If the patient has a fever which is the most common sign of infection, nurses must be aware of it and take effective nursing interventions. Fourthly, using

aseptic technique when nurses need to change the dressing. It is nurse's responsibility to handle the CVC during and before the treatment. Therefore, knowing and following aseptic principle is very important for nurses. Fifthly, it's difficult to maintain CVC, particularly when trying to prevent infection and obstruction. In clinical care heparin is used as an anticoagulant. It can make blood thinner so that the blood clot will not block the catheter. Sixthly, nurses should educate patients and their families about CVC. Even though the patient should be the core person of nursing interventions, good guidance to family members may help with maintaining CVC. (Guimarães, Mendonza, Corrêa, Matos & Guimarães 2017, 1129-1133).

For preventing infection, there is a connector called Tego or Q-Syte. It is needless access devices that are used in the hospital. For saving money and enhance patient's safety, Tego connectors are also to be considered. When using Tego connector, it is not necessary to use heparin. The ports only need to be flushed with normal saline. According to the company which makes Tego connector, it reduces hub manipulation. Therefore, the risk of catheter contamination is getting low. (ICU Medical, 2015) On the other hand, Tego connector can stay in place for 7 days, which reduces the need to handle the hub. (Micklos 2015, 383-386.)

The material of dressing that is put on the CVC is also one of the factors that affect the rate of infection. The study has shown that polyvinylchloride or polyethylene catheters are easier to get microorganisms than silicon elastomer or polyurethane catheters. (Kaya, Turan, Akbal, Tosun, Aksoy, Tunali, & Aydin 2016, 260). However, it is surprising that the transparent polyurethane group cause a higher risk of CRBSIs than the gauze and tape group. It is also controversial because transparent dressings are good for the nurse to check the change of the CVC site. The latest CVC dressing is polyurethane dressing with an external cloth border. It can enhance the catheter safety. (Oliver & Jones 2016, 32). When nurse chooses the material of the dressing, it is important to consider which one is better for the patient.

5.2 How to educate patients regarding the care of CVC

When a nurse is doing the education to patients, firstly it has to be made sure that the nurse has enough knowledge about the care of CVC. E-learning tool is a useful way to help nurses increase confidence and knowledge. It is a traditional method that is widely used for teaching clinical skills. It allows nurses who had not used CVADs to practise procedures before doing it

in clinical. Setting E-learning can support procedural guidance in a right way. There are positive outcomes from the e-learning. The study has shown that nurses think e-learning helps them increase knowledge and understanding, promotes safe practices and increases confidence. (Kelly, Green & Hainey 2017, 2). Before educating patients, having confidence, good theory and technique knowledge are keys to the good education. For further guidance, e-learning also should be updated. Information should be standardized and develop further skills in the use of CVADs.

For preventing infection, nurses and patients should pay attention to hand hygiene. (Kalender & Tosun 2015, 468). It means that it is nurse's responsibility to educate patients when they need to disinfect hands and teach them to choose products for hand hygiene appropriately. Patients should know the importance of keeping the CVC site clean and dry. Since there are many patients who go home with CVAD, they need to know how to manage it by themselves at home. Many organizations provide guidelines to teach patients. Many nurses said they did not know how to educate patients effectively. Therefore, teaching nurses how to educate patients would help the learning of the patients. Many kinds of literature which focus on effective patient teaching show that the patient-centered teaching is effective. One-to-one teaching is a good way. It is important that patients and nurses build a good relationship. They should trust each other. Otherwise, the education won't get the best result.

All the necessary information should be included such as dressing change, opening and locking the line, possible complication, signs, and symptoms of infection, and what should do when the assistance is needed. Nurses should consider patient's individual situation. Every patient has different needs. Nurses should know about their needs and make corresponding adjustments. By explaining the questions that patients may have about the care of CVC, the nurses can educate patient in a way that is effective. It is important to focus on required areas. A teaching process always starts with information that the patients already know, then move to what patients do not know. Nurses can ask what patients have been told about CVC before. This is an important step that helps patients and nurses clarify misconceptions. Another aspect of educating patients is to teach them step by step, from simple concepts to complex ones which follow the logical way. It allows patients to build fundamental knowledge and fully understand the information. (Champ 2013, 18-19)

As we know, being an educator, one of the most important points is that you have to have the ability and confidence to teach. It is necessary to get a deeper understanding of CVC care. (Weingart, Hsieh, Lane & Cleary 2014, 325). The study has shown that nurses feel safe when patients feel safe and ask questions. (Kelly et al, 2015). According to this, nurses should encourage patients to ask, tell them don't be shy or feel bad to ask. When nurses and patients start to build positive interactions, it always brings a good relationship and better education result.

6 DISCUSSIONS

The Literature review showed us a lot of information about the care and prevention of infection caused by CVC. During the past nursing studies, we haven't got so deep into CVC. When we practiced in hospital, we saw a lot of patients who had CVAD. Some of them had to take them home. This made us want to learn about CVC more and more.

According to our research studies, the care of CVC and prevention of infection need cooperation by nurse and patient. During the research, we learnt to know many ways to prevent catheter-associated infection. On the other hand, we wonder how many nurses do these nursing interventions perfectly? There are some deficits nowadays, because of the differences between theory and clinical practice. But we think if the importance of preventing CVC infection can be emphasized, the rate of infection might get lower.

CVC brings advantages to patients, but at the same time, complications can happen. The serious one is CRBSI which has high morbidity and mortality. This is the point that nurses should let patients know about and be aware of. Most patients don't have enough knowledge about taking care of CVC, and therefore they are not careful with hand hygiene.

Educating patients also requires nurses to have confidence and good theory and skill background. E-learning is a good way that helps nurses build confidence and do practice. It is awesome for new nurses. We know when we face patients for the first time, we feel very scared and experience lack of confidence. E-learning provides nurses opportunities to learn more and more.

Nurses feel insecure or less confident when patients don't ask questions. Good communication is essential for educating patients. Nurses should educate patients based on their own needs. One-to-one teaching is more effective. It allows patients to acquire fully understanding. It also makes sure that different patients get the necessary information individually.

After writing this thesis, we learned about how the different materials of dressings influence the rate of CVC infection. This is something we never heard or considered about before. During the research, we also found out that if we want to prevent catheter-associated infection, we

can't just rely on dressings or securement devices. Good inserting technique and continued surveillance both connect together

We think the materials of dressing that influence the rate of catheter-associated infection are worth further researching.

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APPENDIX 1

Authors, title and year	Aim of Research	Method of Research	Findings
1. Micklos, L. 2015. Do needle-free connectors prevent catheter-related blood-stream infections in patients receiving hemodialysis treatments using central venous catheters? <i>Nephrology Nursing Journal</i> , 42(4), 383-386.	To find what evidence is available concerning the relationship between Tego connectors and CRBSIs	Systemic Review	CRBSIs can cause sepsis which is the most dangerous clinical complication. Tego connectors can reduce the risk of catheter contamination and CRBSIs significantly.
2. Kalender, N & Tosun, N. 2015. Nursing Studies about Central Venous Catheter Care: A Literature Review and Recommendations for Clinical Practice. <i>International Journal of Caring Sciences</i> . Vol 8, 461-469	Assessing the data of nurses' responsibilities on central venous catheter and to determine relevant data that may have impact to future research.	Literature Review	Nurses don't have adequate knowledge about skin preparation in CVC care, hand disinfection, how often the dressing should be changed, the type of solution used and how to obtain the blood sample appropriately.
3. Champ, S. 2013. Standardizing Patient Education on the Care of Central Venous Catheters. <i>Vascular Access</i> , 17-20.	For the patients who need central venous access devices, encourage nurses to evaluate them based on previous knowledge and use principles of adult education such as using plain language.	Literature Review	It is necessary to educate patients who receive central venous catheter properly. In order to improve patient understanding and adherence, we need to have standardized education program.

<p>4. Oliver, G & Jones, M. 2016. The Importance of Adequate CVC Securement to Prevent Infection. British Journal of Nursing. Vol 25, 32-34.</p>	<p>Discuss CVC securement and how it relates to the infection prevention. Investigated the effect of CVC as natural skin defenses for the body.</p>	<p>Literature Review</p>	<p>To prevent an IV infection, we can't only rely on a dressing or securement device. There are many essential elements such as good insertion technique, continuous surveillance and audit.</p>
<p>5. Guimarães, G., Goveia, V., Mendonza, I., Corrêa, A., Matos, S., & Guimarães, J. 2017. Nursing Interventions for Hemodialysis Patients through Central Venous Catheter. Journal of Nursing UFPE, 1127-1133.</p>	<p>According to the nursing intervention classification, discuss nursing interventions for patients who are using temporary double-lumen central catheter.</p>	<p>Quantitative Method</p>	<p>There are eight activities that have scientific basis in literature and the use of them help control of infection.</p> <ol style="list-style-type: none"> 1) Measuring pre/post treatment axillary temperature 2) Keeping dressing close 3) Monitoring infection signs and symptoms 4) Using sterile technique while manipulating CVC 5) Standard Precaution 6) After procedure, put the protective cover back to the place. 7) Maintaining permeability of the access with heparin 8) Educating patients and their family about the care of CVC

<p>6. Kelly, L., Green, A & Hailey, K. 2015. Implementing a New Teaching and Learning Strategy for CVAD care. British Journal of Nursing. Vol 24, 4-8.</p>	<p>To determine if introducing new educational intervention let registered nurses get improved on dealing with CVADs and feel more confidence</p>	<p>Self-completion Questionnaires</p>	<p>Education and training help reduce the harm to patients. CVAD training improves the confidence of nurses. It is easier for them go back to clinical practice and gain competence.</p>
<p>7. Kelly, L., Green, A & Hailey, K. 2017. A Blended Learning Approach to Teaching CVAD Care and Maintenance. British Journal of Nursing. Vol 26, 4-12.</p>	<p>Whether the blended learning to teaching CVAD care support nurses' clinical practice and increase their confidence.</p>	<p>A mixed-method electronic questionnaire</p>	<p>E-learning is useful to expand nurses' knowledge, promote safe practice, and increase confidence in use of different CVADs.</p>
<p>8. Kaya, H., Turan, Y., Akbal, S., Tosun, K., Aksoy, E., Tunali, Y., & Aydin, G. 2016. The Effect of Nursing Care Protocol on the Prevention in Neurosurgery Intensive Care Unit. Applied Nursing Research. 257-261.</p>	<p>The impact of nursing protocol on prevention of infection of CVC in neurosurgical intensive care unit.</p>	<p>Literature Review</p>	<p>Hospital acquired infection is a big problem nowadays. Patients who are in intensive care unit receive IV fluid quite often. It can be a risk factor for CVC infection. To reduce the infection, the material of CVC play an important role.</p>

<p>9. Ullman, A., Long, D & Rickard, C. 2014. Prevention of Central Venous Catheter Infections: A survey of pediatric ICU nurses' knowledge and practice. Nurse Education Today. 202-207.</p>	<p>Assess nursing knowledge of evidencebased guidelines to prevent catheter related infection</p>	<p>A cross-sectional, descriptive study using a questionnaire and survey</p>	<p>Currently there are some deficits in nursing knowledge surrounding the CRBSI. There are differences between theory and practice. Preventing CRBSI requires more attention from clinical workers.</p>
<p>10. Weingart, S., Hsieh, C., Lane, S., & Cleary, A. 2014. Standardizing Central Venous Catheter Care by Using Observations from Patients with Cancer. Clinical Journal of Oncology Nursing. 323-325.</p>	<p>To understand vulnerability of cancer patients who have infection that relate to CVC</p>	<p>Literature Review</p>	<p>To improve cancer patient's safety, it is necessary to get deeper understanding of CVC care.</p>