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Nursing interventions for the prevention of catheter associated urinary tract infections.

Literature review

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Abstract:
Catheter associated urinary tract infections (CAUTIs) are one of major global health concerns, which places a huge burden on the health care system. Nurses are expected to play a significant role in preventing CAUTIs. Nevertheless, standard of care and clinical competence of the nurses have been reported fallen short of the expected standards as empirical evidence suggest. Thus, this thesis initially intends to identify the risk factors for catheter associated urinary tract infections and examine the types of nursing interventions which could potentially reinforce the skills and knowledge of the nurses in preventing catheter associated urinary tract infections. Nola Pander's health promotion model and Ajzen's theory of planned behavior, are used in this study as theoretical framework. The study is literature review with qualitative inductive data analysis method. Eleven related research articles were analyzed to find the common themes and those themes were summarized into categories and subcategories. The study found that there are two main types of risk factors for CAUTIs, patient related risk factors and care related risk factors. In that, use of long-term urinary catheters and prolongation are discovered as the core in the acquisition of CAUTIs in most of the patients of every care setting. The findings of the study show that many nursing interventions that emphasize on the protocol-based nursing, clinical skill development and multidisciplinary have been significant for low-ering use and prolongation of urinary catheter use. Avoiding unnecessary catheterization and reducing the duration of the catheterization are the main the focuses of the CAUTI prevention. In average, the consequences of the application of the interventions into the practice have demonstrated substantial progress in reducing CAUTI rates within all care settings the study address. However, the expedition of the nurse in implementing precise practice as assigned by the respective unit is essential. The study is restricted within its capacity since the study has not been capable of analyzing the context of the research that is specific to other healthcare settings other than being limited to a few healthcare settings. Meanwhile, the study recom-mends new researched to be carried out in the basis of researching approaches how the asepsis conduct of the nurse be evolved in a prolific manner.

Keywords:	Acquisition of CAUTIs, Prevention, Indwelling catherters, use and prolonged catheterization, Nursing interventions.
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FOREWORD

Nurses play a significant role in preventing hospital-acquired infections. There are many precautions and ways in which nurses can prevent infection and create safe environment for the patient during their time of hospital stay. During the thesis process I have gained lots of knowledge about preventing catheter related infections which I can use in my future carrier to enhance the quality of the life of the patient.

I would like to thank all the lecturers, teachers, and workers of Arcada University of applied Sciences for the immense support they provided me during my studies and thesis writing process. Especially I would like to thank my thesis supervisors Denise Vilikka and Dr Pamela Gray for their remarkable guidance and support during the whole process of thesis writing.

Furthermore, I would like to remind the immense support I received from my classmates and from my beloved husband throughout the process of writing thesis.

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Asanthi Withanagamage

1 INTRODUCTION

Urinary tract infections are the most common type of healthcare-associated infection, which is more than 30% of nosocomial Infections. (Centre for disease control and prevention, 2009). According to the Lo et al 70%–80% of these urinary tract infections are related to an indwelling urethral catheter. (Lo et al., 2014). Between 15% and 25% of hospitalized patients may receive short-term indwelling urinary catheters at some point during their hospital stay. (CDC, 2009). Catheter associated urinary tract infections (CAUTIs) affect more than 150 million people annually. (Özturk and Murt, 2020). When considering other healthcare related infections mortality and morbidity from CAUTI is comparably low. (CDC, 2009). But because of the frequency of CAUTIs the burden it places on the healthcare system is significant. CAUTIs are associated with morbidity, mortality, extended hospital stays and increased hospital cost. The estimated cost can be more than 600 dollars per single episode of a CAUTI for a patient. (Richards et al, 2017). Inappropriate and unnecessary antimicrobial treatments for CAUTI may lead to antimicrobial resistance. (Lo et al., 2014).

An estimated 17% to 69% of CAUTI may be preventable with recommended infection control measures. (CDC, 2009). This can be approximately 380,000 infections and 9,000 deaths per year could be prevented (Gould et al., 2009). Nursing practice plays a central role in catheter-associated urinary tract infection prevention. (McNeill, 2017). ‘‘Implementation of patient care practices for infection control is the role of the nursing staff’’. (World health organization, 2002). Especially in catheter care nurses play vital role as the front line of the patient care. Nurses are obliged to provide the catheter care from the insertion to the removal of the urinary catheter. Diagnosing of the CAUTIs is one of the main responsible of the staff nurses. (Yoon et al, 2013). Nurses have great opportunity to monitor the indwelling catheter durations and they are primarily obliged for many important interventions such as timely disconnecting of indwelling urinary catheters. (Richards et al 2017). Nurses should have ability to adherence to the evidence-based guild lines thus mitigate catheter related urinary tract infections in care settings. (McNeill, 2017)
The author’s interest to choose this topic was arisen during her practical training period in a post-surgical urological ward in Helsinki. Most of the patients had a urinary catheter

at some point during their hospital stay and there were number of cases where the patient's hospital stays extended due to the CAUTI. The author had an opportunity to learn about the adversity and suffering caused to the patient due to the catheter related infections. After choosing the topic author became aware of that nurses can play vital role in preventing CAUTI to enhance the quality of the life of the patient and reduce the burden CAUTI places on healthcare system as well. These observed facts increased the author's interest in the topic further.

The author has used the introduction chapter to shortly present the concept of the study. The background chapter presents general aspects related to the topic. Two main theories in nursing which used for the study are discussed in theoretical framework. They are Nola Pander's health promotion model and Ajzen's theory of planned behavior. The aim and objectives are presented in chapter 4. Methodology chapter discuss the process of data collection and data analysis. The research method used in this study is qualitative. The results contain the related literature from the analyzed data. The nursing intervention to prevent catheter related urinary infection will be presented in this chapter. The discussion chapter discuss the finding using the theoretical framework.

2 BACKGROUND

In this chapter the background and the main themes for the thesis is discussed. Some of the terms are defined here are since, to prevent CAUTIs, the nurses should have basic knowledge about urinary tract, prevalence of the CAUTIs, different catheterization methods and catheter types and infection prevention. Basic nursing skills and knowledge remain essential in the prevention of nosocomial infections.

2.1 The urinary tract

The human urinary tract is a contiguous hollow-organ system whose primary function is to collect, transport, store, and expel urine periodically to eliminate metabolic waste products and toxic wastes generated in the kidneys. Apart from that, the urinary tract regulates blood pressure and volume, control level of electrolysis and metabolites, and regulate blood Ph. The human urinary tract contains the kidneys, the ureters, the bladder, and the urethra. The kidneys and the ureters are considered as upper urinary tract and the lower urinary tract includes the bladder and the urethra. In addition, the male lower tract urinary comprises the prostrate. (Mangera, Osman & Chappel, 2013). A diagram depicting the anatomy of the urinary system is shown in figure 1.

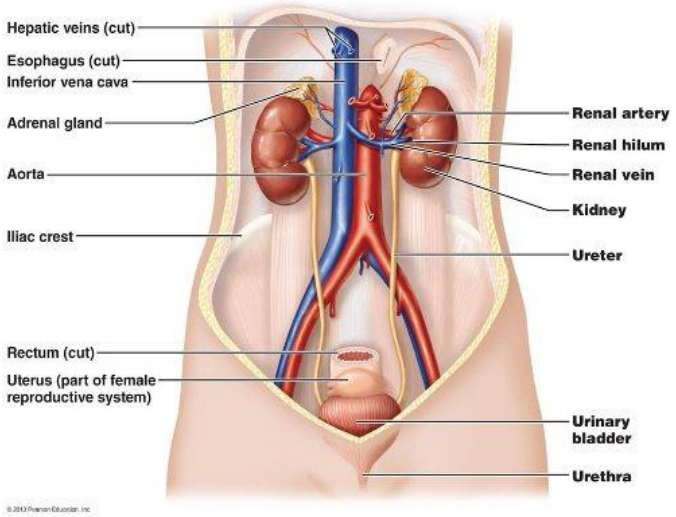

Figure 1. The urinary system. Anterior view of the female urinary organs. Source: (Marieb & Hoehn, 2013. P 961).

The kidneys are pair of bean shaped organs located in superior lumbar region. Frontal section of a kidney has three main regions, renal cortex, renal medulla and renal pyramids. (Marieb & Hoehn, 2013. P 962). Urine formation process is carried out in nephrons, which is the structural and functional unit of the kidney. Each kidney consists of more than millions of nephrons. The filtering process and urine formation occur in the nephrons in three steps, glomerular filtration, tubular reabsorption, and tubular secretion. Within this process the kidney filters nearly 200 liters of fluid daily and eliminate metabolic waste, toxins, and excess ions from the body. (Marieb & Hoehn, 2013. P 969).

The ureters are fibromuscular tubes which arise from the kidney pelvis and descend till renal pelvis then curve forwards and entered to the bladder. The adult ureters are about 25cm long. The main function of the ureters is propelling the urine from the kidneys into the bladder. (Marieb & Hoehn, 2013. P 986)

Human bladder is smooth, collapsible muscular hallow organ. The size and the position of the bladder depends on the volume of the urine accumulated in the bladder. The empty bladder collapses and lies in the pelvic floor and when urine accumulate the bladder expands by stretching the muscles. Normal expanded adult bladder is pear shaped, about 12 cm long and can stores approximately 500ml urine. Human bladder can hold maximum 800ml to 1000ml of urine and extremely full bladder can be palpated abdominally. (Marieb & Hoehn, 2013. P 986). The branches of hypogastric trunk of the internal iliac artery provides the blood supply to the bladder. Bladder receives both parasympathetic and sympathetic nerve stimulus. The primary function of the urinary bladder is to store urine temporally. Apart from that, the urinary bladder supports to expel urine by generating pressure by bladder muscles. (Mangera et al, 2013).

Male urethra is narrow fibromuscular tube which is about 20 cm long. (American Urological Association 2016). The female urethra is relatively short and about 4cm. female urethra emerges at the female external urethral orifice above the vaginal opening. (Mangera et al 2013). The function of urethra is to expel the urine from the body. In addition, the male urethra expels the semen as well. (Marieb & Hoehn, 2013. P 987). In male the prostrate is located behind the symphysis, which is about 20 g in weight and surrounded

by tough fibrous tissues. One third of the seminal secretion is produced in prostrate. (Mangera et al, 2013). Figure 2 shows the anatomy of female and male lower urinary tract.

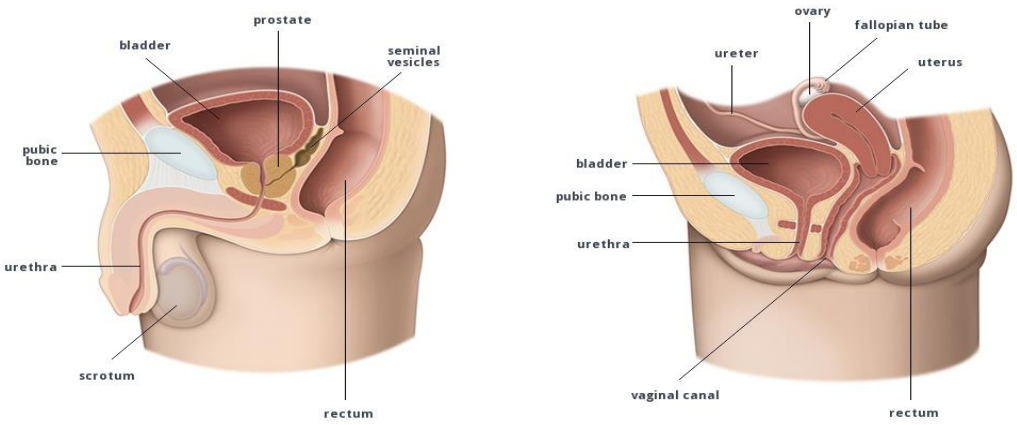

Figure2: Female and male lower urinary tract. Source:(European association of urology,2017).

2.2 Urinary catheterization

Transurethral indwelling catheterization or urinary catheterization is defined as "passage of a catheter into the urinary bladder via the urethra" (European association of urological nurses, 2012).

2.2.1 Indications for urinary catheterization

Acute or chronic urinary retention is the main indication for urinary catheterization. In addition to that urinary catheterization is using to empty the bladder prior to surgery, maintain a continuous outflow of urine for neurological patients, to instill medication, irrigate the bladder, to collect a sterile specimen of urine, to assist in healing of open sacral or perineal wounds in incontinent patients and to determine accurate fluid balance. (EAUN, 2012 & the Australian and New Zealand Urological Nurses Society, 2013)

2.2.2 Intermittent catheterization, short term, and long-term catheterization

In intermittent catheterization the catheter removes immediately after insertion and has very few contraindications. In the hospital intermittent catheterization should be sterile and should be performed by trained healthcare workers. Short term cauterization is mostly using in surgical setting and keep for less than 7 days. If the catheter remains in the patient more than a week it is considered as long-term catheters and they are mostly used in urinary retention. (EAUN, 2012 & ANZUNS, 2013)

2.2.3 Catheter type, size, and length

Catheters are available as one way, two ways and three ways. In intensive care and surgical rooms, the catheters with integrated temperature sensor are used for certain procedures. External diameter of the catheter is measured as the catheter size in Charriere (Ch), French Fg or Fr. 1mm is equal to 3ch. Adult catheter size varies from size 6-24 fr and the standard male catheter length is 41cm-45cm and female catheter length is 20cm-25cm. (ANZUN,2013). Female catheters should not use for men due to the trauma occurs, if the balloon inflated within the urethra. The inflated balloon size varies from 5-30 ml, but standard size is 10ml. (EAUN, 2012). Figure 3 shows the catheter size and international color codes.

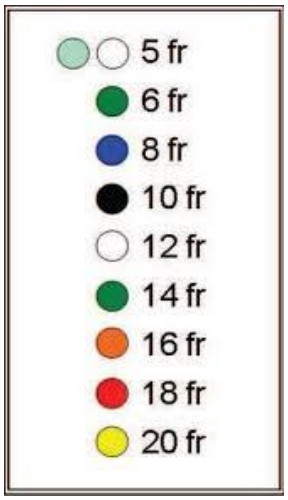

Figure3: Catheter size and international color codes :(Australian and New Zealand Urological Nurses Society).

There are different drainage systems are available and selection of the drainage bag system depends on the various reasons such as duration of catheterization, patient's mobility. When the sterile aseptic technique is used to insert the catheter to the patient, the catheter must be connected to the sterile bag to minimize the risk of catheter associated urinary tract infections. (EAUN, 2012)

2.3 Catheter associated urinary tract infections

Catheter Urinary tract infections are the most common type of healthcare-associated infection, which is more than 30% of nosocomial Infections. (CDC, 2009). 70%–80% of these urinary tract infections are related to an indwelling urethral catheter. (Lo et al., 2014). Between 15% and 25% of hospitalized patients may receive short-term indwelling urinary catheters at some point during their hospital stay. (CDC, 2009). According to the point prevalence survey database (HAI-net) of European Centre for Disease Prevention and Control, in Finland 12% of the HAI are Urinary tract infections and third most frequent infection. (ECDC, 2012).

Catheter Associated Urinary Tract Infection (CAUTI) can define as presence of bacteriuria or funguria with a count of more than 10^5 CFUs/ml with a maximum of 2 isolated microbial species. (World Health Organization, 2002). Duration of the catheterization plays significant role in risk factors of CAUTI. (EAUN, 2012). The incidence of bacteriuria with catheter is estimated as 3%-10%, increased with the prolonged catheterization and reached to the 100% after 30 days. (CDC, 2009).

Urinary tract infections are divided into two groups as lower urinary tract infections and upper urinary tract infections. Lower urinary tract infections are identified as bacterial cystitis (inflammation of the urinary bladder), bacterial prostatitis (inflammation of the prostate gland) and bacterial urethritis (inflammation of the urethra). Upper urinary tract infections are pyelonephritis, which is inflammation of the renal pelvis, interstitial nephritis which is the inflammation of the kidney and renal abscesses. Those upper urinary tract infections are considerably less common than the lower urinary tract infections.

(Smeltzer et al. 2010, 1359). Most common symptoms in urinary tract infections are burning in urination, frequency of urination, urgency, nocturia, incontinence and pelvic pain. (Smeltzer et al. 2010, 1361). Microbes from the urinary tract can spread and cause sepsis, septic shock, and multi-organ failure. (Magnusson, 2019)

2.3.1 CAUTI pathogenesis and epidemiology

CAUTI can be diagnosed from accordingly collected urine sample from the patient, if the one or more pathogens existence is more than 105 cfu/ml. The most common pathogen responsible for CAUTI is *Escherichia coli* and followed by *Enterococcus, Pseudomonas, Proteus, Klebsiella and Enterobacter.* (Majumder et al, 2020). Endogenic sauces of microorganism such as vaginal or rectal colonization or external sauces of microorganism such as contaminated instruments or hands can causes CAUTI. (CDC, 2009)
Biofilm formation along the catheter surface is the most important cause of bacteriuria. Biofilm consists micro-organisms growing in colonies within an extra-cellular mucopolysaccharide substance which is self-developed. Biofilm formation begins immediately after catheter insertion. At the beginning of the formation single organism is usually identified and with the prolonged catheterization polymicrobial bacteriuria is presented. Growing in a biofilm relatively help microbial to protect from antimicrobials. (Majumder et al, 2020)

Antimicrobial resistance is a significant problem related with CAUTI as most of the CAUTI causing pathogens are highly antibiotic resistance. (CDC, 2009). 70% of the bacteria that cause HAI are resistant to at least one relevant antibiotic. (Magnusson, 2019). pathogens within the biofilm are well protected from antibiotics therefore the CAUTI becomes hard to treated. Treatment of asymptomatic bacteriuria in catheterized patients should be avoided as this can only aggravate the problem of antimicrobial resistance in healthcare. (Köves, Magyar and Tenke, 2017).

2.4 Infection prevention

According to the world health organization's report on prevention of hospital-acquired infections, prevention of nosocomial infections is the responsibility of all individuals. Health authorities are responsible for developing national or regional programs to supports hospitals to prevent infections. The prevention is mainly focused on hospitals and healthcare settings. Hospitals should have yearly work plan for infection prevention which includes promote good healthcare, sufficient resources and staff training etc. Infection control physicians and infection control practitioners together made the infection control team of the hospital and this team is responsible for the infection control, as well as preparing the yearly work plan. (WHO, 2002).

The Association of Professionals in Infection Control and Epidemiology has introduced six core competencies for infection preventionists. They are identification of infectious disease processes, surveillance, and epidemiologic investigations, preventing and controlling the transmission of infectious agents, employee-occupational health, management and communication and education and research. (Gase, Leone, Khoury and Babcock, 2015).

2.4.1 Nurses role in infection prevention

Infection prevention has obtained a significant attention regarding the patient safety. The nurses as the key members in patient care, can directly impact on infection prevention (Benson, 2011). Although there are number of evidence base practices and guild lines are available, the nurse's knowledge about the infection prevention seems to be in a poor level. (Vandijck et al, 2010). Understanding the importance of their role in infection prevention could help nurses to follow the recommended guidelines, thus prevent the healthcare related infections. (McNeill, 2017)

As the key character in health care settings the nurses are expected to have competences in infection prevention. According to the WHO the infection prevention nurse's duties are identifying nosocomial infections, investigation of the type of infection and infecting organism, participating in training of personnel and surveillance of hospital infections. In

addition to that the infection prevention nurse is also responsible for participating in outbreak investigation, development of infection control policy and review and approval of patient care policies relevant to infection control. (WHO, 2002).

2.4.2 Chain/cycle of infection

The Processes, which leads the patients to have hospital related infections is described in cycle or chain of infection. It is important to improve the knowledge about this cycle as the infections can be prevented by breaking the chain. (WHO, 2001). The chain of infection is shown in figure 4.

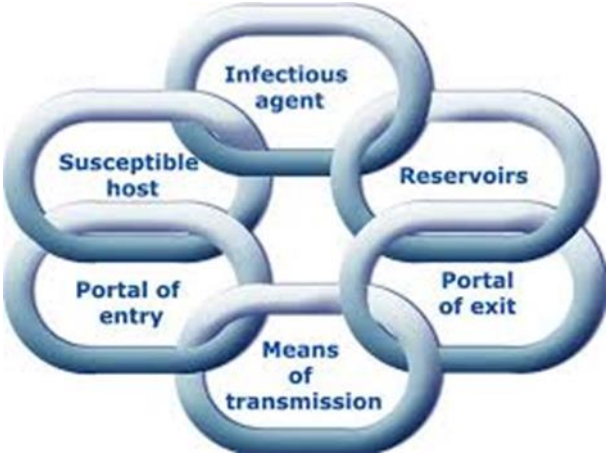

Figure 4: Chain of infection: source study.com

Infectious agents are bacteria, viruses, fungi, protozoa and helminths. There are several means of transmission. For instance, blood borne, airborne, droplet, contact, common vehicle, and vector borne. Blood borne means the transmission through sexual transmission, injury, or inoculation. Airborne and droplets transmit through inhalation. Droplet: also, through inhalation. Contact transmission divided in to two groups as direct and indirect contacts. Transmission through food, water, drugs on through Common vehicle: through food, water, drugs, blood, or other biological products is known as transmission through vehicle. Transmission due to attacks of arthropods is defined as vector borne transmission. Reservoir is where infectious agents live, grow and multiply. This could be human reservoir, animal reservoir or environmental reservoir. Susceptible hosts are for instance

patients with immunocompromised status, patients with chronic diseases such as diabetics. The portal of entry is the way in which a pathogen enters a susceptible host and portal of exit is the means microorganisms leaves the host. Intravenous lines, urinary catheters, wound sites, the respiratory system, damaged skin can be identified as portals of exit within healthcare settings. (WHO 2001)

2.5 Nursing interventions

Nursing intervention is defined as "any treatment based upon clinical judgment and knowledge that a nurse performs to enhance patient's client's outcome. Nursing intervention includes both direct and indirect care those aimed at individuals, families, and community, and those for nurse initiated, physician initiated and other provider-initiated treatments". Treatments performed through interaction with the patient is identified as direct care interventions. The treatments performed away from the patient but with the purpose of improving patient's quality of health is indirect care interventions and both direct and indirect interventions could be physical or physiological. (Butcher et al, 2013)

Treatments or tasks that nurses are empowered to carry out with their own competence level are identified as independent interventions. For examples, nursing assessments, physical and psychological caring. The dependent interventions are treatments which are taking place under the physician's supervision such as medical therapy. The collaborative interventions are activities conduct with the collaboration of multi professional groups to enhance the quality of the life of the patient. (Berman et al, 2008, p 223).

3 THEORETICAL FRAMEWORK

Nursing theory is defined as a "conceptualization of some aspects of nursing reality communicated for the describing of the phenomena, explaining relationships between phenomena, predicting consequences or prescribing nursing care" ((Meleis, 2011, p. 29). Nursing models are conceptual tools or devices that can be used to understand and place complex phenomena into perspective. This gives the viewer a clear explanation or a picture about relationship between the concepts of the theory. (McKenna, 1997, p. 12).
In this thesis the writer used Nola Pender's health promotion model and Icek Ajzen's theory of planned behavior as the theoretical framework.

3.1 Health promotion model.

The health promotion model was developed by Nola Pender in 1982 and revised in1987 and in 1996 according to the new theoretical perspective and empirical findings. (Nursing theory 2016). The purpose of the health care model ''to assist nurses understanding the major determinant of health behaviors as a basis for behavior counseling to promote healthy life-styles'' (Pender, 2011). Person, environment, nursing, health, and illness are the key concepts defined as a basis for the health promotion model. (Nursing theory 2016)

3.1.1 Nurses role as a health promoter

''Health promotion enables people to increase control over their own health. It covers a wide range of social and environmental interventions that are designed to benefit and protect individual people's health and quality of life by addressing and preventing the root causes of ill health, not just focusing on treatment and cure'' (WHO 2016). Nurses play key roles in public health promotion. Their role as a health promoter is demanding multidisciplinary knowledge and experiences. Disease prevention and changing the behavior of patient to improve their quality of life can be identified as main duties of a nurse as a health promoter. It also could include educating patients and improve the self-management of disease. (Kemppainen, Tossavainen, Turunen, 2013). Nurses skills communicating, negotiating, coordinating, and integrating makes the nurses success in providing care and promoting health. (Sullivan and Decker, 2004).

3.1.2 Components of the health promotion model

The theory discusses about three main components. The first component is individual characteristics and Experiences. This includes prior related behaviors and personal factors such as biological, psychological, and sociocultural factors. Secondly the theory focuses on behavior-specific cognitions and affects. This includes awareness of benefits or consequences of action, awareness of barriers or limitations to the action, self-efficacy, and activity related affect such as emotions or feeling prior to, during and after the action. This also includes interpersonal influences such as beliefs and attitudes. Situational influences, commitment to a plan of action and immediate competing demands and preferences also come under second component. The third component is behavioral outcome. The health promoting behavior is the desired outcome and end point of the health promotion model. This model consists of two phases. Decision making phase and action phase. The decision-making phase includes individual perceptions and modifying factors. Perceived barriers to action, the like hood of taking the health promotion action and cues to the action are included in action phase. The health promotion model is based on eight assumptions. (Pender, 2011).

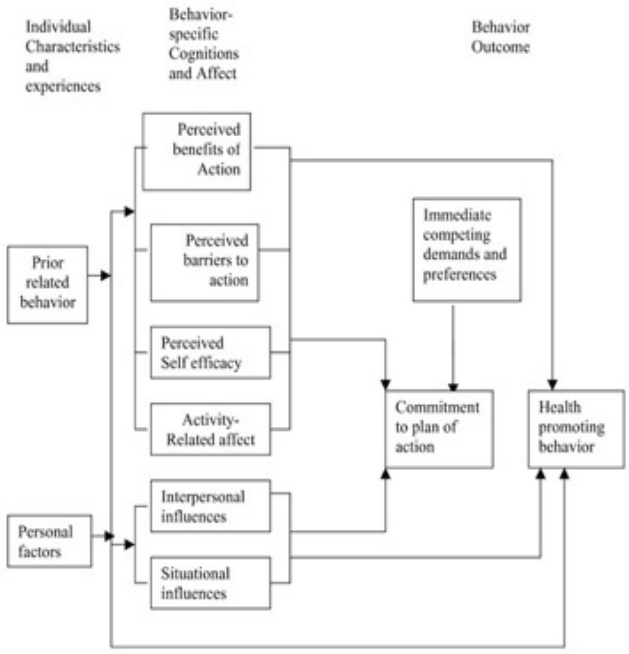

Figure 5: Health promotion model

3.2 Theory of planned behavior

Theory of planned behavior is developed by Icek Ajzen in 1985 by combining constructs from different concepts and theories such as Bandura's social cognitive theory and theory of reasoned action by Ajzen and Fishbein. (Lange, Kruglanski, Higgins, 2012). The theory of planned behavior can be used as leading framework for understanding, predicting, and changing human social behavior. (Ajzen, 1991).

3.2.1 Constructs in the Theory of Planned Behavior

The theory of planned behavior divided in to three types of beliefs. Behavioral, normative and control. This can be elaborate as constructs of attitude, subjective norm, and perceived behavioral control. (Ajzen, 1991). Attitude can be described as personal evaluation of the behavior. Subjective norm is belief about approval or disapproval of the behavior by society or key people. Behavior control is having or practicing control over the behavior. (Ajzen,1991).

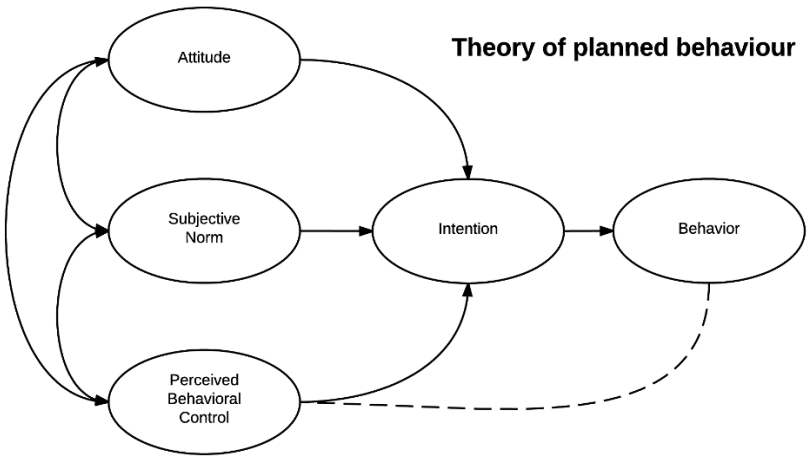

Figure 6: Theory of planned behavior.

3.3 Justification for chosen theories

3.3.1 Applying of HPM

Health promotion model can be used as a holistic predictive model of health promoting. According to this model disease prevention and the health promotion are the major concerns in health care. Pender describes health protection or disease prevention as ‘‘behavior motivated desire to actively avoid illness, direct it early or maintain functioning within the constraints of illness’’. (Nursing theory, 2016). When apply this theory for nurses to prevent CAUTI the nurses should have behavior motivated intention to prevent infections. The nurses can adopt this theory to modify or change their behavior when performing sterile cauterization. According to the HPM, the decision-making phase is affected by individual perceptions and modifying risk factors. Awareness about CAUTI and its consequences, desire of competences and perceived benefit of preventing CAUTI are significant facts in the decision-making phase. Heavy workload and long shifts work related stress and limitation of time could be identified as barriers to the action. The desires for competence and self-awareness are the health promoting factors which pave the way to modified health behaviors, aseptically performed sterile catheterization.

3.3.2 Applying of TPB

To perform a sterile catheterization aseptically, the nurses should have clinical competence as well as confidant on their own knowledge and skills. Nurses should have good surrounding environment and support to perform the task properly. But nurses are most often overloaded with work. Long shifts, work related stress, burnout and time limitation are other examples for barriers for successful performance. Therefore, nurses should have planned behavior to increase the successfulness of the sterile catheterization. Positive attitude towards sterile catheterization, confident on own competence level affect to improve the quality of catheterization. The nurses should have knowledge about the internationally recognized and approved guidelines and standards for catheterization. Having or practicing control on the actions taken while performing catheterization also helps to improve catheterization standards and prevent CAUTIs.

4 AIM AND RESEARCH QUESTIONS

This thesis builds on the knowledge that all the healthcare workers should have clinical competences in infection prevention. However there seems to be a variance in the awareness of nurses regarding the dynamics of preventing catheter related urinary tract infections. Hence this thesis is intending to identify the risk factors for catheter associated urinary tract infections and examine the types of nursing interventions which could prevent or reduce the catheter associated urinary tract infections.

Following questions are set as guidelines to fill this aim.

1. What are the risk factors for catheter related urinary tract infections?
2. What are the nursing interventions to prevent catheter associated urinary tract infections?

5 METHODOLOGY

This study uses qualitative research design, in which research questions will be attempted to answer by reviewing of existing research data and information available in online databases. In this reviewing, a scientific data collection approach will be applied including exclusion and inclusion criteria. After the collection of data, collected data are subjected to an analyzing process in which the inductive data analyzing approach is used.

5.1 Data collection

For collecting relevant data, variety of academic search engines were used. Different key words and searching terms related to the topic and research questions were used to collect the most relevant and updated data. The "Academic Search Elite (EBSCO)" was used initially for data collection. "CAUTI or Catheter associated urinary tract infections" and "prevention" used as key words. Boolean phase was used in an advanced search and limited to 2010-2017. This resulted in 105 hits. After reading through titles and abstracts 6 articles were selected for the study. After the second phase of inclusion and exclusion criteria 3 articles were selected for the study. The EBSCO was searched again using key words 'Catheter associated urinary tract infections' and 'risk factors' and limited to the full text and 2010-2017. This resulted 68 hits and selected one article for the study. In science direct search engine, data retrieval process was carried out with the phrase of "catheter associated urinary tract infection' and 'urinary catheterization". The search was further confined to full text. From 39 results two suitable articles were selected to the study. After confined for full text and 2005-2017, 664 relevant articles were found in SAGE academic database. 660 of them were eliminated at the pre phase of inclusion and exclusion criteria and from 4 articles finally one suitable article was selected for the study. PUBMED search engine gave 116 results for the phrase 'risk factors for catheter associated urinary tract infections' from 2010-2017 full text. After prophase of exclusion and inclusion criteria 18 articles were selected and finally one suitable article was selected for the study. PUBMED resulted 365 hits for phrase 'catheter associated urinary tract infections and pathogenesis'. From those results one article was selected. Finally, PUBMED

was searched by using key words ‘urinary tract infections’ and which resulted 79 hits. One article was selected from those 79 hits. From the relevant articles were found in google scholar, one article was selected after pre phase inclusion and exclusion process. More detailed information about data collecting process and inclusion and exclusion process of the study can be found in appendix 1.

The list of the chosen articles is presented below in alphabetical order.

1. Bernard, M., Hunter, K. and Moore, K., 2012. A Review of Strategies to Decrease the Duration of Indwelling Urethral Catehters and Potentially Reduce the Incidence of Catheter-Associated Urinary Tract Infections. *Urologic Nursing*, 32(1), p.29.

2. Gillen, J., Isbell, J., Michaels, A., Lau, C. and Sawyer, R., 2015. Risk Factors for Urinary Tract Infections in Cardiac Surgical Patients. *Surgical Infections*, 16(5), pp.504-508.

3. Gilles, M., 2020. Implementation of a multifaceted nurse-led intervention to reduce indwelling urinary catheter use in four Australian hospitals: A pre- and postintervention study [Online]

4. Kang, S., Hsu, N., Tang, G. and Hwang, S., 2007. Impact of Urinary Catheterization on Geriatric Inpatients with Community-acquired Urinary Tract Infections. *Journal of the Chinese Medical Association,* 70(6), pp.236-240.

5. Ma, Y. and Lu, X., 2019. Indwelling catheter can increase postoperative urinary tract infection and may not be required in total joint arthroplasty: a meta-analysis of randomized controlled trial. *BMC Musculoskeletal Disorders*, 20(1).

6. McLellan, L. and Hunstad, D., 2016. Urinary Tract Infection: Pathogenesis and Outlook. *Trends in Molecular Medicine*, 22(11), pp.946-957.

7. Richards, B., Sebastian, B., Sullivan, H., Reyes, R., D'Agostino, J. and Hagerty, T., 2017. Decreasing Catheter-Associated Urinary Tract Infections in the Neurological Intensive Care Unit: One Unit's Success. *Critical Care Nurse*, 37(3), pp.42-48.

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5.2 Data analysis

As far as content analysis is considered, the content analysis undertaken in a qualitative research has been distinctive than those of other forms of research designs. There different techniques and methodological approaches have been developed by different authors of over the time. The techniques of interpretation of the contents were basically initiated from the manifest content. Although, later the interpretation of the latent content has also been recognized as valuable and worthy for a qualitative research. Content analysis are applied both to quantitative and qualitative approaches.

Basically, a good content analysis is attempting to maximize the achievement of the research questions by allowing the author to create concrete meaning units, codes, condensed themes, categories, themes and abstracting etc. It also benefits as it allows both the manifest and latent content. These different techniques are separately accompanied by different types of research. The role of each of these techniques are also providing the author to effectively enhance the achievements extensively. (Graneheim and Lundman 2004)

As earlier mentioned, in this study the collected data is analyzed in an inductive way. After reading through all selected articles the author found that nursing interventions for reducing CAUTIs are mentioned in several articles, while risk factors for CAUTIs are mentioned in most of the articles. The risk factors are catheterized under two main categories and nursing interventions are categorized under three main categories. After that, subcategories are selected and summarized from each article. Table no 1 shows the selected main categories and subcategories of this study.

Table 1; Data categorization

Risk factors for CAUTIs	
1. Patient centered	• Older age and female gender • Presence of the other site infection • Unavoidable and Compelling Critical Physical health status of Patients • Other associating risk factors for CAUTI
2. Care related	• Type of catheter • Prolonged Urinary catheterization • Poor administration of urinary catheters
Nursing Interventions for prevent CAUTIs	
1. Nursing Interventions based on reduction of catheter use and Duration	• Bladder bundles • protocol based nursing
2. Nursing interventions related to clinical competence	• Experience based interventions • Education and training-based interventions • Interventions mediated by the administration and the management
3. Nursing interventions related to the management of clinical information aiming on re-duction of CAUTI	• Chart reminders • Computerized physician order entry system- CPOE

5.3 Ethical consideration

‘‘Research ethics may be referred to as doing what is morally and legally right in research’’. (Parveen & Showkat, 2017). Ethical oversight of the research protects participants as well as the researcher and the others who involves in the research. Medical researchers must act in an ethical manner; therefore, it is important to take the approval of the research ethics committee. For some research it is a legal requirement to have an ethical approval, as a research done without appropriate approval can causes serious repercussions. Publishing fake results as real results (Fabrication), omitting editing, or suppressing results (Falsification) or using other people’s work without mentioning the original sources or without permission (Plagiarism) are considered as main violations of research integrity. (All European Academies, 2017).

In this study, the research topic has been accepted by the Arcada University of Applied Sciences, Helsinki and the thesis has been written according to the Arcada’s thesis writing guidelines. Only the university approved scientific search engines has been used for collecting relevant data. The author has carefully maintained honesty, reliability, credibility, and the integrity during the whole process of thesis writing. The author has been careful to avoid fabrication, falsification and plagiarism during the thesis writing to ensure the research integrity.

6 FINDINGS

The study has two main research questions, the first one is What are the risk factors for incidence of urinary catheter associated urinary tract infections? And the Second one is What are the nursing interventions to prevent catheter associated urinary tract infections? Accordingly, as the content analysis suggest these two questions will be answered by a highly comprehensive set of answers that are consisted of various types of data categories as shown below.

6.1 Risk factors for urinary tract infections

6.1.1 Patient centered risk factors

Old age and female gender

The individuals who are of 65 years or over can have a serious risk of acquisition of CAUTIs along with the increased risk for unnecessary catheterization under certain circumstances. This situation can be worsened when the urinary catheters are inserted without proper indications. These improper indications include the bladder emptying in elders with cognitive impairment, incontinence, diminished function in the daily activities and a convenience to staff. **(1)** As discovered in another case study, transurethral or suprapubic catheterization through cystostomy as the means of indwelling urinary are significantly prone to UTI than the patients without any catheterizations in the case of advanced aged and female predominance. In contrast to the males of 25 patients, there have been 69 female patients are detected for UTI's with urinary catheterization. On the other hand, the average age of the patients with urinary catheterization for has been 78 years while it is slightly over 75 for the patients without catheterization in the case of UTIs. Genitourinary issues of the geriatric population are more complex and hence the intractable urinary incontinence or retention are always mediated by inserting transient and long-term indwelling catheters. **(4).** Moreover, the risk of the female gender for acquisition of CAUTIs is found to be attached to the diminished anatomical capacities in the women's urinary system and reproductive system than of the males. The shorter urethral length, shorter

distance from the anus to the urethral meatus and permissiveness of the vaginal and perineal environments to microbial colonization can be highly vulnerable for CAUTIs. At the same time, infants under one year of age and elderly men with prostatic hypertrophy also demonstrate a higher prevalence of CAUATIs. **(6).** In another studies, the female gender has been proved to be a common risk factor associated with the elevated risk of CAUTI. This is due to contamination caused by the shortness of the female urethral and the ascending route of infection. Although, this risk factor has not always been a sole common or independent risk factor for CAUTIs since there are other factors such as severity of illness at admission, unit of admission, length of ICU stay, and prior antibiotic exposure are associated with the CAUTI risk as well. As the same research study reveals, the age factor has also shown a predominance for female gender (54%) than the male gender among the sample of 114 patients with CAUTI. The mean age of this sample is 62 years. **(8,2).**

Presence of Other site or onsite Infections

As a single study discovered, the presence of accompanying nosocomial infections can comprehensively cause the acquisition of CAUTI either concomitantly or before the UTI. Among these accompanying nosocomial infections, pneumonia, intravascular catheter bacteremia, surgical site infections have been abundant. The overall CAUTI rate is 19.02 per 1000 days. Moreover, the presence of another infection in a different active site can be highly risky for CAUTIs. In addition, it is also affirmative that the presence of other site nosocomial infection is correlative with the acquisition of CAUTIs as an independent risk factor. The etiology for this can be the usage of antibiotics on the other site nosocomial infections and the depreciated health status because of prior nosocomial infections. Such incidences are vastly common in the Intensive care units. **(9).** In another study, it is found that the presence of deep sternal wound infection (DSWI) inflicted a greater risk for the acquisition of CAUTIs in patients. Usually, the sternal infections are bacterial in nature. In contrary, all the CAUTI cases detected in the study have been fungal in nature. Although, these DSWIs can comprehensively proceed to CAUTIs. Hence, it can be apprehended that CAUTIs do not form a bacterium or spreads a bacterium into the urinary

tract. Instead, it is a global dysfunction of the immune system. Thus, the antibiotics used for the DSWI is the ultimate cause of the acquisition of fungal CAUTI as well. **(2)**

Unavoidable and Compelling Critical Physical health status of Patients

Postoperative urinary retention (POUR) as a common complication of Total Joint Arthroplasty (TJA) is always mitigated using urinary catheters since abnormal volumes of POUR can lead to bladder ischemia and decreased M receptor density. As the results suggest the use of indwelling urinary catheterization in the postoperative stages of TJA could inflict a significant level of risk of CAUTI for those patients than the patients with non-indwelling urinary catheters. The underlying high risk involved in this procedure is derived on the urinary tract and peri-prosthetics infections caused by urethral injuries caused by indwelling catheters. The risk of infections can also be elevated since it could be asymptotic for next 24 hours from the point of insertion of the indwelling catheters despite of the discomfort and the slow recovery of the patient. Moreover, the diagnosis of the CAUTIs at the question is also problematic since the obtaining of an uncontaminated urinary sample is challenging. Thus, treatments can be delayed. **(5)**

In addition to that, the cardiogenic shock as a critical patient condition can also increase the perioperative risk of acquisition of CAUTIs as justified in a study carried out in USA over 4800 cardiac surgical within the period of year 2002 to 2012. The care needs and the medical treatments that include urgent operations, number of packed blood cells transfused, length of stay in the Intensive care and presence of deep sternal wound infections can also multiply risk for acquisition of CAUTI at both operative and postoperative stages. Number of Packed blood cells transfused is believed to be triggering immunosuppression and consequently these same patients are found to be carrying CAUTIs with their impaired immune system followed by their critical cardiac sicknesses. **(**2**)**

Thirdly, certain inevitable health conditions of the geriatric patients such as intractable urinary retention, incontinence, the higher intensity of the underlying chronic diseases or genitourinary issues of the geriatric patients at final stages of their lives can also eventually trigger the risk of acquisition of CAUTIs. This is due to the obligatory use of the

urinary catheterization in the instance where the urinary complications are required to be treated consistently. **(8)**

Other associating risk factors for CAUTI

In addition to the major risk factors found in this study, the study discovered more other distinctive associating risk factors together with the incidence of CAUTIs in different care settings. These associating risk factors deem to have multiplied the risk of acquiring CAUTIs when there is a presence of another major or secondary level risk factor. Higher Braden scale score at the admission of the patient is one of the associating risk factors that can be recognized in the development of catheter associated infections in high-risk patients. The findings have revealed that the impact of the association of higher Braden scale score among other care related factors elevates the risk of acquisition of CAUTI as soon after the catheter is inserted. The other associating risk factors found in the same study were female predominance, older age and the presence of diabetes as well. The degree of the positive contribution of these components together with the Higher Braden scale on the acquisition of CAUTIs has been inconsistent**.** The direct involvement Braden Score among When the Sex indicator is applied to the study is null. Nevertheless, Braden scale score alarms the bedside nurse for immediate assessment for removal of the catheters where other substantial high-risk factors for CAUTI are at present for the same patients. **(8)** However, in a different study, the body mask index score which does have a correlation with Braden Score is not found to have significantly associated with CAUTI. (**2).** Moreover, the unit of admission, length of ICU stays, prior antibiotic exposure has been discovered as other associating risk factors that have a controversial effect on the acquisition of CAUTIs. Particularly, the use of antibiotics on other infections can lead to the acquisition of CAUTIs easily since the infections can significantly reduce the health status of the patient **(8).** Furthermore, it has also been evidential that the presence of comorbid diabetes mellitus, frequent admissions, immobility status of the patients insignificantly or significantly could cause the prolongation of the urinary catheterization or the use of catheterization by which incidence of CAUTIs rates are positively presented on the subjects**. (4)(2)**

6.1.2 Care related risk factors

Type of catheter

As the findings of one of the studies corroborates, the use of an indwelling catheter for 8 hours to 24 hours postoperatively could elevate the risk of postoperative urinary tract infections such as hematogenous bacteremia, seeding of the prosthesis implantation and joint infections. The requirement of the indwelling catheterization in the postoperative setting has been critical in the performance of the total joint placement since the neuraxial anesthesia could lead to diminish the sense of dilation of the bladder whilst causing neurogenic bladder problems. There are about 36 events of Indwelling urinary catheter associated infection reported for patients in the reviewed studies while there are only 11 cases reported for urinary tract infections of the patients without non-indwelling group. During the insertion of the indwelling catheters, as the risk of urethral injury goes always high, subsequently the risk of urinary tract and Periprosthetic infection could be increased. **(5)** The same phenomenon has also been empirically suggested by another scientific evidence as well. Accordingly, the presence of an indwelling catheters is recognized as an independent risk factors for certain types of infections such as fluroquinolone- resistant or multidrug-resistant organisms. These infections can be symptomatic or asymptomatic and can cause cross contaminations to other vulnerable patients. **(10)**

Prolonged Urinary Catheterizations

Prolonged urinary catheterization is recognized to be an independent risk factor for CAUTI in most of the studies which have been explored during the current study. **(10, 9, 5, 2)** It is also evident that one half of all catheterized patients could be bacteriuric or candiduric by day fifth from the insertion of the catheter. Moreover, a significant number of them would develop symptomatic infections whilst the secondary bacterium is inhabited for those patients with CAUTI at a rate of lower rate. **(10)** The patients over 65 year of age without any nosocomial infections with longer hospital days can subject to CAUTI's than those patients without any form of urinary catheterization. An average of 16 days is spent for a single term of hospitalization by a patient with urinary tract infection (UTI) caused by urinary catheterizations whilst it is about 9 days for those patients of

UTIs without catheterizations. This situation also hence demonstrates the risk of urinary catheterization for the rehospitalization for treatments of specific form of urinary tract infection. **(4)**. In addition to that, prolonged catheterization is identified as most prominent independent risk factor for the acquisition of CAUTIs as reported in a different study. During the insertion of a urinary catheter, an inflammatory environment is triggered in the bladder. Hence, the exposure of exfoliation, edema of the lamina propria and submucosa, urothelial thinning and mucosa lesions could take place. Hence, the condition of the bacteria is very resistant in the way that it can magnify a biofilm on the catheter to enforce a resistance against antibiotics and clearance by host defense. Thus, damaged mucosa and catheter itself provides a suitable platform for the bacterial adhesion. This causes prolonged hospital stays, morbidity and mortality particularly together with the acquisition of CAUTIs such as Enterococcus Faecalis. **(6)** Lengthier Foley catheter has also showed a distinctive predisposition to the acquisition of CAUTI in patients in contrast to the non CAUTI patients. Moreover, in that study the specific protocol of early Foley removal has also failed to reduce the number of CAUTIs as expected. **(2)**

Poor Administration Urinary Catheters

Use of urinary catheters on inappropriate and deficient Indications can increase a considerable level of risk of CAUTIs for individuals of 65 years or more as suggested by one of a specific study. The causes for such a poor administration of urinary catheter has been the lack of recurring assessment of the continued need for the indwelling catheterization. Moreover, such poor practice is related to the use of indwelling urinary catheters for reasons of the individual preference of the nurse at the question. **(1)** Thirdly, insertions of urinary catheters without a physician order by the nurse or insertion of urinary catheters without any documents rationale despite that there is an order from the physician has also contributed to the acquisition of CAUTIs in a remarkable manner. **(1,3)**

6.2 Nursing Interventions for prevent catheter related urinary tract infections

6.2.1 Nursing Interventions based on reduction of catheter use and Duration

Bladder bundles

In this specific intervention that is adopted in the form of multifaceted or bundled manner, the main goal has been to reduce the use of Indwelling urinary catheters and duration of the catheters. **(11)** The Bladder Bundled Interventions are general and effective strategies on evidence-based practices. **(3, 11)** They are proved to have the competence in achieving clinical outcomes related to reduction of use of indwelling catheters in the history. This nurse driven strategy can be deployed to continuously appraising the bladder functions and timely removing of the indwelling catheters. **(3).** In addition, this set of guidelines are also intended strictly to be applied by the health care providers aiming at CAUTI prevention. **(11)** This strategy can be composed of clinical protocols such as maintaining reminders and removal prompts, portable ultrasound monitoring and catheter insertion care, maintenance, and removal. This process is called as NO CAUTI (Need, Obtain, Competency, Asepsis, Unobstructed, Timely and Infection Risk control. **(3)** In addition, it can be consisted of use of silver alloy catheters, securing the device to decrease the fluctuations of the catheter after insertion by the nurses, shifting the catheter tubing when it embraces the floor and removal of the catheter well before two days exceeds from the insertion. **(11)** Impact of both of form of the Bladder bundle interventions discussed above are varying depending on the place, context, and the time of the practice of it. **(11,3)** These bundle guidelines are said to be carefully applied into the practice aiming prevention of CAUTIs. This course of practice is to believe be apprehended by nursing staff as a system of enhancing communication among nurse and physicians. Avoiding cursory catheter insertions by the ED nurses should be also planned to be mitigated by a patient safety programs such as urinary catheter management systems and patient education or with collaboration with ED staff on a practice of indication-based catheter insertion. **(3)**

Other Protocol based nursing intervention

In this model of intervention, the nurses work on a specific protocol of management of Indwelling catheters based on specific indications. Upon the indication, the nurses will assess the necessity of the placement or continuation of Indwelling catheters to a patient together with an opinion of the physician or use of standing order. If an appropriate indication is found, then the continuation of the catheter is assessed actively on daily basis and it is found that this practice has significantly lowered the number of indwelling catheter days per month and subsequently number of numbers of CAUTIs. When the results are compared, it is obvious that there was a distinctive reduction in the CAUTI rates despite there is no overall fall in the length of time where catheters were in situ. Therefore, it can be deducted that enhanced surveillances and minimized catheter days as directed by nursing staff can reduce CAUTIs in a considerable manner. **(1)** Furthermore, as quoted by an Australian study, emphasizing the importance on a documentation-based protocol for catheter maintenance is very essential for the nurses to implement bundle interventions. This could be supported by well-planned education curve, practice adherence auditing and a feedback system. Particularly, the practice adherence audits show a significant improvement in documentation of indication from the first period of intervention to the remainder period of the intervention. However, it deemed necessary to continuously implement the practice adherence audits for identifying rates of the documentation of indwelling catheter (IDC) removals and reviewal of continued need for IDCs since both practices are especially important in prompt removal if IDCs. (**3)**

6.2.2 Nursing interventions related to their clinical competence

Experience based interventions

It is important for the nurses to transform their knowledge or the education which is obtained in the nursing schools or in the field of nursing into the practice concerning the indication based urinary catheterization. It could be problematic or ineffective for the patients with catheterization when nurses do not synthesize their well-established knowledge base behind the indication for catheterization in the practice. Therefore, the critical thinking is essential during the management of catheter care. Meanwhile, the experienced nurses are also required to transform this knowledge into proper practice more and more as certain studies have proven that it is not. **(1)**

Education and training-based interventions

Nurse driven approaches lead to discontinue unnecessary catheter use at own assessment of the nurse when nurses are well trained. Moreover, nurse's clinical competence can also be broadened effectively on the low-risked alternatives to indwelling devices including intermittent catheterizations, use of bedside commodes, condom catheters and prompting for voiding trials in incontinent patients. When this form of skills is integrated with the collaboration of the physician who are in the other end of the computerized physician order entry system 3 cycle session, the results show a vast reduction simultaneously in number of catheter days (79%), use of devices (73%) and rate of CAUTIs (81%). **(9)** As another study has demonstrated, an expertise's involvement in educating and training the nursing staff engaged in catheterization on best practices has been significant finding in this study. These best practices include avoiding unnecessary catheterization, use of aseptic insertion techniques, proper maintenance of catheters and assessment of the necessity of the continuation of the catheter. These have been amazingly effective in reducing overall rate of CAUTIs. Additionally, the more inputs such as more huddles to reviewing safety and quality matter driving in the management of catheters are encouraged as best practices in subordinating to these interventions, the nurses who are acquiescent with CAUTI prevention interventions as mandated by the ward are rewarded with gift vouch-

ers. **(7)** Furthermore, similar form of interventions is reported from USA concerning effective education methods on urinary catheter management. In that, nurses can be educated on various indications based on guidelines of the American Center of disease control and prevention. Thus, Nurses become competent enough to assess the presence of the indication for identified patients and to remove the indwelling catheter after the doctor being contacted. The study has revealed these education-based interventions as successful similarly as Informatics led interventions identified in the same study. **(1)** In addition, the emphasis of the need to continuously educate nurse staff on the proper handling of urinary catheter and care by the leadership and the educational teams has been identified as vital in the use of urinary catheters since previous studies have signified valuable outcomes of reduction of CAUTI rates. The education should be regarded to cover the gaps of knowledge prevailing in the ramifications of inappropriate urinary catheter use, proper urinary catheter care and proper insertion technique in order to gain maximum outcome in the high-quality care. **(3,11)** In addition to the nursing diligent education on urinary catheter use, the patient education has also been discovered as an important part of the CAUTI prevention process. As the records suggest, the improved patient education enables more patients to negotiate with the physician about the continued need for their urinary catheters and to get the urinary catheter removed potentially. **(3)**

Interventions mediated by the administration and the management

As hospital's policy is revised on the the insertion and care of urinary catheters upon the recommendation by certain state health care organization, it can reinforce the nurses for a better clinical practice in managing urinary catheter and to lowering catheter days significantly. For instances, an introduction of a Unit base safety programs (CUSP) by a Neurosurgical and Neurological intensive care unit of a hospital in USA(NNICU) also has been ideal for enhancing nursing skills related to the proper care of urinary catheters together with HOUDIN system (hematuria, obstruction, decubitus ulcers, intake & output , no code/ comfort care and immobility due to physical constraints) . This project is implemented by a team consisting of nursing leadership, quality leadership and patient safety for achieving goals in the CSUP. In achieving these goals, this team presented three

education modules of standardization of urinary catheter care in which techniques addressing precise urinary catheter insertion interventions for CAUTI prevention, Precise urinary catheter care intervention for CAUTI prevention and CAUTI actions plan are included for all NNICU nurses. As the results are analyzed, it is implicit that the rate of CAUTI remains still while the use of urinary catheter rates drops. Overall, the effort of the nursing leadership in their policy making has been able to maneuver the nursing staff in a practice where it leads to achieve caring goals profoundly. In doing so, the nursing education, guidelines, and daily systems are critical for standardizing the practice of catheter care and preventing complications for patients in a significant manner ultimately. **(11)** Inclusion of new devices and equipment for management of urinary incontinence by heads of the ward unit can be identified as supportive interventions by the administration aimed at minimizing CAUTI rates. These devices and equipment include disposable, absorbent pads, redesigned condom catheters, barrier protection products and a new version of stool diversion device. **(7)**

6.2.3 Nursing interventions related to the management of clinical information aiming on reduction of CAUTI

Chart reminders and audits-based stop order system

There was a substantial reduction is reported in both duration of catheter use and number of CAUTIs when a system of automatic pre-written stop order reminder system or a nurse generated daily reminder system or is adhered to discontinue the use of catheters when there is no indication for catheter use is manifested. **(1,11)** The continuation of catheter is ceased unless the nurse at question does not choose an indication out of the followings. They are urinary obstruction, neurogenic bladder, urinary retention, urological surgery, fluid challenge for acute renal failure, open sacral wound for incontinence patients and urinary incontinence in terminally ill patients. **(1)** In addition, other similar interventions of Daily charts audits can be discussed while comparing the differences of both. In this specific hospital setting in USA, the charge nurses with the assistance of CAUTI arrest team undertakes daily chart audits while the patient's records concerning the catheterization are reviewed for current physician orders, appropriate indications, and duration of

catheterization. Then, the result is subjected to an assessment on the necessity of the continuation of the catheter by the multidisciplinary team including the physician. Meanwhile, the chart audits are also meant for assessment of documentation of perineal and catheter care and for daily reviewing of records of the decision made on continued need for catheters. Eventually, the orders made in this regard are connected to the auto stop feature in the computer system for automatic discontinue orders for catheters after three days in place. **(7)** Some of the interventions addressed above also lead to maximize the patient safety and to save unnecessary hospital cost related to raised treatment procedures or prolonged stays in wards. **(11)**

Computerized physician order entry system (CPOE)

This specific study is a prospective study in which four general medical Hospitals locating in Connecticut in USA are chosen as the place of the study. This specific study is indented to prove the effectiveness of the communication between Physician and the emergency care nurse with a computerized physician order entry system leading to minimizing the rate of CAUTIs. When the documentation of a catheterization is added to the floor nursing report, there will be an automatic notification issued by CPOE to the physician as part of the admission orders. This electronic notification then will urge the physician to discontinue the device or to continue the catheter for a period of 48 hours or to continue the device chronically. It is very obvious that this interventions cannot sustain without a strong collaboration of the both nurses and physicians in their own accountabilities. It is about the change of cultures in which the aim is to raise the awareness of the risks involved in catheterizations and importance of managing them dynamically. **(9,1)** Alternatively there is a specific study, in which the different form of computerized reminder system is placed for prompt removal of urinary catheters. In this system, the physician at question assign the indication on the catheterization and after three days, daily reminder is issued for determining on the continuation of the catheter. In contrast to the control unit, this system has shown higher reduction in the catheterization days whilst the lower CAUTI rate progresses minimally. This is said to be specifically due to the lack of blinding on the control unit. **(1).** This could be due to a lack of blinding elicited from the staff in the control ward during the intervention. **(9, 1)**

7 DISCUSSION

This study aims to answer two major research questions by exploring the ten scientific articles chosen based on primary and secondary research carried out on CAUTIs and multifaceted CAUTI prevention interventions. As stipulated by the hypothesis of the study, the first research question is to discover overall causing or risk factors for CAUTIs. The Second question is what nursing interventions can be integrated for reducing the acquisition or incidence of CAUTIs. Respectively as the contents of these all eleven articles are analyzed, it is implicit that every article has recognized at least pre dispositioning risk involved in the use and duration of catheters with the acquisition of CAUTIs. Mainly the patient centered risk factors emphasize the compelling nature of the geriatric patient's lowered physical health and anatomy of urinary tract and reproductive system of female population for acquisition of CAUTI during insertion of mandatory indwelling catheters. **(4,1 ,8,2)** Care related risk factors highlight significant concerns related to the skills and care of the nurses for an optimal level management of urinary catheterization. The form of the indwelling catheter also has manifested certain level of inevitable risk over other forms. In the second research questions, most of the interventions analyzed in the study have addressed nurse centered inputs whilst few of the interventions are mixed interventions that require an integration of the organizational resources and other healthcare officials. However, most of the interventions are experimentally efficient and reasonable as the results suggest. Thus, discussion will be compounded into several comprehensive chapters synchronize implications of the findings with the aims and theories of the study.

7.1 Discussion on the Research Question 1

It is evident that the acute or chronical catheterization is the major indication for urinary catheterization of all forms. (EAUN, 2012 & ANZUNS, 2013) Secondary indications for use of urinary catheters are essential in perioperative conditions, as a supportive mechanism in the treatments of open sacral or perineal wounds in incontinent patients, administering certain medicines and irrigating the bladder. Moreover, there are basically two forms of the catheterization. The short-term catheterization is called as the intermittent and the long term is called as the Indwelling catheterization. (EAUN, 2012 & ANZUNS,

2013). Nevertheless, the acquisition of urinary catheter associated infections are highly common with any type of urinary catheterization. (CDC, 2009). The Biofilm formation along the catheter surface has been identified as the most important cause of bacteriuria. (Majumder et al, 2020). The prolongation of the use of urinary catheters has also understood as a one of major risk involved in the acquisition of urinary tract infections. (EAUN, 2012). In particular, the use of indwelling catheters within a period of 8 to 10 hours could cause higher risk for acquisition of CAUTIs for patients particularly in postoperative settings. In common, all the ten scientific articles chosen to this study have in one way or other have suggested that the prolonged catheterization relates to the incidence or acquisition of CAUTIs whilst some confirm that it is independently a risk factor for CAUTI Overall, it is crystal clear that Indwelling catheterization is highly riskier than the intermittent catheterizations. **(5,9,8,2)**

Besides, the moderate nursing competence and care of the nurses have also been recognized as causing factors for acquisition of CAUTIs particularly in emergency departments. The failures in the decision taking by the nurses in regard to the choice of precise indication of the bladder management is vastly significant in this finding. (**1)** Thus, this level of practice has been inconsistent with theories of HPM and TPB. Particularly the HPM models especially dignifies that the importance of nursing competence in decision making phase directed at the promotion of health and prevention of CAUTIs. Hence, the nursing competence should address the areas of self-awareness about CAUTI and its consequences, desire of competences and perceived benefits of preventing CAUTI are significant. (Pender, 2011), (Ajzen, 1991), (**1**)

Critical physical health conditions also pose a greater risk on the acquisition of CAUTIs with or without concerning the form or point of the catheterization. This risk specifically applies in the use of urinary catheters for surgeries of TJAs. The post-operative condition called POUR ignites the necessity for use of catheters to bladder managements due to the risk factors for POUR such as age, male gender, and America society of anesthesiologists rating than in perioperative stages. **(5).** In contrast, other health conditions such as diabetes mellitus and cardiogenic shock become perioperatively risk factor for CAUTIs as discovered in a study which examined 4800 cardiac surgeries. Moreover, there can be seen

an association of three critical health conditions (Packed blood cell transfusion, deep sternal wound infection, urgent operations) which accelerates the acquisition of CAUTIs in any stage of the operation. Nevertheless, the Patients are suspected to acquire CAUTIs as a reason of lowered immunity as caused by the packed blood transfusion. (**2)** Therefore, the risk of temporarily or permanently lowered physical health can be recognized as an independent risk factor for acquisition of CAUTIs with or without the associating risk factors.

Next most vulnerable risk factor recorded for the study is the influence of accompanying nosocomial infections in the same site or other sites and other non-accompanying infections as an independent risk factor or cofounding risk factor. It is also explicit that this CAUTI acquisition within the presence of other accompanying infections is very evident to happen from within catheter period. Moreover, the risk of acquisition of CAUTI has been accelerative when there is a presence of another site infection such as DSWIs. The influence of the same site or other site infection for CAUTIs is caused by the depreciation of and the lowered immunity of the patient at the question. The previous usage or current treatments of antibiotics is proved to have lowered immunity level of the patient and as a result, CAUTIs are infected. The significance of this phenomenon is that type of the pathogen of the same site or other site nosocomial infection which is under antibiotic treatments or which is treated has been completely a different version of pathogen than of the CAUTI at the question. (**9,2)** Therefore, accompanying infections or other site infections can always be highly risky for acquisition of CAUTIs particularly when the treatment is involved with antibiotics. **(8)** Further to that, treatment of asymptomatic bacteriuria in catheterized patients should be avoided as this can only aggravate the problem of antimicrobial resistance in healthcare. (Köves, Magyar and Tenke, 2017).

The older age of the patients is another impeding independent risk factor for the victims of CAUTI patients as reported in several studies of ten chosen articles. In addition, patients who are in palliative care with chronical and genitourinary issues elicit an elevated risk for CAUTIs since the urinary catheterization becomes an inevitable at the stage for overcoming serious bladder complications. Thus, the prolonged catheterizations with other ongoing infections of the patients have increased a higher risk of CAUTIs for elderly patients of over 60 in general. In addition, Meanwhile the female predominance has

also inflicted a greater risk for acquisition of CAUTIs for females than males. This conclusion is that the female predominance either has become the independent or the co-founding factor for CAUTIs. The anatomy of the urethra of the female is vastly vulnerable for infections due to its shortness and for the ascending route of infections. **(1,4,6,8,2)**

7.2 Discussion on the Research Question 2

In this phase of the discussion, it is vital to emphasize that both direct and indirect form of interventions are required for the success of preventing CAUTIs as the variety of interventions identified in the study demand. (Butcher et al, 2013). Nursing assessment, physical and psychological care such as maintenance of chart reminder, insertion of catheters and educating patients are some of the tasks inherited to the intervention of CAUTI prevention by the nurse. (Berman et al, 2008, p 223). As these theories define and the most compelling risk factors imply, the enhanced nurse centered interventions are substantial for preventing CAUTIs in several manner. First, the nurses should have the accountability and cognitive competence to exclusively managing the maintenance and timely removal of urinary catheters. Secondly, it is their responsibility to maintain their clinical competence for preventing CAUTIs as stipulated by the TPB. Thirdly, the nursing leadership, education and experience have been proved to effectively reinforce their skills regarding the prevention of CAUTIs. (Pender, 2011)

The protocol-based interventions such Bladder Bundles and Indication based interventions are found to effective and efficient in different levels for preventing CAUTIs mainly when the HPM theory is satisfied. As the results indicate, the most common goals of a CAUTI prevention interventions are to reducing the use of unnecessary urinary catheters by nurses. As the third phase of the HMP model specifically assigns, the nurses should be sufficiently self-motivated to prevent infectious illnesses in the first place. (Pender, 2011) Secondly, their cognitive preparation or commitment to act in given situation for preventing CAUTIs are well emphasized in the Bladder bundle model. This is called NOCAUTI action plan in which the nurses are presented with a plan of various actions leading from the assessment of the necessity of urinary catheters by nurses to the stage of timely removal of catheters followed by accurate documentation. These actions plan also

addresses other significant inputs such as leadership, championship, education, monitoring and development of resources including the nurses themselves as key for the success of the NOCAUTI plan. **(3)** The most important factor is that the competence and knowledge of the nurse who participated in these interventions have significantly enhanced and increased. Other protocols such as indication-based protocols identified in this study are also highly significant as well. This Indication based protocol facilitates the nurses to take decisions on removal of catheters based on their own assessment together with the permission of a physician when a suitable indication is met. This can be urged by active and effective communication with the physician. This intervention has flourished in two previous studies recognized by this study. Documentation protocol is also an exclusive protocol which materialize the implementation of the bladder bundle protocol by the nurses in the evidence-based care culture. This protocol can also be reinforced further by associating education programs, practice adherence auditing and feedback systems. (**11, 1)**

The second most importance intervention discussed here does centralize the skills, knowledge and competence or experience of the nurses on the prevention of CAUTIs as derived on strategic education and use of unused knowledge of experienced nurses. The study finds that the nurse directed two-week education programs focused on diligence catheter maintenance practice can significantly reduce the rate of IDCs. (**1)** Moreover, the importance of transforming the prior experience into the practice is found to be poor in the study. Therefore, the third phase of the HPM theory can only be accorded partially with this theory since in the decision-making process the personal perception and the skill of modifying risk factors is based on the critical thinking of the nurse at the question. (Pender, 2011)

Thirdly, the study meets specific multifaceted education programs that have proved to be effective and enhancing regarding combating CAUTIs by the nurse in various levels. The education programs concerning the clinical competence of the nurse is one of the studies how nurse can replace effective alternatives for reducing use of IDCs. Use of intermittent catheters, bedside commodes, condom catheters and prompting voiding trials for incontinences are the certain instances for that. Nevertheless, these strategies cannot improve the CAUTI prevention without the contribution of the physician in the CPOE system.

Thereof, number of catheter days, use of devices and rate of CAUTIs have remarkably lowered. Further to that, the expertise based clinical education and trainings has also been found to improve the CAUTI prevention rates in a greater manner. This intervention completely interfaces with theoretical planned behavior model as it demands the competence in the context of the aseptic techniques, proper of maintenance of catheters and critical thinking of the nurses. The morning huddle is another promising education-based intervention for nurses to improve by reviewing the safety and quality of the urinary catheter management process. In addition, the education offered by the education department has been also vital concerning clinical competence of the nurses. Moreover, the new evidence-based knowledge of nursing specialists on the urinary catheter management with the on-field support of CAUTI arrest teams have also resulted in the optimal level for Standard Infection Ratio for CAUTIs in 2014. Thus, the significance of various educational intervention discussed above have been directly or indirectly attached for the purpose of preventing of CAUTIs. **(9,10)**

The third part of the second phase enables the nurses to acquire new skills, insights, and self-confidence through policy changes by the relevant hospital in the basis of recommendations of Society of Healthcare Epidemiology of America and Infectious Disease Society of America and evidence-based practice of the hospital at question. **(11)** In addition, the CSUP program delivered by the NNICU department has also excelled the clinical competences of the critical care nurses concerning CAUTI prevention together with the HOUDIN system. It has three specific modules dedicated to sterile techniques, cleaning techniques and indication-based nursing depending on the HOUDINI guidelines Documentation of the catheter care through out every stage is also held highly obligatory. Moreover, taking a urine reflex or urine sample from admitting patients is also compulsory using proper aseptic techniques as well. The effectiveness of this process has been very highly popular during the study period as the CSUP program has certainly eliminated the unnecessary catheterizations or it has well enhanced the patient safety methods for patients having catheters. The nursing leadership, quality leadership and patient safety goals are the drivers of this project by the NNICU as well. **(11)** However, it is convincing that this process is not highly uncommon procedure from the many of the concurrent catheter management protocols of many hospitals. Although, during the intervention period, it has performed remarkably well for lowering the catheter rates or rates of CAUTIs.

The structure of the process has also been very conventional. Hence, the application of the same protocols in an advanced manner could bring about excellent results despite the type of the ward or location.

The final phase of the nursing intervention discusses the implications brought by the chart reminders and computerized physician order entry (CPOE) system. The objective of the application of these two interventions is to harness the decision-making ability and the alertness of the nurses centered on indication based urinary catheter maintenance. Moreover, the daily chart audits are a more similar extended version of the chart reminders in which the stop order are automated and activated after three days from the insertion. These interventions can be applied for patients under terminal care, post-operative care, intensive care and for patients with chronical bladder or urinary complications. The progress of the intervention is inspiring as well. CPOE system has also been used successfully for reducing the usage and the duration of urinary catheters. The computerized order system allows the nurse to send automated reminders to physician at the admission of the patient for early removal of catheters in the basis of their evaluation within a 48 hours' period. The overall CAUTI reduction rate is 81% in contrast to the preintervention stage. Meanwhile, the collaboration among the multidisciplinary team in the ward for a better implementation of these interventions is reported to be highly influential as indirect nursing intervention **(11, 9, 1)** Thus, accompanying of technology into the catheter management system can be highly effective if the staff training or the financial capacities of the hospital do allow so. However, in contrast, the computerization of a chart reminder system can always be assured or traceable than the of using a manual reminder system since artificial intelligence is unavoidable element in the health sector in nowadays.

8 CONCLUSION

The nursing interventions discussed in this study for combating CAUTIs have been proved to be empirically effective and congenial in a reasonable standard to both theoretical models used in this study. Moreover, most of the interventions discussed in the study have focused on nurse centralized means of preventing CAUTIs or reducing urinary catheter use and duration. Number of normative interventions also have been empirically successful to decrease number of catheter days, duration and CAUTI rates across miscellaneous healthcare sites during longer terms. Although, a few interventions do not empirically insist on decreasing CAUTIs as same as they do for catheter days or use. Most of the interventions found emphasize on the management of cognitive behavior of nurses concerning the catheter maintenance in the first place. The decision-making skills, critical thinking capacities, alertness and collaboration of the nurses can be stated as the key areas that these specific interventions have focused on. Interventions directed to improve clinical competence of the nurses regarding handling catheter also deem exceptional in the study. Thirdly. the goals of reducing catheter days and use, education, innovative approaches, and protocols in changing hospital practice by the leadership programs have also been highly substantial as interventions for successfully overcoming CAUTIs. However, all these interventions are followed up by one or more negative outcomes when they are compared to the preintervention stage. The responsibility of the nurses in both individual and the collective domains of their profession for a better practice is inevitable and irreparable. Therefore, the application of most of the interventions recognized in the study to any form of a hospital ward to reducing the CAUTIs is certainly affirmative and evidential based.

8.1 Strength, Limitations, and recommendations

The included ten scientific articles through the inclusion and exclusion criteria have not been able to trace those other intended scientific articles which would have been more effective and appropriate for addressing nursing interventions applied for many other forms of nursing or forms of healthcare settings. Most of these eleven articles are mainly

assigned on emergency care departments or on the surgical departments of these hospitals. For instance, medical care department, rehabilitation hospitals, urological wards, homecare patients are not sufficiently explored in these eleven articles. Moreover, most of the intervention discussed in this study stands on their own in terms their creditability or availability since same intervention has not been always consistent with the interventions met by other articles. They may be applied in different versions or partially applied. For examples, CSUP intervention is an exclusive intervention where the bladder bundle intervention can be approximated in a completely different way.

As far as the strengths of the study are concerned, the main strength is implied in the results in which number of nurses led interventions are met and they have always been flourishing in content and evidenced based. Moreover, the study has included prolific two theoretical frameworks for which the study has consistently responded through its findings. The study is held unbiased by presenting both admissive and contradictive findings. The research questions are formed in the way a broader aspect of the phenomenon of CAUTI can be explored without adhering to a single hypothesis concerning CAUTI.

The study recommends more primary and secondary studies to be carried out on the same phenomenon with more variable being explored. The use of antibiotics, other drugs for CAUTI and its relationship with competence of the nurse to accept that challenge are specific areas that should be explored. Secondly, the nursing assessment skills regarding foreseeable confounding risk factors of CAUTI is another specific area that future studies will have to focus on separately. Further to that, the study appreciates if more studies can be conducted with the aim of educating the nurses on step-by-step sterile procedure depending on the type of catheterization. Moreover, the IDC and intermittent catheterization should be proportionately studied together with incidence of CAUTI to understand the association between CAUTI, sterile techniques, number of catheterizations and asymptomatic infectious risk.

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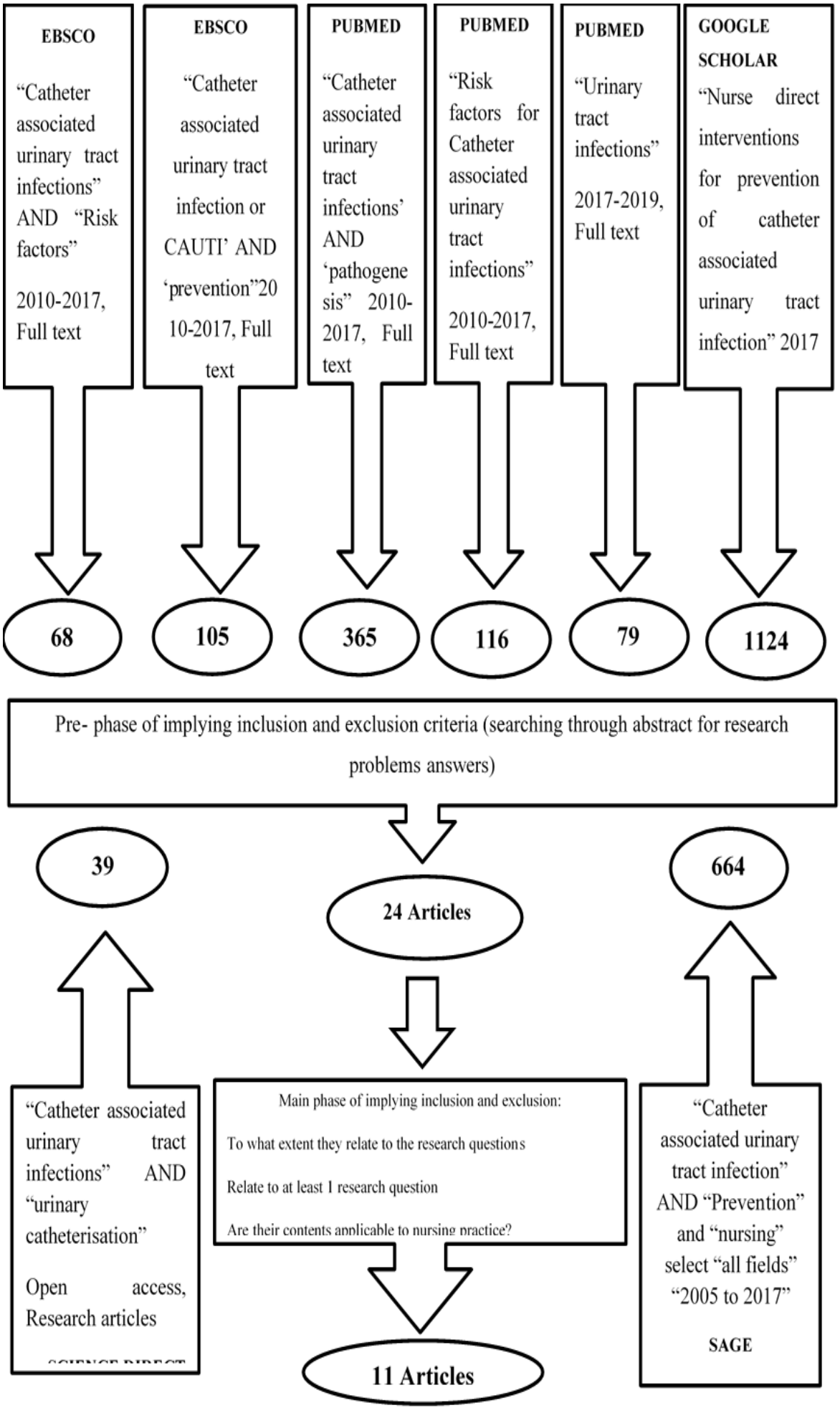
APPENDICES


EBSCO
"Catheter associated urinary tract infections" AND "Risk factors"
2010-2017, Full text
EBSCO
"Catheter associated urinary tract infection or CAUTI' AND 'prevention"2010-2017, Full text
PUBMED
"Catheter associated urinary tract infections' AND 'pathogenesis" 2010-2017, Full text
PUBMED
"Risk factors for Catheter associated urinary tract infections"
2010-2017, Full text
PUBMED
"Urinary tract infections"
2017-2019, Full text
GOOGLE SCHOLAR
"Nurse direct interventions for prevention of catheter associated urinary tract infection" 2017
68
105
365
116
79
1124
Pre- phase of implying inclusion and exclusion criteria (searching through abstract for research problems answers)
39
24 Articles
664
"Catheter associated urinary tract infections" AND "urinary catheterisation"
Open access, Research articles
Main phase of implying inclusion and exclusion:
To what extent they relate to the research questions
Relate to at least 1 research question
Are their contents applicable to nursing practice?
"Catheter associated urinary tract infection" AND "Prevention" and "nursing" select "all fields" "2005 to 2017"
SAGE
11 Articles