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Nursing Interventions Aimed at Reducing the Incidence of Hospital Acquired Catheter-Associated Urinary Tract Infections.

Abdella, Roun
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Background: Urinary tract infections (UTIs) account for 40% of all hospital-acquired infections. Of those, approximately 80% are caused by urinary catheters. Catheter-associated urinary tract infections (CAUTIs) are associated with increased mortality, morbidity, length of hospital stay and cost of care, and place a huge burden on the healthcare system.

Aim: The aim of this thesis is to determine which kind of nursing interventions can be used to reduce the incidence of CAUTI in hospitals.

Methods: The method of this thesis is a literature review, with inductive qualitative data analysis. To gather relevant literature, three databases were searched. These included CINAHL, Laurea FINNA, SAGE journals, resulting in a total of 12 articles selected.

Results: We deduced from the data that the four foundations of CAUTI prevention are the reduction of unnecessary catheter use, timely catheter removal, catheter care and maintenance and education and training.

We determined from the findings that there is a huge gap in nurses' education of CAUTI. There is also a distinct lack of awareness amongst nurses and other healthcare professionals about the consequences of CAUTI. Catheters are frequently inserted for the wrong reasons, and the care and maintenance of catheters is often non evidence-based. We also discovered a lack of consistent documentation of catheter insertion and care.

Conclusions: In conclusion, the effective prevention and reduction in the incidence of CAUTIs in hospitals requires a consistent commitment from different members of staff, in all hospital departments. Nurses have a large part to play, as the majority of day-to-day catheter related care and maintenance is their responsibility. Nurses require further education and training about the prevention of CAUTI. We also recommend that nurses engage in continuous professional development to ensure that their knowledge is kept up to date.

The best prevention strategies combine the utilisation of systems-wide innovations, with education and a combination of tactics aimed to reduce catheter insertion and catheter dwell time.

Keywords: Catheter-associated urinary tract infection, hospital-acquired, nursing interventions, UTI, prevention

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1 Introduction

Urinary tract infection (UTI) is the most common hospital-acquired infection, accounting for 40% of all nosocomial infections (Saint, Kowalski, Forman, Damschroder, Hofer, Kaufman, Creswell & Krein 2008). Out of all urinary tract infections, an estimated 80% are associated with the use of a urinary catheter (Weber, Sickbert-Bennett, Gould, Brown, Huslage & Rutala 2011). These infections are defined as ‘catheter-associated urinary tract infection’, or CAUTI for short.

The burden that CAUTI places on the healthcare system is undeniable; CAUTI is associated with increased mortality, morbidity, length of hospital stay and cost of care (Bruminhent, Keegan, Lakhani, Roberts & Passalacqua 2010). The scale of the problem is extensive; an estimated 15-25% of all hospitalised patients have a urinary catheter at some point during their stay (Loveday, Wilson, Pratt, Golsorkhi, Tingle, Bak, Browne, Prieto & Wilcox 2014). The estimated cost of each episode of hospital-acquired UTI in the United Kingdom (UK) is £1968 (2500€ approx.), amounting to an annual financial burden of £99 million (1.26 billion Euros approx.). Finland, as in the UK, has a publically funded health service, thus reinforcing the need to prevent these potentially avoidable infections.

We, the authors, have witnessed the hospital-acquired urinary tract epidemic first hand through our work as nurses. We are also well aware of the consequences that this brings, especially the suffering and inconvenience faced by the patients. Observing this only heightened our interest in the topic, and after a quick online search, we discovered the devastating effects of hospital-acquired CAUTI are not only seen in Finland, but are experienced worldwide.

In the past, CAUTI has not gained the same level of media attention as other high-profile hospital infections (Buckley et al. 2015). That’s not to say that its prevention is any less important than infections caused by *Clostridium difficile* (C.Diff) or Methicillin Resistant *Staphylococcus Aureus* (MRSA), for example. More needs to be done to raise the profile of this potentially life-threatening infection, and to raise the awareness of it amongst healthcare professionals. Despite the well-established link between catheters and urinary tract infections, there has been no universally recognised or consistent strategy put in place to prevent these infections from occurring (Buckley et al. 2015).

The development of successful CAUTI prevention strategies is needed now more than ever. The overuse of antibiotics to treat potentially preventable infections is contributing to the increasing antibiotic resistance of bacteria. An estimated 23.000 people die each year in the

United States alone, as a direct result of this resistance (Centers for Disease Control and Prevention (CDC), 2016). The prevention of avoidable infections is the first step to combat this.

2 Background

Here, the theoretical framework is explained, and the main concepts of the thesis are defined.

2.1 The Urinary Tract

The urinary tract is a part of the human body's urinary system, which consists of the kidneys, ureters, the urinary bladder and the urethra. The kidneys are responsible for filtering the blood in order to remove waste and to produce urine. The urinary system is also responsible for maintaining the homeostasis of water, blood pressure, ions, calcium and red blood cells inside the human body. The urinary tract is made up of the ureters, urinary bladder and urethra. The urinary tract drains urine from the kidneys, stores it and releases it during urination. (Shier, Butler & Lewis 2006, 470). A diagram depicting the anatomy of the urinary system is shown in figure 1.

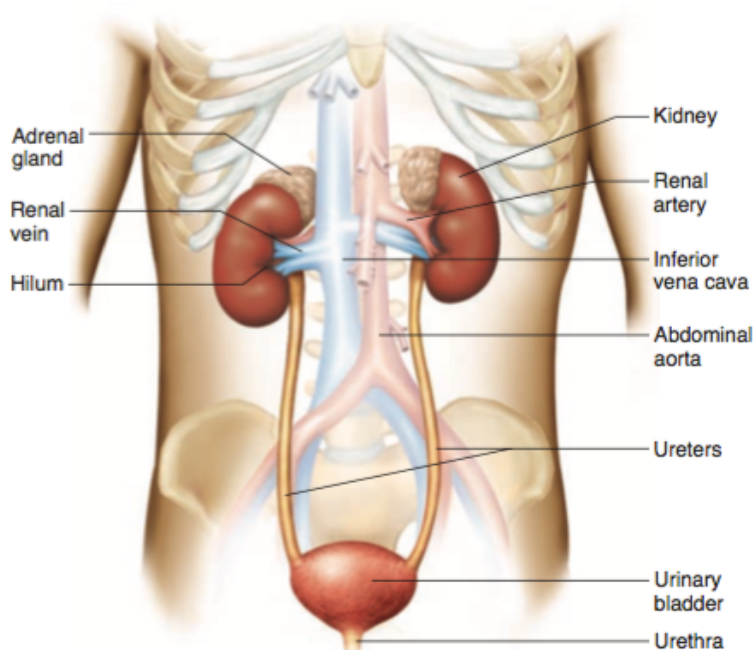


Figure 1: Diagram of the entire urinary system, (Shier et al. 2006, 470)

The ureters are the tubes which carry urine from the kidneys to the urinary bladder. In an adult, the ureters are usually between 25 to 30 cm long, and they run on the left and right sides of the body, parallel to the spine (vertebral column). The urine is moved into the uri-

nary bladder through gravity and muscle contractions (peristalsis) of the smooth muscle tissue inside the walls of the ureters. They extend into the urinary bladder, where the entry point is sealed by valves, preventing urine from flowing back into the kidneys (Shier et al. 2006, 483).

The urinary bladder is a pear-shaped hollow organ, where urine is stored. The location of the urinary bladder inside the human body is along the body's midline at the inferior end of the pelvis. The bladder opens into the urethra at the neck of the bladder.

When urine enters the urinary bladder through the ureters, the hollow space of the bladder is filled and its elastic walls are stretched. Urine then remains inside the urinary bladder until the body is ready to excrete it. As soon as the urinary bladder has stored between 150 and 400ml of urine, the walls inside the urinary bladder start to stretch. Stretch receptors inside the walls then send a signal to the brain and spinal cord, which leads to an involuntary relaxation of the internal urethral sphincter. This will result in the person to feel a need to pass urine. Urination, however, does not need to occur immediately and can be delayed as long as the urinary bladder does not exceed the maximum volume. The urethra is kept closed by the urethral sphincter, which is a muscular structure that helps to keep the urine inside of the bladder until urination is possible. (Shier et al. 2006, 483-485).

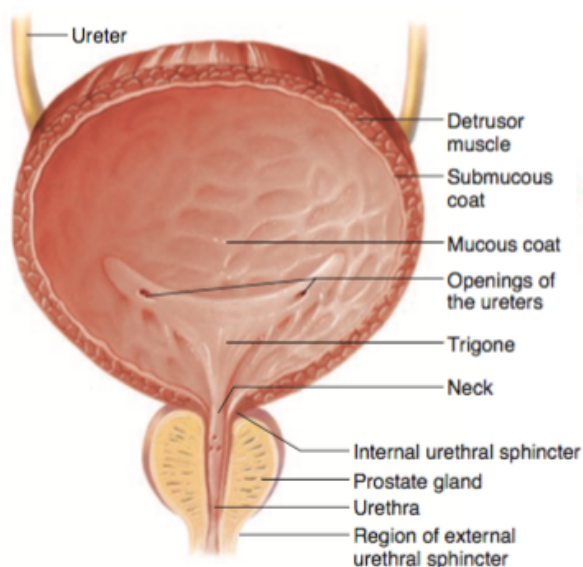


Figure 2: Diagram of the male urinary bladder, (Shier et al. 2006, 485)

Urination starts with the relaxation of the urethral sphincter muscles. At the same time, the smooth muscles inside the walls of the urinary bladder start contracting which then allows the urine to be expelled from the bladder through the urethra (Shier et al. 2006, 485).

The urethra in males and females differ in length and structure. The urethra in males is about 18 to 20cm long and it passes along the length of the penis before emptying. The urethra passes through the prostate gland and it is entered by the seminal ducts from the testes at each side, in order to transmit semen as well as discharging urine (Schenkman 2013).

The female urethra is located within the vaginal wall and its opening can be found between the labia. The female urethra is about 4cm long and therefore much shorter than the male urethra. The external opening is just past the urethral sphincter (Schenkman 2014). The male and female urinary tracts are shown in figure 3.

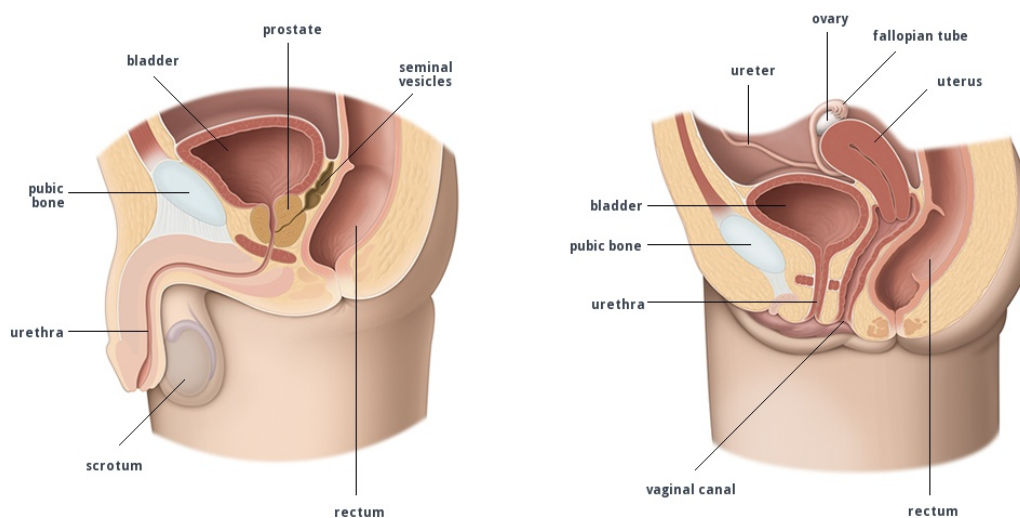


Figure 3: Male and female anatomic view (European Association of Urology Nurses 2016)

2.2 Indwelling Urinary Catheters

Urinary catheterisation is a very common procedure found in hospitals, and is even more common in intensive care units (ICU). Approximately 15-25% of all hospitalised patients will receive a catheter at some point during their stay (Loveday et al. 2014).

An indwelling urinary catheter, commonly known as a Foley catheter, is a thin, flexible tube that is generally made from rubber, plastic (PVC), silicone or latex. The catheter tube is inserted into the bladder via the urethra, in order to drain urine. A Foley catheter is a double lumen (tube) catheter; the larger lumen drains urine from the bladder, and the smaller lumen is used to inflate the small balloon at the tip of the catheter. The inflated balloon anchors the catheter tube inside the bladder. A 22cm long catheter is used for females, and for males, a 40cm catheter (Berman, Snyder, Kozier & Erb 2008, 1303).

Indwelling urinary catheters are connected to a closed, gravity drainage system comprised of the catheter, tubing and a urine collection bag. These types of systems rely on the force of gravity to drain the bladder (Berman et al. 2008, 1304).

The catheterisation of females is generally considered to be less complicated than males, due to the shorter length of the urethra. As the urethra in male patients is longer and more twisting, there is a greater risk for urethral trauma (Berman et al. 2008, 1303).

Urinary catheters are inserted in hospitals for a variety of reasons, however the most widely accepted and standardised list of indications is that which is provided by the United States Centers for Disease Control and Prevention (CDC):

The appropriate indications for catheterisation are defined as acute urinary retention, bladder outlet obstruction, the accurate measurement of urinary output in critically ill patients, continuous bladder irrigation for urinary haemorrhage, urinary incontinence posing a high risk for the patient, palliative care for the terminally ill and the preoperative and postoperative use in some surgeries (Gould, Umscheid, Agarwal, Kuntz & Pegues 2009).

2.3 Hospital-Acquired Infections

Hospital-acquired infections, also referred to as healthcare-associated infections (HAI) or nosocomial infections, are defined by the World Health Organisation (WHO) as: “an infection occurring in a patient during the process of care in a hospital or other health care facility which was not present or incubating at the time of admission” (WHO, n.d.).

Healthcare-associated infections affect an estimated 1.7 million people annually in the United States, and account for around 99,000 deaths (Bruminhent et al. 2010). Common hospital-acquired infections include catheter-related bloodstream infections, Clostridium Difficile infection, surgical site infections and ventilator associated pneumonia, although most sources agree that catheter-associated urinary tract infection (CAUTI) is the most prevalent HAI in high-income countries (WHO n.d.).

The prolonged and inappropriate use of invasive devices (such as central lines, urinary catheters and ventilators), is the main risk factor for acquiring a HAI. Other risk factors include the extended use of antibiotics, the use of high-risk and sophisticated medical procedures, and the poor application of infection control protocols. Immunocompromised patients are also at a greater risk of developing a HAI (WHO n.d.).

The recommendations given by the National Institute for Health and Care Excellence (NICE) for the avoidance of healthcare-associated infections are based on the five following themes: hospital environmental hygiene, hand hygiene, the use of personal protective equipment

(PPE), the safe use and disposal of sharps, and the principles of asepsis (Loveday et al. 2014). Most of these general principles can equally be effectively applied for the prevention of CAUTI.

2.4 Catheter-Associated Urinary Tract Infections

A UTI is caused by the presence of pathogenic bacteria in the urinary tract. Infections of the lower urinary tract are very common, and include cystitis (inflammation of the bladder), prostatitis (inflammation of the prostate gland) and urethritis (inflammation of the urethra). Infections of the upper urinary tract are less common, and include pyelonephritis (inflammation of the renal pelvis), and interstitial nephritis (inflammation of the kidney) (Smeltzer, Bare, Hinkle & Cheever 2010, 1359)

The signs and symptoms of a UTI vary depending on the location of the inflammation. Many uncomplicated, lower UTIs are asymptomatic, however signs of infection may include increased frequency and urgency of urination, pain on urination, haematuria and lower back pain (Smeltzer et al. 2010, 1361). Patients with upper UTIs often have more serious symptoms; in addition to the symptoms of a lower UTI, these may include chills, fever, pyuria, nausea, flank pain, headache, and painful urination (Smeltzer et al. 2010, 1365).

A urinary culture is often taken to diagnose bacteriuria, and to determine the specific type of organism present. Generally, UTIs are treated with a course of antibiotics (Smeltzer et al. 2010, 1362). The antibiotic chosen depends on the type of bacteria, level of infection and symptoms. Commonly used antibiotics for uncomplicated urinary tract infections include Nitrofurantoin and Trimethoprim (University of Maryland Medical Center 2012).

The use of a urinary catheter is the single biggest risk factor for UTI, accounting for more than 80% of all nosocomial UTIs (Loveday et al. 2014; Weber et al. 2011). The presence of the indwelling catheter inside the bladder makes the patient much more susceptible to infection. Normally, the urinary tract is kept sterile by the flow of urine during micturition, which flushes out bacteria. Additionally, the urethral sphincter helps to keep the bladder closed, and prevents the reflux of contaminated urine back into the bladder (Loveday et al. 2014). However, the catheter system bypasses the urethral sphincter meaning that bacteria are able to gain access to the urinary tract and bladder, either intra- or extraluminally (Loveday et al. 2014). If there are any breaks in the closed catheter system, bacteria will enter intraluminally (Gould et al 2009). Extraluminal bacterial contamination often occurs during the insertion process, spread from health-care workers' hands, or from the patient's own perineal flora (Loveday et al. 2014).

In addition, Loveday et al. (2014) mention the role of the 'biofilm' in the development of CAUTI. A biofilm is a bacterial coating on the inside of the catheter that grows over time, in every catheterised patient. The bacteria in biofilms can cause additional problems as they contribute substantially to the deposit of mineral crystals inside the catheter. These deposits are known as 'encrustation', and can lead to the blockage of the catheter and the reflux of urine (Loveday et al. 2014). Urinary reflux is highly associated with the development of CAUTIs (Smeltzer et al. 2010).

According to the CDC, a diagnosis of CAUTI can be made based on the presence of a urinary catheter, in conjunction with one or more symptoms of a UTI and a positive urine culture (Gould et al. 2009).

Nosocomial urinary tract infections associated with the use of an indwelling urinary catheter have a considerable risk of becoming complicated (Smeltzer et al. 2010, 1359). Approximately 3.6% of patients with CAUTI will go on to develop life-threatening secondary infections such as bacteraemia or sepsis. The mortality rate of sepsis is very high; around 10-33% of septic patients will not recover (Loveday et al. 2014).

Additionally, the consequences of CAUTI include prolonged hospitalisation and increased hospital readmissions. Complications such as inflammation, urethral trauma, bladder calculi and urethral strictures are also possible. CAUTI has been shown to contribute to patient falls and delirium, especially in the elderly. The physical and psychological discomfort of the patient should also not be underestimated.

In addition to the risks of harming the patient, the prolonged hospitalisation and treatment of patients with CAUTI contributes significantly to the financial burden on the health service (Loveday et al. 2014).

2.5 Nursing Interventions

Nurses insert up to 50% of catheters and subsequently are responsible for the majority of catheter care (Leaver 2007). Nurses therefore are in a prime position to make a positive impact on the care of patients with catheters, and on the prevention of CAUTI, through the effective use of appropriate nursing interventions.

A nursing intervention is defined by Berman et al as "any treatment based on clinical judgement and knowledge, that a nurse performs to enhance patient/client outcomes" (2008, 1553). A nurse, in providing care for her patients, follows a typical nursing process. It is explained by Berman et al. as a systematic and client-centred method of planning and delivering nursing care. The stages of the nursing process include assessing, diagnosing, planning, implementing and evaluating. Through this nursing process, problems will be defined, a nurs-

ing diagnosis will be decided, a care plan will be drawn up and implemented, and the outcomes will be evaluated (2008, 160).

Nursing interventions are decided during the planning phase, and performed during the implementation phase. The decision to use one particular nursing intervention over another is based on sound nursing knowledge. In addition, evidence-based rationale helps nurses to decide which interventions are likely to lead to the desired patient outcomes after considering the risks and benefits of all options (Berman et al. 2008, 223).

Berman et al. propose that there are three different types of nursing interventions. Independent interventions are those activities that nurses are licensed to initiate independently, according to their own knowledge and training. These include physical care, emotional support and assessment. Dependent interventions are nursing interventions which are carried out under physicians' orders or supervision, for example, medication, tests or treatments. The final type of nursing interventions are collaborative interventions. This is where nurses carry out actions in collaboration with the multi-disciplinary team, for example physiotherapists and dieticians, to work towards a common goal. The types of nursing interventions employed by a nurse depends heavily on the department where she is working, the individual needs of the patient, and the experience of the nurse (2008, 223).

3 Purpose Statement and Research Question

3.1 Purpose Statement

The purpose of this thesis is to gather together relevant and current literature, in order to determine which kind of nursing interventions can be used to reduce the incidence of CAUTI in hospitals. The aim is to create a valuable source of information for nursing staff involved in the insertion and care of urinary catheters, providing them with best practice guidelines and advice.

3.2 Research Question

What kind of nursing interventions can be used to reduce the incidence of hospital acquired catheter associated urinary tract infections?

4 Methodology

4.1 Literature Review

The research method used in this thesis is a literature review. The purpose of a literature review is to collect and summarise known information about a subject, using research evidence (Polit & Beck 2014, 371-372). The first step of a literature review is to formulate a research

question; this is to focus the search to a specific topic. The next step is to devise a strategy to gather the necessary data to answer the research question. Lastly, the information found is analysed and interpreted, and conclusions from the data are drawn (Polit & Beck 2012, 94-96).

A high quality literature review must be comprehensive, thorough and up to date. The literature search must also be systematic, with clear inclusion and exclusion criteria. Furthermore, a good review should be reproducible, meaning that a researcher following the same methodology and rules would reach similar conclusions (Polit & Beck 2012, 96-97). This literature search followed systematic methods of data retrieval and analysis. This helps to ensure reproducibility and accuracy.

4.2 Database Search

To find data to answer the research question, three different electronic bibliographical databases were searched. These included the Cumulative Index to Nursing and Allied Health Literature (CINAHL). CINAHL is one of the most important sources of nursing and allied-health material, and contains nearly 3,000 journals dating back from 1981 (Polit & Beck 2012, 100). The other two databases included were Laurea FINNA and SAGE Publications. Laurea FINNA is the electronic article search portal of Laurea University of Applied Sciences, and SAGE is an online database of more than 900 different scientific journals. The literature search was conducted in April 2016. The search terms used in combination were 'nursing interventions', 'nursing', 'catheter associated urinary tract infection' and 'hospital acquired'. The Boolean operator AND was used to restrict the search to find data containing all of the search terms (Polit & Beck 2012, 99). This process is described in Table 1.

Search Terms	Database	Exclusions	No. of Hits	1 st Selection Stage	2 nd Selection Stage
Nursing Interventions + Catheter Associated Urinary Tract Infection + Hospital Acquired	CINAHL (EBSCO)	Full text only, English language, published 2005 - 2016	2	2	1
Nursing + Catheter Associated Urinary Tract Infection + Hospital Acquired	CINAHL (EBSCO)	Full text only, English language, published 2005 - 2016	11	6	3
Catheter Associated Urinary Tract Infection + Hospital Acquired	CINAHL (EBSCO)	Full text only, English language, published 2005 - 2016	23	0	0
Nursing Interventions + Catheter Associated Urinary Tract Infection + Hospital Acquired	SAGE	Full text only, English language, published 2005 - 2016	0	0	0
Nursing + Catheter Associated Urinary Tract Infection + Hospital Acquired	SAGE	Full text only, English language, published 2005 - 2016	47	6	2
Nursing Interventions + Catheter Associated Urinary Tract Infection + Hospital Acquired	Laurea FINNA	Full text only, English language, published 2005 - 2016	8	5	0
Nursing + Catheter Associated Urinary Tract Infection + Hospital Acquired	Laurea FINNA	Full text only, English language, published 2005 - 2016	83	18	2
Catheter Associated Urinary Tract Infection + Hospital Acquired	Laurea FINNA	Full text only, English language, published 2005 - 2016	539	21	4
Totals:			713	58	12

Table 1: The electronic literature search process, detailing the number of articles retrieved

4.3 Inclusion and Exclusion Criteria

The database searches were restricted to full text only, English-language articles, published between the years of 2005-2016. The restriction of age was to ensure that only the most current and up-to-date articles were included. With these restrictions enabled, the primary search generated a total of 713 articles. From these search results, articles were first selected based on their title and abstract. Only articles which appeared to be relevant to this study according to their title and abstract were selected for further examination; this was a total of 58 articles. The second selection phase involved an assessment of the full-text article. From

this assessment, the relevance and quality of the article was determined. Only articles which answered the research question, and that were deemed to be of good enough quality were selected for inclusion. A total of 12 articles remained after this selection process.

The PRISMA flow diagram is a tool that can be used to clarify the different phases of the literature search process. (Moher, Liberati, Tetzlaff, & Altman 2009). The process of the literature review undertaken by the authors is described in Figure 1.

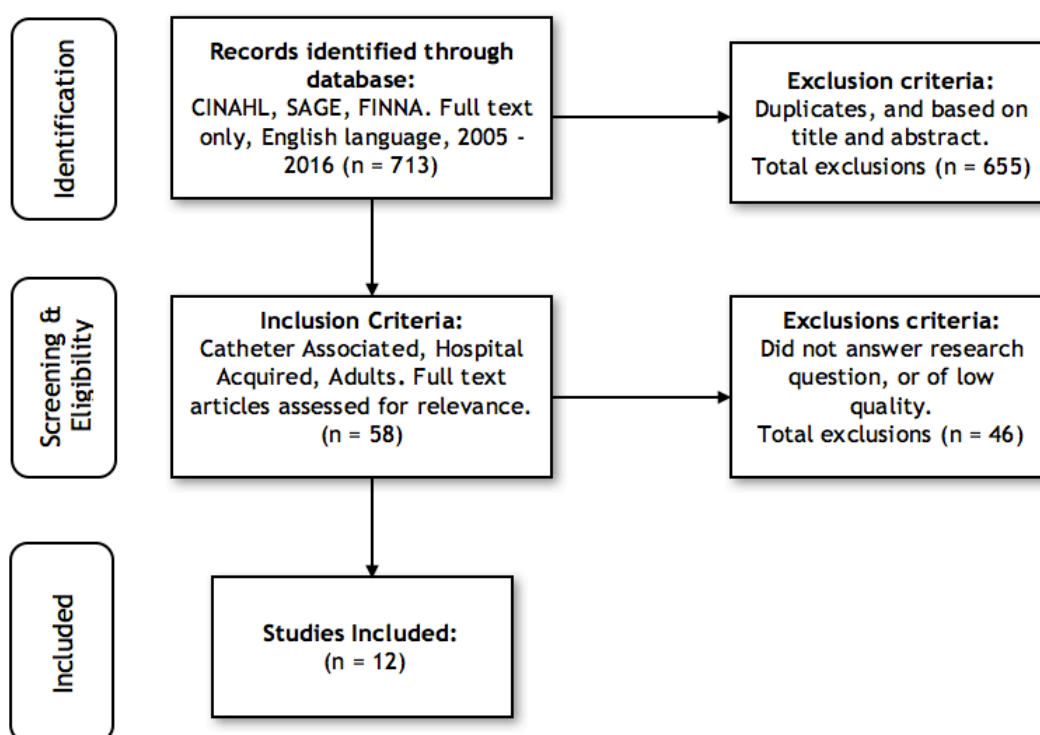


Figure 4: PRISMA Tool: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

4.4 Data Appraisal

According to Teing (2007), critical appraisal is one of the most important steps when conducting a literature review. The quality and outcome of the literature review is fully dependent on the quality of the initial articles used (Teing 2007).

The Johns Hopkins Nursing Evidence-Based Practice Model (Newhouse, Dearholt, Poe, Pugh & White 2007, 44-45) was used to appraise the strength and quality of the evidence found. It is a useful tool to help ensure the trustworthiness of all data used. Level I is deemed to be the strongest form of evidence and level V is the weakest. Levels I - III are experimental or systematic reviews, whereas levels IV - V are literature reviews or rely upon expert opinion rather than scientific fact. Additionally, the quality of each individual article can be judged

according to the Johns Hopkins tool. (Newhouse et al. 2007) High quality evidence, indicated as Quality A on the scale, has “consistent, generalizable results; sufficient sample size for the study design; adequate control; definitive conclusions; consistent recommendations based on comprehensive literature review that includes thorough reference to scientific evidence.” (Newhouse et al. 2007, 207). Good quality evidence, indicated as Quality B on the scale, has “reasonably consistent results; sufficient sample size for the study design; some control; fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence.” (Newhouse et al. 2007, 207).

Of the 12 data sources selected for this literature review, 10 are research based papers, indicated as levels I - III according to the parameters of the scale. The remaining 2 are non-research based papers, indicated as levels IV - V on the scale. 8 of the articles are deemed to be Quality A, of high quality, and 4 articles are Quality B, of good quality. All articles of poor quality i.e. of less than quality B, were discarded and not included in this literature review. The majority of studies included in the literature review were of Level II strength and Quality A.

Polit and Beck (2012, 95) suggest that a good literature review should predominately rely on primary sources rather than secondary sources. Primary sources are research documents written by the researcher conducting the study. As opposed to secondary sources, which are descriptions of studies prepared by someone else, for example, a literature review. This was taken into account during the article selection process for this literature review.

Level of Evidence	No. of Articles	Quality A (High Quality)	Quality B (Good Quality)
Level I			
Level II	8	6	2
Level III	2	1	1
Level IV			
Level V	2	1	1
Total:	12		

Table 2: Johns Hopkins Nursing Evidence Appraisal

4.5 Data Extraction

Data extraction is the process of reading the included studies and extracting results relevant to the research question (Munn, Tufanaru, & Aromataris 2014). In order to minimise the risk of error when extracting data, a data extraction form should be utilized (Teing 2007). The use

of a suitable form will help the reviewer to find and extract relevant data. It is also recommended that at least two different people review the data independently, to minimize bias and reduce errors (Munn et al. 2014).

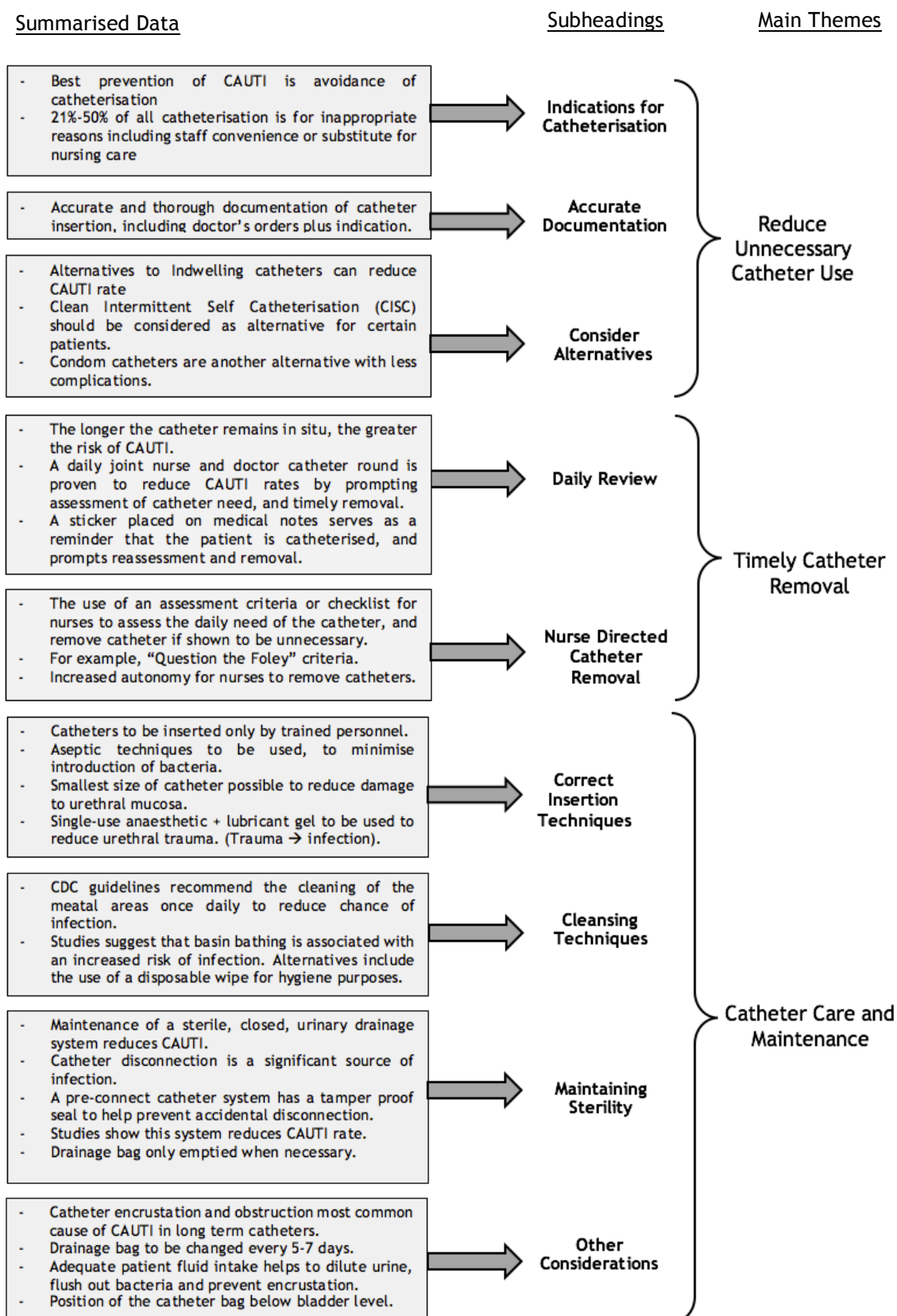
All three authors independently reviewed each article and extracted relevant data into the extraction form. The focus at all times was to find data which would help to answer the research question. Once this stage was completed, the authors discussed their findings with each other, and the data was pooled together into one single form, including only the most relevant data. (See appendix 1)

4.6 Data Analysis

The data was analysed according to the qualitative content analysis method, a method which is used to analyse and interpret written data. The subjective interpretation of the data is achieved through a systematic classification process, whereby themes and patterns are identified (Hsieh & Shannon 2005).

An inductive approach to content analysis was used in this paper. An inductive method of content analysis seeks to make sense of the data by open coding, grouping and classifying data (Elo & Kyngäs 2008). This approach was used as the articles retrieved from the literature search are all unique studies with different findings. The inductive method allows the researcher to combine the findings and identify recurring themes throughout the data. Blakestone (2012, 41) describes the process as starting with a set of observations before moving onto more general propositions. In other words, moving from specific data to general theory.

This process involved thoroughly examining all of the written material, and generating a series of sub-headings to describe all aspects of the content (Elo & Kyngäs 2008). These sub-headings were then grouped together according to their general theme. The aim of grouping data is to reduce the number of categories by combining those that are similar into higher-order categories (Elo & Kyngäs 2008). Throughout this process, it became clear that there were 4 main recurring themes in terms of CAUTI prevention. These were: Reduction of unnecessary catheter use, timely catheter removal, catheter care and maintenance and education and training.



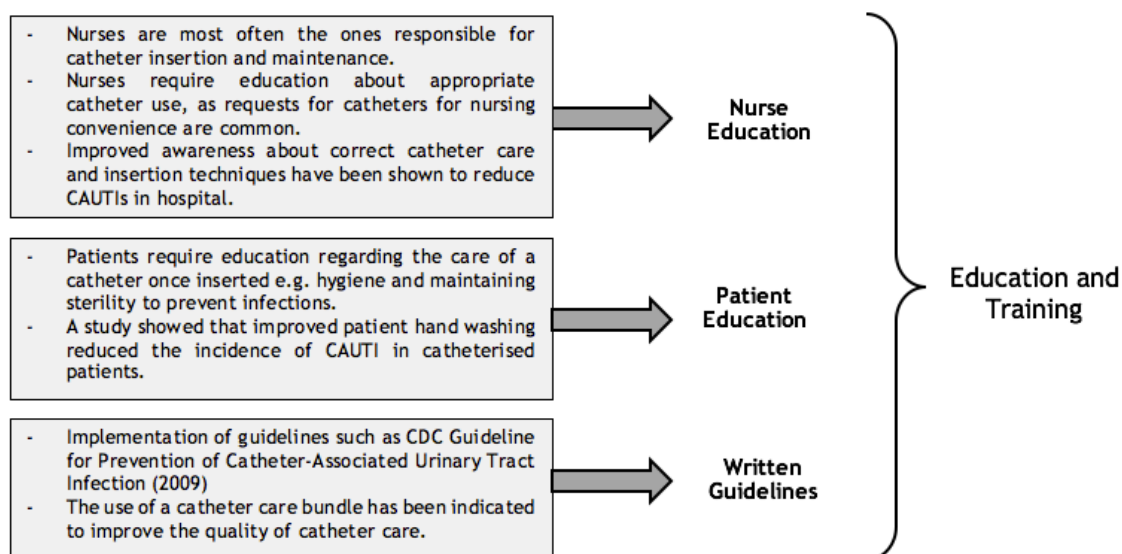


Figure 5: Description of the inductive content analysis process

5 Findings

Twelve articles were systematically reviewed, and the data extracted from them was compiled in the findings section. As mentioned earlier, the findings are comprised of 4 distinct main themes, with 12 different sub-sections. The authors induced from the data that the foundations of CAUTI prevention are: the reduction of unnecessary catheter use, the timely removal of catheters, the correct catheter care and maintenance and education and training.

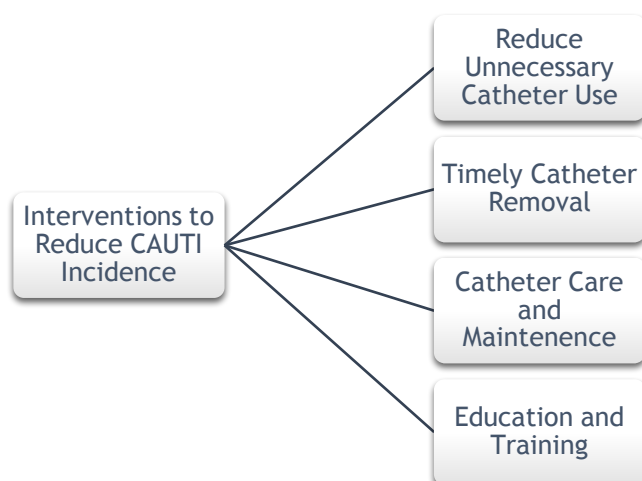


Figure 6: Interventions to reduce the incidence of CAUTI, 4 main themes.

5.1 Reduce Unnecessary Catheter Use

5.1.1 Indications for Catheterisation

There is no doubt that the best way to prevent CAUTI is by avoiding catheterisation in the first place (Elvy & Colville 2009; Meddings et al. 2013). Yet despite this, studies indicate that between 21-63% of patients have urinary catheters inserted without a valid indication (Meddings et al. 2013). Tiwari et al. discovered in their 2011 study that out of a total of 436 patients, 40% experienced at least one day of inappropriate catheterisation. Inappropriate catheterisation places patients at unnecessary risk of contracting CAUTI, and potentially causes them serious harm from complications (Fakih, Heavens, Grottemeyer, Szpunar, Groves & Hendrich 2014).

If catheterisation is unavoidable, there should be an appropriate clinical indication for its order and the catheter should only be used for as short a period of time as possible (Bruminhent et al. 2010; Elvy & Colville 2009). According to the 2009 Centers for Disease Control and Prevention (CDC) Healthcare Infection Control Practices Advisory Committee (HICPAC), the appropriate indications for the insertion of an indwelling catheter are as follows: urinary retention or bladder outlet obstruction, the accurate measurement of urinary output in critically ill patients, for patients undergoing urologic or genitourinary tract surgery, the need for accurate measuring of intraoperative urine output, for incontinent patients with open sacral or perineal wounds, to improve comfort in end of life care and for patients with prolonged immobilisation such as trauma or surgery (Gould, Umscheid, Agarwal, Kuntz & Pegues for HICPAC 2009).

As mentioned earlier, indwelling catheters are often used for inappropriate reasons, contrary to the 2009 CDC guidelines (Tiwari, Charlton, Anderson, Hermsen, Pharm and Rupp 2011). Catheters are frequently inserted for nursing convenience, and as a substitute for nursing care in patients with urinary incontinence (Buckley et al. 2015; Salamon 2009). Other common inappropriate indications are for the collection of a urine sample when the patient can urinate voluntarily, and the prolonged use post-operatively without appropriate reasons. Urinary catheters typically should be discontinued within 24 hours post-surgery if there are no clinical indications for continuation (Agency for Healthcare Research and Quality (AHRQ) 2015).

A study conducted at St Vincent's Medical centre, a 473 bed hospital in south-western Connecticut determined that from a total of 126 catheterisations, 54 were inserted inappropriately. As a consequence of the high number of inappropriately placed catheters, the incidence of CAUTI was also very high (Bruminhent et al, 2010).

Effective interventions aimed at decreasing unnecessary catheter placement tend to be based on the implementation of catheter placement restriction protocols. These catheter restriction protocols seek to remind clinicians of the appropriate indications, before the actual insertion occurs (Meddings et al. 2013). Gokula, Smith and Hickner (2007) investigated the impact of using a urinary catheter indication sheet in conjunction with staff education sessions, in the Emergency Department of a 550-bed hospital in the United States. The researchers aimed to determine whether the use of a urinary catheter indication sheet improved the appropriate use of Foley catheters. The indication sheet detailed the appropriate indications for catheter placement, and was attached to all of the catheter insertion trays in the emergency department. The person inserting the catheter was requested to either select an appropriate indication from the sheet, add an alternative reason if not on the list, or decide against inserting the catheter after reading the sheet. The results of this clinical trial showed a dramatic increase in the appropriate usage of indwelling urinary catheters. Over a period of 3 years, the number of Foley catheters inserted in the emergency department decreased by 80%. Although the incidence of CAUTI was not a factor measured in this trial, other evidence reinforces the correlation between the reduction of inappropriately placed catheters and the incidence of CAUTI in hospitals (Gokula et al. 2007).

5.1.2 Accurate Documentation

CAUTI is one of the most prevalent hospital-acquired infections, yet records for up to 50% of hospitalised patients with indwelling catheters lack documentation of the evidence-based criteria for their insertion (Welden 2013).

Documentation is a fundamental principle of nursing and medical practice. Nurses have a duty of responsibility to their patients, and a legal obligation to accurately document all care and procedures given to them (Berman et al. 2008, 246). Studies suggest that the accurate documentation of catheter insertion corresponds with the reduction of unnecessarily placed catheters, and consequently, a reduction of the incidence of CAUTIs (Meddings et al. 2013). Physicians are frequently unaware that their patients have urinary catheters, due to a lack of documentation. This means that a large number of unnecessary catheters are forgotten about, creating a substantial risk for CAUTI (Bernard, Hunter & Moore 2012).

The National Institute for Health and Care Excellence (NICE) hospital acquired infection guidelines (2014) emphasise the importance of documenting catheter insertion and care (Loveday et al. 2014). The NICE guidelines state that “the clinical indication(s) for catheterisation, date of insertion, expected duration, type of catheter and drainage system, and planned date of removal” must be documented for every patient with an indwelling urinary catheter (Loveday et al. 2014, 33).

Meddings et al. (2013) suggest that the use of catheter placement restriction protocols, in combination with requiring documentation of every catheter insertion, generates accountability for each individual placement of a urinary catheter. This means that clinicians must take responsibility for their actions, and face the consequences if catheters are inserted without a valid reason. The requirement for accurate documentation of every catheter insertion is in itself a good deterrent to inappropriate catheterisation (Meddings et al. 2013).

A clinical trial (Fakih, Heavens, Grotemeyer, Szpunar, Groves & Hendrich 2014) in 18 different emergency departments in the United States, evaluated the effect of an intervention to reduce unnecessary placement of urinary catheters. The intervention incorporated the education of staff about the appropriate clinical indications of urinary catheters, in conjunction with a computerised catheter order and documentation system. The computerised catheter order system forced the clinician to select an indication from the drop-down list, in order to continue with the catheterisation process. The appropriate catheter indications were based on the CDC guidelines for catheter use. The results of this clinical trial indicated that this method of documentation and catheter ordering was successful in reducing the number of inappropriately placed catheters. A sustained 30% reduction in catheter insertion was recorded in the 6 months postimplementation. The researchers concluded that promoting compliance with obtaining a physician's order for each catheter insertion is a simple way of increasing appropriate use (Fakih et al. 2014).

Another study conducted by Quinn (2015) reinforces this conclusion. The use of electronic medical records (EMR) was shown to be highly effective in a CAUTI reduction program. Physicians were instructed to document every catheter insertion into the EMR, including the indication for its insertion. The EMR also enabled the nurses to re-evaluate the purpose of the catheterisation and suggest to the physician whether to consider discontinuing or renewing the order. The series of interventions implemented by Quinn (2015) were shown to have contributed to a significant decrease in the incidence of CAUTI in this particular hospital. The CAUTI incidence decreased from 4.9% of catheterised patients in 2008, to only 0.3% in 2013.

Documentation enables the nurses to question the right indications for the order and also facilitates discussion of the issue with the physician. Accurate documentation has been shown to be successful in reducing the number of inappropriate catheterizations and CAUTIs. (Gray, Nussle, Cruz, Kane, Toomey, Bay & Ostovar 2016).

A study conducted by Parry, Grant and Sestovic (2013) suggested that appropriate nursing documentation and follow up was significantly associated with a reduction in the number of catheterised patients, as well as CAUTIs. In this study, a physician reminder chart was added onto the EMR to remind the physician of the presence of a catheter, and the need to address a device removal plan (Buckley, Clements & Hopper 2015).

5.1.3 Consider Alternatives

The HICPAC suggests that before catheterising, alternative methods of treatment should be considered (Gould et al. 2009). AHRQ (2015) reiterates the importance of considering alternatives to indwelling catheterisation, in accordance with patients' individual care needs. The majority of alternatives to indwelling or Foley catheters are associated with a much lower risk of CAUTI, and are recommended in many cases (AHRQ 2015).

Despite being the number one reason for catheter misuse, incontinence has many alternative forms of treatment. For example, alternatives such as using a bedside commode, incontinence garments and condom catheters are successfully indicated for incontinent patients (AHRQ 2015). However, these alternatives are often met with resistance from nursing staff due to the perceived extra work load involved (Saint et al. 2008).

For patients with bladder emptying dysfunction, spinal injury or neurologic bladder, the use of intermittent straight catheterisation (ISC) is considered to be the 'gold standard' of care (Herter & Kazer 2010). ISC is associated with a reduced risk of CAUTI and complications compared to indwelling catheters. Intermittent catheter use allows the patient their right to privacy, and it also makes it easier for them to return to normal activities of daily living. (AHRQ 2015).

Furfari and Wald (2008) propose the use of bedside bladder scanners to reduce the number of catheters inserted. The bladder scanner is used to first confirm the presence of urinary retention before a catheter is inserted, and its use has been linked to fewer cases of CAUTI (AHRQ 2015; Furfari & Wald).

5.2 Timely Catheter Removal

5.2.1 Daily Review

Hooton et al. (2010) estimate the daily incidence of bacteriuria associated with indwelling catheterisation is 3-8%; with the duration of catheterisation being the most significant risk factor for the development of CAUTI. Herter and Kazer (2010) suggest that after 30 days of indwelling catheterisation, bacteriuria will be present in virtually every catheterised patient. Evidence proves that urinary catheters are commonly left in place despite being no longer needed, leading to an increased risk of CAUTI for every day that passes (Meddings et al. 2013).

Both the CDC and the NICE guidelines highlight the importance of a daily review of catheterised patients. The purpose of the review is to assess the need for continued catheterisation,

or to prompt removal of the catheter (Gould et al. 2009; Loveday et al. 2014). In addition, plenty of recent studies demonstrate the effectiveness of a reminder system and daily reviews to prompt the assessment of a catheterised patient (Buckley et al. 2015; Bruminhent et al. 2010; Tiwari et al. 2011; Hooton et al. 2010; Fakhri, Dueweke, Meisner, Berriel-Cass, Savoy-Moore, Brach, Rey, DeSantis & Saravolatz 2008).

Buckley et al. (2015) demonstrated a reduction in CAUTI incidence in a UK hospital after the implementation of a reminder system. The system was incorporated into the patients' existing medical documentation, and consisted of a catheter documentation form which prompted catheter re-assessment after 2 days of indwelling catheter use. The question 'is the catheter still indicated?' was used to help reduce unnecessarily placed catheters. If the answer to the question was no, the nurse was instructed to seek medical advice and remove the catheter. If the answer was yes - the catheter is still indicated, the nurse was instructed to continue to review the catheter daily.

Bruminhent et al. (2010) demonstrate further the potential benefits of implementing a reminder system to reduce CAUTI incidence. In this study, a reminder sticker was placed on each patient's medical record binder to remind the physicians and nurses that the patient has an indwelling urinary catheter. The sticker prompted the staff to re-evaluate the indications of the catheterisation and consider discontinuing the urinary catheter if it was deemed to be unnecessary. The results of this study showed a significant relationship between the appropriate use of urinary catheter and decrease incidence of CAUTIs. At 6 months postintervention, the rates of CAUTI dropped from 7.02 per 1,000 catheter days, to 2.72 per 1,000 catheter days; a significant improvement (Bruminhent et al. 2010).

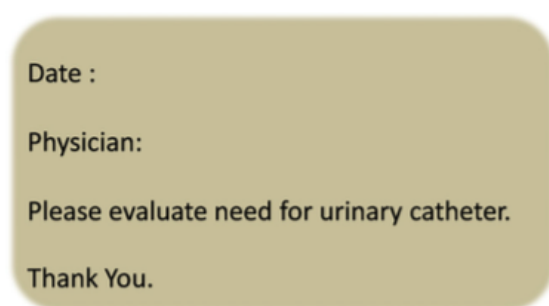


Figure 7: A reminder sticker placed on patients' medical notes (Bruminhent et al. 2010, 690)

A literature review conducted by Bernard et al. (2012) concluded that the daily follow up of patients with indwelling catheters, and assessment of indication by ward nurses, are associated with a decrease in CAUTI incidence and number of catheterisations.

This statement is confirmed further by Fakhri et al. In their 2008 clinical trial, they assessed the effect of a daily nurse catheter round on the number of inappropriate catheterisations. The dedicated catheter nurse would take part in the daily multi-disciplinary round. During the rounds, the nurse would assess each patient for the presence of a urinary catheter, and whether the catheter was indicated for use. If no appropriate indication was found, the nurse would discuss the need for the removal of the catheter with the physician, and the catheter would be removed. This intervention resulted in a reduction in the number of inappropriate catheterisations, from 102 per 1,000 catheter days, to 64 per 1,000 catheter days. This reduction in inappropriate catheter use can also generally be associated with a reduction in CAUTI incidence. (Fakhri et al. 2008).

5.2.2 Nurse Directed Catheter Removal

As discussed in the previous sub-section 'daily review', there are many interventions designed to serve as a reminder for catheter review and removal. However unfortunately, these interventions are often easy to ignore. In this case, a catheter 'stop order' may be beneficial. A stop order is where clinicians are prompted to remove the catheter as default after a certain time period, unless the catheter remains clinically indicated (Meddings, Krein, Fakhri, Olmsted & Saint 2013). Clinical evidence suggests that nurse-initiated stop orders may be used to prevent prolonged, unnecessary catheterisation (Buckley et al. 2015; Loeb, Hunt, O'Halloran, Carusone, Dafoe & Walter 2008; Topal, Conklin, Camp, Morris, Balcezak & Herbert 2005). In addition, Quinn (2015) and Bernard et al. (2012) describe the potential benefits of nurse-led catheter removal initiatives.

In a review of experimental studies, Bernard et al. (2012) concluded that nurse-led initiatives have been successful in reducing the length of catheterizations and subsequently, the occurrence of CAUTI. Further studies, such as Quinn (2015), add credibility to this claim. In an investigation spanning 5 years, Quinn assessed the impact of a multi-faceted CAUTI prevention program in a 301-bed community hospital, which included the implementation of a daily, nurse-led, catheter removal evaluation. This initiative was called 'question the Foley' and it served as a checklist for nurses to assess whether continuation of a Foley catheter was appropriate. If it was discovered that the catheter had no valid indication, the nurse would contact the physician for an immediate catheter removal order. The criteria for catheter removal is detailed below.

<i>Ask Daily if the Foley Catheter Is Being Used to:</i>	
1.	Provide bladder irrigation and/or instill medication?
2.	Provide relief from urinary tract obstruction not manageable by other means?
3.	Permit urine drainage in a patient with neurogenic bladder dysfunction, hydronephrosis, or urinary retention not manageable by other means?
4.	Obtain accurate intake and output in critically ill patients?
5.	Aid in urologic surgery or other surgery in the contiguous area (GYN or lower GI surgery)?
6.	Manage urinary issues or special purposes/circumstances such as a difficult insertion per the urologist?
7.	Manage urinary incontinence in patients with Stage III or Stage IV pressure ulcers?
8.	Provide comfort care in terminally ill or hospice patients?

If the patient meets NONE of the above criteria, the RN will contact the physician and discuss the possibility of catheter removal.

Figure 8: Question the Foley Criteria (Quinn 2015, 321)

This catheter removal initiative proved to be highly effective. The average dwell time, or time the catheter is in place, decreased from 5.6 days in 2008 to 3.7 days in 2009. The reduction in dwell time directly correlated with a reduction in CAUTI incidence in this particular hospital (Quinn 2015).

Other researchers suggest that a nurse-initiated stop order may be of benefit to reduce catheter dwell time (Buckley et al. 2015; Loeb et al. 2008; Topal et al. 2005). A nurse-initiated stop order, as opposed to a nurse-led removal evaluation, does not require a physician's order to discontinue the catheter. Nurse-initiated catheter removal empowers the nurse to remove the catheter without seeking medical advice if there is no clear indication for the catheter to remain in place (Buckley et al. 2015).

In a 2005 study, Topal et al. investigated the impact of a nurse-initiated catheter stop order on the length of dwell time and the rates of CAUTI. In their clinical trial, nurses were empowered to remove a patient's catheter if they no longer fit the criteria for catheter use. This resulted in a significant decrease in catheter days, thus leading to a relative reduction in CAUTI incidence.

Despite the potential benefits of a nurse-initiated catheter stop order, Meddings et al. (2013) report that nurses are often reluctant to remove a catheter, even though they are empowered to do so. They suggest this may be due to the nurses' desire to avoid the inconvenience of increased patient care needs after catheter removal, especially in cases of incontinence. Other nurses report that they feel unqualified to remove the catheter without a physician's order. However, through the use of peer-support and education, it is possible to overcome these barriers (Wenger 2010).

5.3 Catheter Care and Maintenance

5.3.1 Correct Insertion Techniques

An estimated 10-20% of all CAUTIs are caused by the introduction of bacteria during the insertion process (Leithauser 2005). Aiming to reduce this, the Centers for Disease Control and Prevention (CDC) (2009) and also the National Institute for Health and Clinical Excellence (NICE) (2014) have published guidelines describing the correct aseptic catheter insertion techniques. These techniques should be followed by all healthcare professionals during the catheterisation process in order to reduce the risk of CAUTI. According to the NICE guidelines published by Loveday et al., asepsis is defined as the absence of potentially infective microorganisms. An aseptic technique aims to minimise the risk of contamination by using standard principles of infection prevention (Loveday et al. 2014).

Indwelling urinary catheters should be only inserted by trained healthcare professionals who are familiar with the correct insertion techniques (Agency for Healthcare Research and Quality 2015). It is crucial that they are able to perform the catheter insertion aseptically in order to avoid the introduction of bacteria during the catheter insertion (Herter & Kazer 2010). In an acute hospital setting, an aseptic technique should be maintained for the entire catheter insertion (Gould et al. 2009). AHRQ (2015) recommend the use of a second staff member as an assistant for the catheter insertion procedure; this helps to maintain the sterile field.

Handwashing is considered to be the first and also the most important measure to help prevent infection during the catheter insertion process (Emr & Ryan 2004). Epidemiological evidence shows that microbial transmission via hands is the main contributing factor in the spread of hospital acquired infections (Loveday et al. 2014). It is therefore essential that every nurse should perform a thorough hand wash before starting the insertion process, in order to decontaminate their hands (Gould et al. 2009; Loveday et al. 2014). Handwashing with soap and water is the only effective way to remove soiling and spores (Infection Control Nurses Association 2003).

Typically, a urinary catheter insertion kit comes in a sterile package and includes a sterile urethral catheter, sterile gloves, drapes, sponges, antiseptic solution and a single-use pack of sterile lubricant (Shlamovitz 2016). In case of contamination of the equipment during the insertion procedure, the nurse should get a new catheter and restart the process to avoid the risk of infection. Furthermore, the catheter package be inspected carefully before opening. If the package shows any signs of damage or opening, it should not be used.

Studies suggest that the smallest gauge of catheter, which will still allow free flow of urine, should be used (Nicolle 2014). This helps to prevent urethral trauma, mucosal irritation and

residual urine in the bladder, all of which are known risk factors for CAUTI (Loveday et al 2014). There is also some evidence which suggests that the use of a silver-alloy coated catheter lowers the risk of catheter acquired urinary tract infections (Leidberg & Lundeberg 1990; Schumm and Lam 2008). Also the use of catheters which are impregnated with antibiotics have proven to reduce bacterial growth in patients which are catheterised for less than a week, thus reducing CAUTI (Schumm and Lam 2008). However, these catheters are also associated with increased removal rates and patient discomfort, therefore, current evidence does not support their routine use (Nicolle 2014).

Before inserting, the catheter tip should always be lubricated with sterile single-use lubricant or anaesthetic gel. A well-lubricated catheter will reduce urethral friction and trauma which in turn reduces the chances of infection (Loveday et al. 2014).

Cleansing of the patient's perineal area before the catheter insertion is recommended to avoid bacterial contamination (Herter & Kazer 2010). For female patients, the nurse will do so by separating the labia minora and washing the urethral meatus and the inside of the labia minora with sterile water and swabs. In male patients, the nurse will clean the penis by retracting the foreskin and washing the glans with sterile water and swabs. Contamination risk of the urethral meatus during cleansing can be minimised by using downward strokes, and by using one sterile swab per wipe (Mangnall & Watterson 2009). According to expert opinion, the use of sterile normal saline or water is sufficient for the cleansing of the urethral meatus. The use of an antiseptic preparation for cleansing is not necessary and does not provide any advantages (Gould et al. 2009).

5.3.2 Cleansing Techniques

Nurses are responsible for their patients' daily hygiene, and assist their patients with this if they are unable to take care of themselves. Part of these responsibilities includes the cleansing of the perianal and genital area (Berman et al. 2008, 742, 755). For patients with an indwelling urinary catheter, the CDC recommends cleaning of the meatal areas once daily to reduce the chance of infection (Gould et al. 2009).

The NICE guidelines advise that a non-sterile, clean technique should be used before coming into contact with a patient's catheter. This includes the process of thorough handwashing and the application of clean non-sterile gloves (Loveday et al. 2014).

The Joint Commission stresses the importance of repeating the procedure of hand washing and applying gloves, for example, in cases where the nurse needs to first clean a patient after a bowel movement before cleansing the meatal area and catheter (Joint Commission 2011).

Traditionally, basin bathing is used as a method for daily hygiene within hospital settings, especially for those patients who are unable to take a shower (Strouse 2015). However, several studies suggest that basin bathing is associated with an increased risk of hospital-acquired infection, with the basin being a reservoir for bacteria (Johnson, Lineweaver & Maze 2009). In their 2009 experimental trial, Johnson et al. found that 98% of a sample of 92 hospital bath basins were contaminated by bacteria. Furthermore, it is very uncommon for healthcare workers to sterilize the bath basins after use due to a combination of cost and time factors.

There are studies which indicate that the use of alternative methods for patient bathing help to reduce the spread of hospital-acquired infections, including CAUTI (Strouse 2015; Larson, Ciliberti, Chantler, Abraham, Lazaro, Venturanza & Pancholi 2004). Johnson et al. (2009) suggest the use of pre-packaged bath products such as disposable bathing wipes. The same wipe should not be used for cleansing of the entire body, but several wipes will be used for different body parts, to minimise the risk of bacterial spread from one body part to another (Larson et al. 2004).

There is no evidence to suggest that using antiseptic solutions for the cleansing of the meatal area offers any advantage over routine personal hygiene (Webster, Hood, Burrige, Doidge, Phillips, & George 2001; Classen, Larsen, Burke, Alling & Stevens 1991).

In addition, the Society for Healthcare Epidemiology of America (SHEA) state that care givers should use only routine hygiene when cleaning the meatal area as the use of antiseptic solutions is unnecessary (SHEA 2014).

Furthermore, the CDC state in their CAUTI prevention guidelines that antiseptic solutions are not recommended for the cleansing of the periurethral area while a urinary catheter is in place, and does not offer any protection against CAUTIs (Gould et al. 2009).

5.3.3 Maintaining Sterility

After the catheter is inserted, the most effective way of avoiding CAUTI is to maintain a closed and sterile system (Godfrey & Fraczyk 2005). A closed urinary drainage system will help to avoid bacteria entering the catheter system, thus reducing the risk for urinary tract infection. Both the CDC and NICE guidelines stress the importance of maintaining a sterile and closed catheter system (Gould et al. 2009; Loveday et al. 2014). To help maintain the sterility of the system, a clean, non-sterile technique must be used prior to manipulating the catheter site and drainage system, including when emptying the catheter. The regular emptying of the drainage bag is necessary, however, opening of the bag should be kept to a minimum to avoid unnecessary risk of contamination (Godfrey & Fraczyk 2005). In cases where the drainage bag needs to be opened in order to obtain a urine sample, NICE guidelines suggest that a sample is obtained from the sampling port, and an aseptic technique is used (Loveday et al. 2014).

Accidental catheter disconnection is a significant source of infection, as microbes may gain access to the urinary tract (Madeo, Barr & Owen 2005). If accidental catheter disconnection occurs, it is advisable to replace the catheter and the entire drainage system to reduce the infection risk. Catheter replacement should also be considered if there is a break in aseptic technique while handling the catheter or if leakage occurs (Gould et al. 2009). Before reconnecting to a new drainage system, the catheter tubing junction should be disinfected (APIC 2011).

Some studies suggest the use of a pre-connect catheter system to prevent CAUTI. This system has a tamper-proof seal which helps to prevent accidental catheter disconnection and breakage in the sterile system (Madeo et al. 2005). A 2005 study by Madeo, Barr and Owen investigated the effects of using a pre-connect catheter system on the rates of CAUTI in a UK hospital. After a trial period of 6 months, the rates of CAUTI were 41% lower than the rates during the pre-intervention period. The researchers concluded that a pre-connect catheter system has the potential to reduce the incidence of CAUTI by preventing the accidental disconnection of the catheter system (Madeo et al. 2005).

5.3.4 Other Considerations

NICE guidelines state that the urine drainage bag should be emptied before it is more than three-quarters full. Regular emptying of the drainage bag helps to avoid trauma to the urethra caused by the weight of the bag (Getliffe 1995). In addition, regular emptying helps to prevent backflow of the urine and urine stagnation which are also potential causes of CAUTI (Bissett 2005). Backflow and stagnation of urine can be prevented furthermore by maintaining an unobstructed flow of urine. This can be achieved through the use of a catheter stand, and the positioning of the drainage bag below bladder level (Loveday et al. 2014).

There are conflicting recommendations in terms of how often the catheter drainage bag should be changed, varying from 5 days to 4 weeks (Jones, Brooks, Foxley & Dunkin 2007). However, current NICE guidelines in the UK suggest that the drainage bag is only changed when necessary, and according to the manufacturer's guidelines (Loveday et al. 2014).

Over time, catheters become susceptible to encrustation, which is the build-up of mineral salts. If allowed to build up, the encrustation can be a major cause of catheter blockage and back-flow of urine (Godfrey & Fraczyk 2005; Getliffe 2003). To reduce the effects of catheter encrustation and associated CAUTI which may occur as a result of this, the CDC recommends changing the catheter whenever clinically indicated. Clinical indications include suspected encrustation, obstruction, infection, or when the closed system has been compromised (Gould et al. 2009).

Despite popular belief, no evidence has been found supporting the benefit of cranberry pills or cranberry juice in order to avoid urinary tract infection (Jepson, Williams & Craig 2012). Nevertheless, it is important to provide the patient with adequate hydration. The Society of Urological Nurses (SUNA) (2005) recommends a fluid intake of 30ml/kg per day, to maintain a daily urine output of 1.5 - 2 litres. This helps to reduce the incidence of CAUTI by diluting urine, flushing out bacteria and preventing catheter encrustation and blockage (SUNA 2005).

5.4 Education and Training

5.4.1 Nurse Education

The implementation of evidence-based strategies designed to reduce the rate of CAUTI is hindered by the reluctance of nursing staff to change well-established habits and beliefs (Meddings, Krein, Fakh, Olmsted & Saint 2013). Targeted nurse education is essential to overcome these barriers and to improve the uptake of new methods and interventions. Bernard et al. (2012), Quinn (2015), Madeo et al. (2005), Gray et al. (2016), Godfrey & Fraczyk (2005) and Buckley et al. (2015) mutually reiterate the importance of nurse education in the prevention and reduction of CAUTIs.

The CDC (2009, 16) recommend that care-givers must be provided with “education about CAUTI, other complications of urinary catheterisation, and alternatives to indwelling catheters.”

Gray et al. (2016) suggest as a method of reducing CAUTI rates in hospital, a multi-disciplinary education and training campaign is highly effective. In this case study, the education focussed on teaching the latest evidence-based practices, including implementing tightly defined indications for indwelling catheter use, the importance of a daily review, and a discussion of the alternatives to catheterisation. This education was successful in not only reducing the incidence of CAUTI, but also increased the awareness of healthcare workers about the consequences of CAUTI, and the importance of CAUTI prevention (Gray et al. 2016).

A study performed by Quinn (2015), assessed the impact of a CAUTI reduction program in combination with targeted nurse education. The study took place in a 301-bed community hospital in New York City, over a period of 5 years. This included the implementation of varied and diverse education sessions, in large groups in the hospital auditorium, as well as small information sessions on all of the wards. These sessions were led by clinical nurse specialists during morning, evening and night shifts, and covered a wide variety of topics relating to CAUTI prevention. These nurse education sessions, in combination with other CAUTI prevention tactics, were shown to have dramatically reduced the incidence of hospital acquired CAUTI within the first year. Furthermore, the rate of CAUTI continued to decrease year on year from 110 cases of CAUTI in 2008, to only 2 cases in 2013 (Quinn 2015).

Buckley et al. (2015) highlights the importance of teaching pre-registration nursing students about the risks and consequences of CAUTI, and ways of preventing CAUTI from occurring. They suggest to use peer teaching as an effective form of learning for students on clinical placements (Buckley et al. 2015). Alternatively, Bernard et al. (2012) recommends that the teaching of CAUTI could be integrated into the students' learning of the catheterisation skill.

Bernard et al. (2012) reported in their findings that after a period of time, nurses are likely to regress to old habits and practices. This highlights the importance of continuing education, and on-going support for nursing staff. It is also mentioned in the CDC Guidelines for CAUTI prevention (2009, 16) to "ensure that healthcare personnel and others who take care of catheters are given periodic in-service training regarding techniques and procedures for urinary catheter insertion, maintenance, and removal."

As professionals, nurses have responsibility for their own ongoing learning. According to the United Kingdom Nursing and Midwifery Council (NMC) Code of Conduct for Nurses (2015, 17), all nurses have an obligation to keep their knowledge and skills up to date, and to take part in learning and continued professional development (CPD) activities to maintain and develop their competency.

In addition, employers have a degree of responsibility to provide training opportunities for their staff. Despite there being no legal obligation to provide time for CPD-related learning for their staff (Royal College of Nursing 2016), the NMC (2016) suggests it is good practice for employers to provide training opportunities for their continued education and improvement of competency.

5.4.2 Patient Education

Providing education to patients and their families is a core competency of nursing practice, and has been shown to improve health outcomes, reduce readmissions to hospital and improve patient satisfaction (Xu 2012).

Godfrey and Fraczyk (2005) suggest that one of the nurse's key roles in catheter care is the education of patients. In addition, the Agency for Healthcare Research and Quality (AHRQ) (2015) advise that it is important to engage the patient and their family with the care of their catheter. They recommend that the risks involved with catheter use should be communicated to the patient, along with their role in the care and maintenance of the catheter, including how to prevent CAUTI (AHRQ 2015).

The Society for Healthcare Epidemiology of America (SHEA) (2008) advocates the use of patient teaching material regarding the prevention of CAUTIs. Their teaching material provides patients with easy-to-understand guidelines explaining each aspect of CAUTI, including explanation of catheter use, a description of CAUTI and its symptoms and ways the patient can prevent CAUTIs from occurring (SHEA 2008). These simple guidelines for patients reinforce the importance of practicing good hand hygiene when touching the catheter, to prevent the introduction of infection causing bacteria. This guidance is highlighted furthermore by Fox et al. (2015), in their study assessing the effects of a patient hand washing protocol. The protocol consisted of a hand washing regime, where patients' hands were washed three times daily. The results of this study indicated that patients' improved hand hygiene was associated with a reduction of the incidence of CAUTI on the unit. Therefore, it is imperative for nurses to emphasise to patients the importance of good hand hygiene before touching their indwelling catheter (Fox et al. 2015).

5.4.3 Written Guidelines

Clinical practice guidelines are evidence-based documents to assist practitioners in making clinical decisions about specific situations (Thomas 1999). The use of guidelines aims to promote the delivery of high-quality, evidence-based care, for the best patient outcomes. Recommendations given in clinical practice guidelines should be based on sound scientific evidence obtained from high-quality clinical trials (Tong 2001).

In relation to CAUTI guidance and prevention, Godfrey and Fraczyk (2005) encourage the use of the United Kingdom National Institute for Health and Care Excellence (NICE) Guidelines. The current NICE accredited guidelines were published in 2014 and aim to provide "comprehensive recommendations for preventing [healthcare associated infections] in hospital and other acute care settings based on the best currently available evidence" (Loveday et al. 2014, 1). This includes CAUTI, amongst other hospital-acquired infections. The incorporation of these guidelines into daily clinical practice can enhance patient safety and reduce the risk of contracting a hospital acquired infection (Loveday et al. 2014). The Centers for Disease Control and Prevention (CDC) published an equivalent guideline in 2009: Guideline for Prevention of Catheter-Associated Urinary Tract Infections. The guideline was produced following a targeted systematic review of the best available evidence (Gould et al. 2009).

A review and comparison of national and international CAUTI prevention guidelines was undertaken by Conway and Larson (2011). They concluded that recommendations in all of the major governmental guidelines were remarkably consistent, lending credibility to the quality of the guidelines. The consistency could be attributed to a strong body of evidence for the recommendations, meaning that the implementation of these guidelines in practice will most

likely lead to reduced rates of CAUTI and improved patient outcomes (Conway & Larson 2011).

Official guidelines can be converted into care bundles for use in hospitals. Buckley, Clements and Hopper (2015) mention the use of bundles as a way of managing catheter care and preventing CAUTI. The use of a ‘bundled’ approach to catheter care has been successfully indicated for the reduction in occurrence of CAUTI (Association for Professionals in Infection Control and Epidemiology (APIC) 2014; Blanck, Donahue, Brentlinger, Dixon Stinger & Polito 2014), and is recommended by APIC (2014) for use in hospitals to prevent CAUTI.

A bundle is defined as “a set of interventions, when used together, significantly improve patient outcomes” (McCarron 2011, 30). Usually comprised of 3-5 evidence-based interventions, it is a simple and straightforward set of instructions that should be followed for every patient, every time (Haraden n.d.). The omission of even a single step alters the intended effect (McCarron 2011). An example of a CAUTI maintenance bundle is shown below. This particular example was published in the supplement ‘On the CUSP: Stop CAUTI’ (APIC 2014b, 12). The simple yes/no questions are to be applied to every patient, each day that an indwelling urinary catheter is present. When each intervention is implemented, the patient is less likely to contract CAUTI (APIC 2014b).

DATE	BUNDLE CRITERIA							
	Daily documented assessment of need	Tamper evident seal is intact	Catheter secured-securement device in place	Hand hygiene performed for patient contact	Daily meatal hygiene performed with soap and water	Drainage bag emptied using a clean container	Unobstructed flow maintained	Action Remove or continue
	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	REMOVE CONTINUE
	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	REMOVE CONTINUE
	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	REMOVE CONTINUE
	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	REMOVE CONTINUE
	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	REMOVE CONTINUE
	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	YES NO	REMOVE CONTINUE

Figure 9: CAUTI Maintenance Bundle (APIC 2014b, 12)

Blanck et al. (2014) investigated the impact of using a bundled approach to CAUTI prevention. The results were clinically significant, showing a 50% decrease in the incidence of CAUTI over

a period of 3 months. The evidence suggests that in terms of CAUTI prevention, the use of a catheter care bundle has a positive impact on patient outcomes.

6 Discussion

The majority of the articles reviewed, with the exception of one, focused on the general interventions to be used to prevent CAUTI, and were not specifically tailored to nursing professionals. To answer the research question, “What kind of nursing interventions can be used to reduce the incidence of hospital acquired catheter associated urinary tract infections?”, specific nursing interventions were deduced from the findings.

The interventions described in the findings included a combination of system-level and individual-level interventions. For example, the introduction of hospital-wide protocols, guidelines and care-bundles are defined as system-level interventions. The provision of equipment, such as specialist anti-microbial catheters or pre-connect catheter systems are also system-level interventions, as a nurse would be unable to implement these interventions herself on an individual basis. System-level interventions have the potential to substantially improve the care and treatment of a large number of patients. They must be implemented on a hospital-wide, state-wide or even national basis to make a difference. However, nurses have the potential to make a difference and to improve the experience of the individual patients that they take care of, by implementing interventions on an individual level (Minnesota Department of Health 2001).

The individual-level interventions deduced from the findings that nurses can use to help reduce the incidence of CAUTI are detailed below:

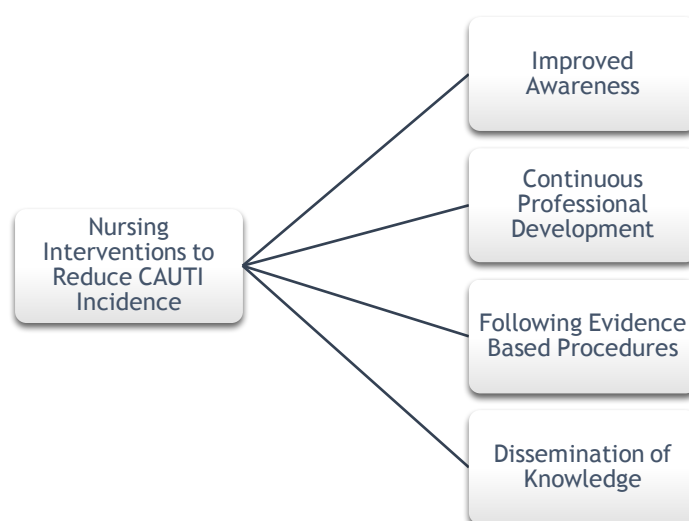


Figure 10: Summary of nursing interventions aimed to reduce the incidence of CAUTI in hospitals.

6.1 Improved Awareness

When examining the findings, it became apparent that most healthcare professionals, including nurses, have a distinct lack of awareness about CAUTIs. In the past, much of the focus has been on high-profile hospital 'bugs' such as Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* (C.Diff) whereas the implications and consequences of CAUTI have been largely ignored despite their importance (Buckley et al. 2015). Nurses, unaware of the consequences of their old bad habits, have inadvertently contributed to the spread of CAUTIs in hospital. The only way to overcome this, is for nursing staff to improve their awareness of this potentially harmful infection (Salamon 2009).

6.2 Continuous Professional Development

As discussed in the findings, nurses have a duty of responsibility to their own continuous professional development. They have an obligation to themselves and to their patients to ensure that their nursing knowledge is up-to-date and sufficient (NMC 2015; International Council of Nurses (ICN) 2012, 3). Failure to update their knowledge puts their patients at risk of unnecessary harm, which directly contradicts the ethical commitment of nurses to prevent illness and promote health (ICN 2012, 1). Consistent prevention of CAUTI in hospitals can only be achieved if nurses are committed to the constant and continuous professional development that this requires.

6.3 Following Evidence Based Procedures

The findings of this study suggest that nurses are still using non-evidence based techniques when caring for patients with catheters. This could be due to a combination of habit, reluctance to embrace new techniques or the perceived extra workload involved with learning new techniques (Saint et al 2008). The old habits of nurses have been shown to endanger patients by putting them at increased risk of contracting CAUTI. Therefore, it is of utmost importance that nurses follow the latest evidence-based guidelines, such as the current NICE or CDC guidelines, to help to reduce the chances of their patients catching a CAUTI (Godfrey & Fraczyk 2005). It is important for nurses to take responsibility for their own actions (ICN 2012, 3), and to maintain accountability for catheter insertion and care.

6.4 Dissemination of Knowledge

A core role of the nurse is that of an educator. Not only do nurses provide education and guidance to their patients, they also assist and support their fellow colleagues (ICN 2012, 4). The nurse's role in peer-support amongst work colleagues should not be underestimated. This can be an effective strategy to increase the awareness of their peers about the latest guidelines and prevention policies. Peer-support has been shown to improve tolerance and uptake

of the latest CAUTI guidelines, especially when the guidelines are deemed unfavourable for nurses (Wenger 2010). In addition, patient guidance also has an important role in CAUTI prevention. It is important for nurses to spend time with their patients, explaining the risks involved in the procedure, and mentioning the steps that patients can take to protect themselves against CAUTIs (AHRQ 2015).

7 Conclusion

In conclusion, the effective prevention and reduction in the incidence of CAUTIs in hospitals requires a consistent commitment from different members of staff, in all hospital departments. Nurses have a large part to play, as the majority of day-to-day catheter related care and maintenance is their responsibility. However, the most effective strategies in CAUTI prevention have been multi-dimensional approaches with multi-disciplinary collaboration. Studies highlight the importance of multi-disciplinary teamwork in CAUTI reduction, especially between nurses and doctors. Traditionally, the nurse-doctor relationship has been difficult. However, an effective CAUTI reduction program cannot be sustained without a good working relationship between nurses and doctors. The best prevention strategies combine the utilisation of systems-wide innovations, with education and a combination of tactics aimed to reduce catheter insertion and catheter dwell time.

8 Ethical Considerations

Legal and ethical principles were followed at all times throughout the entire thesis writing process.

According to Resnik, when conducting scientific research, it is of the utmost importance that ethical codes are adhered to, as the ultimate aims of research are “knowledge, truth and avoidance of error”. In order to achieve trust and minimise error, all efforts must be made to avoid fabricating, falsifying or misrepresenting research. (Resnik 2015)

The authors of the studies and materials used in this literature review were given full credit, and referenced accordingly. Plagiarism was avoided at all costs, and copyrighted work was respected and not used in a malicious manner. Laurea’s guidelines for referencing (King 2013) were followed at all times to ensure transparency and disclosure of all sources used.

Due to the nature of this thesis, a literature review, there were no ethical issues relating to gaining research permissions, researcher-participant anonymity or confidentiality.

9 Trustworthiness

The trustworthiness of a publication is an indication of its accuracy and quality.

To ensure that only the most current and up-to-date research was used, only articles from 2005-2016 were considered as part of the literature review. In addition, the methods used to obtain the data were clearly and systematically documented in the methodology, to ensure reproducibility. The quality of all the data retrieved was assessed to the best of the authors' ability, and low quality evidence was discarded. This process helped to confirm the strength of the findings. Only articles, books and material deemed to be from reliable sources were included in this study.

The accuracy of this publication was maintained by avoiding bias during the data extraction and analysis process; the authors reviewed the articles independently and avoided the slanting of the data towards a particular direction (Wager & Wiffen 2011). The authors were careful when reporting the findings in order to avoid errors through negligence, and the finished thesis was carefully and critically examined for inaccuracies (Resnik 2015).

10 Limitations

Although the research has reached its aims, there were some unavoidable limitations. Firstly, the majority of the articles reviewed were conducted in two countries (United Kingdom and United States). Therefore, the nursing interventions extracted from the literature search should be applicable in those countries.

Secondly, there is always the unavoidable possibility of bias in the articles collected in the process of the literature review. For instance, one of the publications screened passively mentioned the interventions taken in hospital level.

Thirdly, we acknowledge, since we have only selected research articles written in English language and full text; some relevant data might be missed. In addition, we were limited to the databases provided by Laurea UAS, meaning that other potential relevant articles were unattainable.

Finally, lack of in-depth knowledge in different research methodologies encountered during the screening of the initial research articles could possibly reduce the quality of our work. This is due to the fact that we are only beginners in this field of research.

11 Recommendations

From the findings, our main recommendation is that nurses receive effective training to be able to identify the appropriate indications for indwelling catheter insertion. In addition, we suggest specific training on the techniques of insertion and maintenance in order to prevent

inappropriate use of catheters and their infection. We feel that nurses' awareness and education of CAUTI is severely lacking, and this is an issue that desperately needs tackling in all hospitals, nationally and internationally.

The majority of published CAUTI prevention guidelines and material is aimed at health care professionals in general. However, we feel that a guideline specifically written for nursing staff would be of great benefit, as nurses are the staff members taking care of the day to day maintenance of catheters. Therefore, we recommend that future researchers should compile an evidence-based guideline of CAUTI prevention and catheter care, specifically for nurses.

Furthermore, the current literature review was restricted to English language literatures and few countries. Therefore, we recommend further research to be conducted in order to confirm our findings in different countries and suggest evidence based practice to improve CAUTI care.

References

- Agency for Healthcare Research and Quality. 2015. Technical Interventions to Prevent CAUTI. Accessed 10.05.2016. <http://www.ahrq.gov/professionals/quality-patient-safety/hais/cauti-tools/guides/implguide-pt3.html>
- Association for Professionals in Infection Control and Epidemiology (APIC). 2014a. Guide to Preventing Catheter-Associated Urinary Tract Infections. Accessed 11.05.2016. http://apic.org/Resource_/EliminationGuideForm/0ff6ae59-0a3a-4640-97b5-eee38b8bed5b/File/CAUTI_06.pdf
- Association for Professionals in Infection Control and Epidemiology (APIC). 2014b. On the CUSP: Stop CAUTI. A Supplement to Prevention Strategist. Accessed 12.05.2016. <http://www.ahaphysicianforum.org/resources/appropriate-use/antimicrobial/content%20files%20pdf/APIC-On-CUSP-Stop-CAUTI-Supplement.pdf>
- Association for Professionals in Infection Control and Epidemiology (APIC) 2011. Urinary Catheterisation Sample Policy. Accessed 15.05.2016. http://www.onthecuspstophai.org/wp-content/uploads/2011/04/Appendix_L_Urinary-Catheterization-Policy.doc
- Berman, A., Snyder, S. J., Kozier, B. & Erb, G. 2008. Fundamentals of Nursing: Concepts, Process and Practice. 8th Edition. New Jersey: Pearson Prentice Hall.
- Bernard, M. S., Hunter, K. F. and Moore, K. N. 2012. A Review of Strategies to Decrease the Duration of Indwelling Urethral Catheters and Potentially Reduce the Incidence of Catheter-Associated Urinary Tract Infections. *British Journal of Infection Control*, 6 (4), 22-25.
- Bissett, L. 2005. Reducing The Risk of Catheter-Related Urinary Tract Infection. *Nursing Times*; 101 (12) 64-67.
- Blackstone, A. 2012. Principles of Sociological Inquiry: Qualitative and Quantitative Methods (v. 1.0). Maine: Saylor Foundation.
- Blanck, A.W., Donahue, M., Brentlinger, L., Dixon Stinger, K. & Polito, C. 2014. A Quasi-Experimental Study to Test a Prevention Bundle for Catheter-Associated Urinary Tract Infections. *Journal of Hospital Administration* 3 (4), 101-108.
- Bruminhent, J., Keegan, M., Lakhani, A., Roberts, I. M. and Passalacqua, J. 2010. Effectiveness of a Simple Intervention for Prevention of Catheter-Associated Urinary Tract Infections in a Community Teaching Hospital. *American Journal of Infection Control*, 38 (9), 689-693.
- Buckley, C., Clements, C. and Hopper, A. 2015. Reducing Inappropriate Urinary Catheter Use: Quality Care Initiatives. *British Journal of Nursing (Urology Supplement)*, 24 (9), 18-22
- Centers for Disease Control and Prevention. 2016. Urinary tract infection (Catheter Associated Urinary Tract Infection [CAUTI] and Non-Catheter Associated Urinary Tract Infection [UTI]) and other Urinary System Infections [USI] events. Accessed 24.04.2016. <http://www.cdc.gov/nhsn/pdfs/pscmanual/7pscscauticurrent.pdf>.
- Classen, D.C., Larsen, R.A., Burke, J.P., Alling, D.W. & Stevens, L.E. 1991. Daily meatal care for prevention of catheter-associated bacteriuria: Results using frequent applications of poly-antibiotic cream. *Journal of Infection Control and Hospital Epidemiology*, 12 (3), 157-162.
- Conway, L. J., & Larson, E. L. 2012. Guidelines to prevent catheter-associated urinary tract infection: 1980 to 2010. *Heart & Lung: The Journal of Critical Care*, 41 (3), 271-283
- Elo, S. & Kyngäs, H. 2008. The qualitative content analysis process. *Journal of Advanced Nursing* 62(1), 107-115

Elvy, J. and Colville, A. 2009. Catheter Associated Urinary Tract Infection: What is it, What Causes it and How Can We Prevent it? *Journal of Infection Prevention*, 10 (2), 36-41.

Emr, K., & Ryan, R. 2004. Best Practice for Indwelling Catheter in the Home Setting. *Home Healthcare Nurse*, 22 (12), 820-828.

European Association of Urology Nurses. 2016. Overactive Bladder Syndrome. Accessed 16.05.2016. <http://patients.uroweb.org/i-am-a-urology-patient/overactive-bladder-syndrome/>.

Fakih, M.G., Dueweke, C., Meisner, S., Berriel-Cass, D., Savoy-Moore, R., Brach, N., Rey, J., DeSantis, L. & Saravolatz, L.D. 2008. Effect of Nurse-Led Multidisciplinary Rounds on Reducing the Unnecessary Use of Urinary Catheterization in Hospitalized Patients. *Infection Control and Hospital Epidemiology*, 29 (9), 815-819.

Fakih, M.G., Heavens, M., Grottemeyer, J., Szpunar, S.M., Groves, C. & Hendrich, A. 2014. Avoiding Potential Harm by Improving Appropriateness of Urinary Catheter Use in 18 Emergency Departments. *Annals of Emergency Medicine*, 63 (6), 761-768.

Fox, C., Wavra, T., Ash Drake, D., Mulligan, D., Pacheco Bennett, Y., Nelson, C., Kirkwood, P., Jones, L. and Bader, M. K. 2015. Use of a Patient Hand Hygiene Protocol to Reduce Hospital-Acquired Infections and Improve Nurses' Hand Washing. *American Association of Critical-Care Nurses*, 24 (3), 216-224.

Furfari, K. & Wald, H. 2008. How can we Reduce Indwelling Urinary Catheter Use and Complications? *The Hospitalist*. Accessed 15.05.2016. <http://www.the-hospitalist.org/article/how-can-we-reduce-indwelling-urinary-catheter-use-and-complications/?singlepage=1>

Getliffe, K. 1995. Long-Term Catheter Use in the Community. *Nursing Standard*, 9 (31) 25-27.

Getliffe, K. 2003. How to Manage Encrustation and Blockage of Foley Catheter. *Nursing Times*, 99 (29), 59-60.

Godfrey, H. and Fraczyk, L. 2005. Preventing and Managing Catheter-Associated Urinary Tract Infections. *British Journal of Community Nursing*, 10 (5), 205-212.

Gokula, R.M., Smith, M.A. & Hickner, J. 2007. Emergency Room Staff Education and Use of a Urinary Catheter Indication Sheet Improves Appropriate Use of Foley Catheters. *American Journal of Infection Control*, 35 (9), 589-593.

Gould, C.V., Umscheid, C.A., Agarwal, R.K., Kuntz, G., Pegues, D.A. Healthcare Infection Control Practices Advisory Committee (HICPAC). 2009. Guideline for Prevention of Catheter-Associated Urinary Tract Infection

Gray, D., Nussle, R., Cruz, A., Kane, G., Toomey, M., Bay, C. and Ostovar, G. A. 2016. Effects of a Catheter-Associated Urinary Tract Infection Prevention Campaign on Infection Rate, Catheter Utilization, and Health Care Workers' Perspective at a Community Safety Net Hospital. *American Journal of Infection Control*, 44 (1), 115-116.

Haraden, C. No Date. What is a Bundle? Institute for Healthcare Improvement. Accessed 11.05.2016. <http://www.ihc.org/resources/Pages/ImprovementStories/WhatIsaBundle.aspx>

Herter, R. & Kazer, M.W. 2010. Best Practices in Urinary Catheter Care. *Home Healthcare Now*, 28 (6), 342-349. Accessed 12.05.2016. <http://www.nursingcenter.com/cearticle?tid=1027118>

Hooton, T.M., Bradley, S.F., Cardenas, D.D., Colgan, R., Geerlings, S.E., Rice, J.C., Saint, S., Schaeffer, A.J., Tambayh, P.A., Tenke, P. & Nicolle, L.E. 2010, Diagnosis, Prevention, and Treatment of Catheter-Associated Urinary Tract Infection in Adults: 2009 International Clini-

cal Practice Guidelines from the Infectious Diseases Society of America'. *Clinical Infectious Diseases*, 50 (5), 625-663.

Hsieh, H.F. & Shannon, S.E. 2005. Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*. 15 (9), 1277-1288.

Infection Control Nurses Association. 2003. *Asepsis: Preventing Healthcare Associated Infection*. Bathgate: ICNA

International Council of Nurses. 2012. *The ICN Code of Ethics for Nurses*. Accessed 16.05.2016. http://www.icn.ch/images/stories/documents/about/icncode_english.pdf.

Jepson, R.G., Williams, G. & Craig, J.C. 2012. Cranberries for Preventing Urinary Tract Infections. *Cochrane Database of Systematic Reviews* 2012, 10, CD001321

Johnson, D., Lineweaver, L. & Maze, L. 2009. Patients' Bath Basins as Potential Sources of Infection: A Multicenter Sampling Study. *American Journal of Critical Care*, 18 (1), 31-40.

Joint Commission. 2011. *Clinical Care Improvement Strategies: Preventing Catheter-Associated Urinary Tract Infections*. Accessed 10.05.2016. <http://www.sageproducts.com/lit/22425.pdf>.

Jones, S. Brooks, A., Foxley, S. & Dunkin, J. 2007. Care of Urinary Catheters and Drainage Systems. *Nursing Times*; 103 (42), 48-50.

King, S. 2013. *Guidelines for referencing*. Laurea University of Applied Sciences.
Larson, E., Ciliberti, T., Chantler, C., Abraham, J., Lazaro, E., Venturanza, M., & Pancholi, P. 2004. Comparison of Traditional and Disposable Bed Baths in Critically Ill Patients. *American Journal of Critical Care*, 13 (3), 235-241.

Leaver, R.B. 2007. The Evidence for Urethral Meatal Cleansing. *Nursing Standard*, 21 (41), 39-42.

Leithauser, D. 2005. Urinary Tract Infections. In *APIC Text of Infection Control and Epidemiology*, 1-15. Washington DC: Association for Professionals in Infection Control and Epidemiology.

Liedberg, H. & Lundeberg, T. 1990. Silver Alloy Coated Catheters Reduce Catheter-Associated Bacteriuria. *British Journal of Urology*, 65 (4), 379-381.

Loeb, M., Hunt, D., O'Halloran, K., Carusone, S. C., Dafoe, N., & Walter, S. D. 2008. Stop Orders to Reduce Inappropriate Urinary Catheterization in Hospitalized Patients: A Randomized Controlled Trial. *Journal of General Internal Medicine*, 23 (6), 816-820

Loveday, H.P., Wilson, J.A., Pratt, R.J., Golsorkhi, M. Tingle, A., Bak, A., Browne, J., Prieto, J. & Wilcox, M. 2014. epic3: National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England. NICE Accredited Guidelines. *Journal of Hospital Infection*, 86 (S1), S1-S70.

Madeo, M., Barr, B. and Owen, E. 2005. A Study to Determine Whether the Use of a Pre-Connect Urinary Catheter System Reduces the Incidence of Nosocomial Urinary Tract Infections. *Urologic Nursing*, 35 (1), 11-17

Mangnall, J. & Watterson, L. 2009. Principles of Aseptic Technique in Urinary Catheterisation. *RCNP Journal Supplements*, 3 (1), 15-24.

McCarron, K. 2011. Understanding Care Bundles. *Nursing Made Incredibly Easy!* 9 (2), 30-33.

Meddings, J., Krein, S.L., Fakhri, M.G., Olmstead, R.N. & Saint, S. 2013. Reducing Unnecessary Urinary Catheter Use and Other Strategies to Prevent Catheter-Associated Urinary Tract Infections: Brief Update Review. In: Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices. Accessed 09.05.2016.
<http://www.ncbi.nlm.nih.gov/books/NBK133354/>

Minnesota Department of Health. 2001. Three Levels of Public Health Practice. Accessed 15.05.2016.
http://www.health.state.mn.us/divs/opi/cd/phn/docs/0103phn_levelsofpractice.pdf

Moher, D., Liberati, A., Tetzlaff, J. & Altman, D. 2009. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. Accessed 27.04.2016
<http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1000097>.

Munn, Z., Tufanaru, C. & Aromataris, E. 2014. Data Extraction and Synthesis: the steps following study selection in a systematic review. *The American Journal of Nursing*, 114 (7) 49-54.

Newhouse, R., Dearholt, S., Poe, S., Pugh, L. & White, K. 2007. Johns Hopkins Nursing Evidence-Based Practice Model and Guidelines. Indianapolis: Sigma Theta Tau International.

Nicolle, L.E. 2014. Catheter Associated Urinary Tract Infections. *Antimicrobial Resistance and Infection Control*, 3 (23). Accessed 14.05.2016. <http://doi.org/10.1186/2047-2994-3-23>

Nursing and Midwifery Council (NMC). 2015. The Code: Professional Standards of Practice and Behaviour for Nurses and Midwives. London: NMC.

Nursing and Midwifery Council (NMC). 2016. Employers Guide to Revalidation. Accessed 11.05.16. <https://www.nmc.org.uk/globalassets/sitedocuments/revalidation/employers-guide-to-revalidation.pdf>

Parry, M. F., Grant, B. and Sestovic, M. 2013. Successful Reduction in Catheter-Associated Urinary Tract Infections: Focus On Nurse-Directed Catheter Removal. *American Journal of Infection Control*, 41 (12), 1178-1181.

Plowman, R., Graves, N., Griffin, M., Roberts, J.A., Swan, A.V., Cookson, B. & Taylor, L. 1999. The Socio-Economic Burden of Hospital-Acquired Infection. Accessed 16.05.2016.
http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4089725.pdf.

Polit, D.F. & Beck, C. 2012. *Nursing Research: Generating and Assessing Evidence for Nursing Practice*. 9th Edition. Philadelphia: Lippincott, Williams & Wilkins.

Polit, D.F. & Beck, C. 2014. *Essentials of Nursing Research: Appraising Evidence for Nursing Practice*. 8th Edition. Philadelphia: Lippincott, Williams & Wilkins.

Quinn, P. 2015. Chasing Zero: A Nurse-Driven Process for Catheter-Associated Urinary Tract Infection Reduction in a Community Hospital. *Nursing Economics*, 33 (6), 320-325.

Resnik, D.B. 2015. What is Ethics in Research and Why is it Important? Accessed 15.05.2016.
<http://www.niehs.nih.gov/research/resources/bioethics/whatis/>

Royal College of Nursing. 2016. RCN Factsheet: Continuing Professional Development (CPD) for nurses working in the United Kingdom (UK). Accessed 11.05.2016.
<https://www.rcn.org.uk/about-us/policy-briefings/pol-1614>

Saint, S., Kowalski, C.P., Forman, J., Damschroder, L., Hofer, T.P., Kaufman, S.R., Creswell, J.W. & Krein, S.L. 2008. A Multicenter Qualitative Study on Preventing Hospital-Acquired Urinary Tract Infection in US Hospitals. *Infection Control and Hospital Epidemiology*, 29 (4), 333-341.

Salamon, L. 2009. Catheter-Associated Urinary Tract Infections- A Nurse-Sensitive Indicator in an Inpatient Rehabilitation Program. *Rehabilitation Nursing*, 34 (6), 237-241.

Schenkman, N.S. 2013. Male Urethra Anatomy. Medscape. Accessed 16.05.2016. <http://emedicine.medscape.com/article/1972482-overview>.

Schenkman, N.S. 2014. Female Urethra Anatomy. Medscape. Accessed 16.05.2016. <http://emedicine.medscape.com/article/1972504-overview>.

Schumm, K. & Lam, T.B.L. 2008. Types of Urethral Catheters for Management of Short-Term Voiding Problems in Hospitalised Adults. *The Cochrane database of systematic reviews*, 2, CD004013.

Shier, D., Butler, J. & Lewis, R. 2006. *Hole's Essentials of Human Anatomy and Physiology*, 10th Edition. New York: McGraw Hill.

Shlamovitz, G.Z. 2016. Urethral Catheterization in Men. Accessed 12.05.2016. <http://emedicine.medscape.com/article/80716-overview#a2>

Smeltzer, S.C., Bare, B.G., Hinkle, J.L. & Cheever, K.H. 2010. *Brunner and Suddarth's Textbook of Medical-Surgical Nursing*, 12th Edition. Philadelphia: Lippincott, Williams & Wilkins.

Society for Healthcare Epidemiology of America (SHEA). 2008. Patient Resources for Catheter Associated Urinary Tract Infection. Accessed 10.05.2016. <http://www.shea-online.org/Patients.aspx>

Society of Urological Nurses and Associates. 2005. Clinical Practice Guideline: Care of the patient with an indwelling catheter. Accessed 14.05.2016. http://www.fycurology.com/indwelling_catheter_care.pdf

Strouse, A. C. 2015. Appraising the Literature on Bathing Practices and Catheter-Associated Urinary Tract Infection Prevention. *Urologic Nursing*, 32 (1), 29-37.

Teing, L. 2007. Systematic Review Made Simple for Nurses. *SGH Proceedings*, 16 (2) 104-110.

Thomas, L. 1991. Clinical Practice Guidelines. *Evidence-Based Nursing*, 2 (2), 38-39.

Tiwari, M. M., Charlton, M. E., Anderson, J. R., Hermsen, E. D., Pharm, D. P. and Rupp, M. E. 2011. Inappropriate use of urinary catheters: A prospective observational study. *American Journal of infection control*, 40 (1), 51-54.

Tong, A. 2001. Clinical Guidelines: Can They Be Effective? *Nursing Times* 97 (9), 3.

Topal, J., Conklin, S., Camp, K., Morris, V., Balcezak, T. & Herbert, P. 2005. Prevention of nosocomial catheter-associated urinary tract infections through computerized feedback to physicians and a nurse-directed protocol. *American Journal of Medical Quality*, 20 (3), 121-126.

University of Maryland Medical Center. 2012. Urinary tract infection. Accessed 30.04.2016. <http://umm.edu/health/medical/reports/articles/urinary-tract-infection>.

Wager, E. & Wiffen, P.J. 2011. Ethical Issues in Preparing and Publishing Systematic Reviews. *Journal of Evidence Based Medicine*, 4 (2), 130-134.

Weber, D.J., Sickbert-Bennett, E.E., Gould, C.V., Brown, V.M., Huslage, K. & Rutala, W.A. 2011. Incidence of catheter-associated and non-catheter-associated urinary tract infections in a healthcare system. *Infect Control Hospital Epidemiology*, 32 (8), 822-823.

Webster, J., Hood, R.H., Burrige, C.A., Doidge, M.L., Phillips, K.M., & George, N. 2001. Water or Antiseptic for Periurethral Cleaning Before Urinary Catheterization: A Randomized Controlled Trial. *American Journal of Infection Control*, 29 (6), 389-394.

Welden, L. 2013. Electronic Health Record: Driving Evidence-Based Catheter-Associated Urinary Tract Infections (CAUTI) Care Practices. *OJIN: The Online Journal of Issues in Nursing* 18 (3). Accessed 13.05.2016.
<http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Vol-18-2013/No3-Sept-2013/Articles-Previous-Topics/Electronic-Health-Record-CAUTI-Care-Practices.html>

Wenger, J.E. 2010. Cultivating quality: reducing rates of catheter-associated urinary tract infection. *American Journal of Nursing*, 110 (8), 40-45.

World Health Organisation (WHO) No Date. Health care-associated infections FACT SHEET. Accessed 16.05.2016.
http://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf.

Xu, P. 2012. Using Teach-Back for Patient Education and Self-Management. *American Nurse Today*, 7 (3). Article from *American Nurse Today*, Official Journal of American Nurses Association. Accessed 10.05.2016. <https://americannursetoday.com/using-teach-back-for-patient-education-and-self-management/>

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Appendices

Appendix 1: Data Extraction Form 50

Appendix 1: Data Extraction Form

Authors, Year	Title	Level of Evidence (Johns Hopkins)	Aim	Conclusions
Strouse, A. C. (2015)	Appraising the Literature on Bathing Practices and Catheter-Associated Urinary Tract Infection Prevention	Systematic review (Level III, Quality A)	To explain the importance of reducing health care-associated infections. Discuss bathing practices that may help reduce catheter-associated urinary tract infections (CAUTIs).	To reduce CAUTI, health care workers should consider the use of disposable cleaning wipes instead of basin bathing, in their daily hygiene practice.
Madeo, M., Barr, B. and Owen, E. (2005)	A Study to Determine Whether the Use of a Pre-Connect Urinary Catheter System Reduces the Incidence of Nosocomial Urinary Tract Infections	Experimental study, Randomised controlled trial. (Level I, Quality A)	To discover whether the use of a pre-connect urinary catheter system is effective in reducing the rate of CAUTI, compared to a conventional bag and latex catheter system.	The pre-connect catheter system was effective in reducing the incidence of CAUTI compared to a conventional catheter system. The rate of CAUTI was 41% lower in the experimental group, compared to the control.
Bernard, M. S., Hunter, K. F. and Moore, K. N. (2012)	A Review of Strategies to Decrease the Duration of Indwelling Urethral Catheters and Potentially Reduce the Incidence of Catheter-Associated Urinary Tract Infections	Review of experimental studies (Level III, Quality B)	To review current research on strategies for timely removal of urethral catheters, and to assess the impact on the incidence of CAUTI.	The available evidence supports nurse-led or chart reminders to stimulate consistent daily assessment of the continuing need for a catheter and to remove it as soon as possible. Timely removal of unnecessary catheters helps prevent CAUTI.

Salamon, L. (2009)	Catheter-Associated Urinary Tract Infections- A Nurse-Sensitive Indicator in an Inpatient Rehabilitation Program.	Experimental study, randomised controlled trial. (Level I, Quality B)	To discover whether education of staff nurses and caregivers about the care and implications of catheters, leads to a reduction of CAUTI rate in an in-patient rehabilitation unit.	After a comprehensive nurse education programme about catheter care and urinary tract infections, the rate of CAUTIs was reduced on the ward, compared to baseline measurements.
Quinn, P. (2015)	Chasing Zero: A Nurse-Driven Process for Catheter-Associated Urinary Tract Infection Reduction in a Community Hospital.	Quasi-experimental study (Level II, Quality A)	To discover the impact of a series of tactics designed for CAUTI reduction in a 301 bed community hospital.	The tactics used in combination were: - 'question the Foley' criteria, - physician support, - informatics collaboration, - targeted education & - daily monitoring These tactics reduced the incidence of CAUTI by 50% over the period of 1 year. Between 2008 - 2013, the CAUTI rate dropped from 4.9% to 0.3%.
Bruminhent, J., Keegan, M., Lakhani, A., Roberts, I. M. and Pas-salacqua, J. (2010)	Effectiveness of a Simple Intervention for Prevention of Catheter-Associated Urinary Tract Infections in a Community Teaching Hospital	Experimental study, randomised controlled trial (Level I, Quality A)	This study aims to assess the effect of using a reminder sticker system on the notes of catheterised patients, to see whether it reduces unnecessary catheters, thus reducing CAUTI incidence.	A sticker placed on patients' medical records to remind healthcare workers to remove unnecessary urinary catheters significantly increased the appropriate utilisation of urinary catheters and decreased the rate of CAUTI in the community hospital.

<p>Gray, D., Nussle, R., Cruz, A., Kane, G., Toomey, M., Bay, C. and Ostovar, G. A. (2016)</p>	<p>Effects of a Catheter-Associated Urinary Tract Infection Prevention Campaign on Infection Rate, Catheter Utilization, and Health Care Workers' Perspective at a Community Safety Net Hospital</p>	<p>Quasi-experimental study (Level II, Quality A)</p>	<p>To study the impact of the implementation of a multidisciplinary CAUTI prevention campaign on the rates of CAUTI.</p>	<p>There was a statistically significant reduction in the rate of CAUTI postintervention, compared to preintervention. There was a 12% decrease in the CAUTI rate and 20% reduced catheter utilisation.</p>
<p>Elvy, J. and Colville, A. (2009)</p>	<p>Catheter Associated Urinary Tract Infection: What is it, What Causes it and How Can We Prevent it?</p>	<p>Literature Review (Level V, Quality B)</p>	<p>To discuss the diagnosis, causative microbiology and pathogenesis of CAUTI, and consider complications of catheterisation and how these might be prevented.</p>	<p>CAUTI is caused by a wide variety of infective organisms. The most important method of prevention is to avoid catheterisation altogether, or to remove the catheter as soon as possible.</p>
<p>Godfrey, H. and Fraczyk, L. (2005)</p>	<p>Preventing and Managing Catheter-Associated Urinary Tract Infections.</p>	<p>Literature Review (Level V, Quality A)</p>	<p>To find relevant literature regarding the prevention and management of catheter-associated urinary tract infections.</p>	<p>Effective strategies to prevent CAUTI include:</p> <ul style="list-style-type: none"> - Avoid catheterisation - Use clean, intermittent self-catheterisation as first choice - Remove indwelling catheters as soon as possible - Insert using aseptic techniques - Choose smallest size catheter as possible - Use closed catheter systems - Use clean techniques when opening the closed system - Maintain adequate urine flow - Ensure adequate fluid intake

				<ul style="list-style-type: none"> - Wash meatal areas daily - Education of patients, carers and healthcare workers.
Buckley, C., Clements, C. and Hopper, A. (2015)	Reducing Inappropriate Urinary Catheter Use: Quality Care Initiatives	Quasi-experimental study (Level II, Quality B)	To discuss the implementation of a strategy to reduce inappropriate use of urinary catheter and to reduce CAUTI in a large NHS trust. This included the introduction of a new catheter care document, and the education of student nurses.	The efforts to reduce the incidence of CAUTI has successfully raised awareness about the issue, and to make healthcare workers think twice before catheterising patients unnecessarily.
Parry, M. F., Grant, B. and Sestovic, M. (2013)	Successful Reduction in Catheter-Associated Urinary Tract Infections: Focus On Nurse-Directed Catheter Removal	Experimental study, randomised controlled trial (Level I, Quality A)	To see whether the implementation of a nurse-directed catheter removal protocol in a 300 bed community hospital is successful in reducing catheter utilisation rates, thus reducing CAUTI rates.	A 50% hospital wide reduction in catheter use was achieved, and an overall 70% reduction in CAUTIs over a 36 month period.
Fox, C., Wavra, T., Ash Drake, D., Mulligan, D., Pacheco Bennett, Y., Nelson, C., Kirkwood, P., Jones, L. and Bader, M. K. (2015)	Use of a Patient Hand Hygiene Protocol to Reduce Hospital-Acquired Infections and Improve Nurses' Hand Washing	Experimental study, randomised controlled trial (Level I, Quality A)	To investigate a new patient hand hygiene protocol designed to reduce hospital-acquired infection rates and improve nurses' hand-washing compliance in an intensive care unit.	The implementation of a hand washing protocol in an intensive care unit was associated with the reduction of hospital acquired infections, including CAUTIs. The protocol not only included nurses hand washing, but the washing of patients' hands three times daily.